Workplace Electrical Safety Guidance Document

Revision 3.1

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Annexes

1 Scope

1.1 General

This document covers safety-related work practices and procedures to protect workers from electrical hazards.

This document applies to all PotashCorp employees, visitors and contractors.

1.2 Policy

Electrical conductors and circuit parts shall be placed into an electrically safe work condition before work is done on or near those conductors or parts unless:

(a) the work is infeasible in a de-energized state or;
(b) it can be demonstrated that de-energizing introduces additional or increased hazards.

Work that is infeasible in a de-energized state is limited to voltage and current measurements, troubleshooting and diagnostic testing such as thermography that cannot be performed unless the electrical conductor or circuit part is energized.

Exceptions to working on energized conductors or circuit parts (excluding the tasks mentioned above) are only permitted after obtaining an Energized Electrical Work Permit (Annex A) with approval from a Superintendent, Safety Supervisor, and the electrical supervisor.

Note: *Energized parts that operate at **50 volts** or less to ground are not required to be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.*

1.3 Incident Reporting

As per the PotashCorp SHE Guide for Managers all accidents/incidents shall be reported to management. This includes electrically associated incidents such as injuries, shock, arc flash, and electrical equipment damage. Further to that anyone who receives an electrical shock shall be provided with medical attention. Reporting (flash and taproot if necessary) shall be done in accordance with the requirements of the PotashCorp SHE Guide for Managers.

1.4 Auditing

The electrical safety program shall be audited to ensure that the principles and procedures of the program are being followed. Audits may be used to,

- Evaluate the effectiveness of the electrical safety program
- Evaluate the performance of workers with regard to safety procedures (in addition to site audits Key Procedure Audits may be performed on a regular basis)
- Evaluate the status of safety related activities such as documentation, training, communication, etc.
- Recommend actions for improvement.

In addition to site audits, key procedure audits shall be performed on all qualified workers to ensure compliance with the program.

Note: *See Annex D for example forms used in a typical site audit.*

2 Definitions

Abnormal Condition – any state a component, or piece of equipment, may be in that deviates from an experienced users judgment of a "normal condition". In the case of electrical equipment, examples of an abnormal condition could be: exposed conductors or circuit parts due to cover removed/doors open, human interaction, compromising gap between exposed conductors or parts, insulation failure, failure due to incorrect operation, failure due to lack of maintenance, failure due to environmental conditions, failing to follow an approved procedure, bypassing safety interlocks, infant mortality, changes in operating characteristics, incorrect over current protection (e.g. breaker or fuse) installed, and using an incorrect tool for the work task.

Arc Flash Hazard – a dangerous condition associated with the possible release of energy caused by an electric arc. An arc flash hazard can exist when energized electrical conductors or circuit parts are exposed or are within equipment in a guarded or enclosed condition, if a person is interacting with the equipment in a manner that could cause an electric arc. Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard.

Arc Flash Hazard Analysis – a study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of PPE.

Arc Flash Protection Boundary – when an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur.

Arc Flash Suit – a complete FR clothing and equipment system that covers the entire body, except for the hands and feet. This includes pants, jacket, and bee-keeper-type hood fitted with a face shield.

Arc Rating – the maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to break-open or at the onset of a second-degree skin burn (ASTM F 1506-08). Arc rating is normally expressed in cal/cm^2.

Note: *When the Arc Thermal Performance Value (ATPV) of the material cannot be determined due to breakopen, the arc rating is determined by measuring the Breakopen Threshold Energy (EBT) according to Test Method F 1959. When the arc rating represents the Arc Thermal Performance Value, it is*

indicated as arc rating (ATPV); when representing the Breakopen Threshold Energy, it is indicated as arc rating (EBT).

Arc Thermal Performance Value (ATPV) – the incident energy on a fabric or material that results in sufficient heat transfer through the fabric or material to cause the onset of a second-degree burn based on the Stoll curve (ASTM 1506-08).

Breakopen Threshold Energy (EBT) – the average of the five highest incident energy exposure values below the Stoll curve where the specimens do not exhibit break-open. EBT is reported when ATPV cannot be measured due to FR fabric break-open.

Note: *Break-open is a material response evidenced by the formation of one or more holes in the innermost layer of flame-resistant material that would allow flame to pass through the material.*

Backfeed – where equipment may become energized by a power source (e.g. capacitors, standby generators, UPS systems, etc.) on the secondary side of the prime electrical supply(s).

De-energized – free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

Disconnecting Means – a suitable load-rated device used for physical and electrical separation of a circuit's source of electrical energy. There may be cases in which there are more than one disconnection means.

Electrical Equipment – any apparatus, appliance, device, instrument, fitting, fixture, machinery, material, or thing used in or for, or capable of being used in or for, the generation, transformation, transmission, distribution, supply, or utilization of electric power or energy, including, e.g., any assemblage or combination of materials or things that is used, or capable of being used or adapted, to serve or perform any particular purpose or function when connected to an electrical installation, even if part or all of such materials or things are mechanical, metallic, or non-electric in origin.

Electrical Hazard – a dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or blast.

Electrically Safe Work Condition – a state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary.

Energized – electrically connected to or having a source of voltage.

Exposed – capable of being touched or approached nearer than a safe distance. It is applied to parts that are not suitably guarded, isolated, or insulated.

Flame-Resistant (FR) – the property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source.

Note: *Flame resistance can be an inherent property of a material, or it can be imparted by a specific treatment applied to the material.*

Ground-fault circuit interrupter (GFCI) – a device whose function is to interrupt, within a predetermined time, the electrical circuit to a load when a current to ground exceeds a predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

Note: *Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. A Class B ground-fault circuit interrupter will trip on greater than 20 mA current to ground.*

Grounded – intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the build-up of voltages that may result in undue hazards to connected equipment or to persons.

Grounds, Temporary Protective – intentional temporary connections added between the de-energized phase conductors and the ground conductors at the point of work to ensure a zero potential, safer work environment.

Guarded – covered, shielded, fenced, enclosed, or otherwise protected by suitable covers, casings barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.

Hazard – see Arc Flash Hazard, Electrical Hazard, and Shock Hazard for definitions of each.

Incident Energy – the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units used to measure incident energy is calories per centimeter squared (cal/cm^2).

Insulated – separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

Note: *When an object is said to be insulated, it is understood to be insulated for the conditions to which it is normally subject. Otherwise it is considered to be uninsulated.*

Isolate – physically disconnected or separate from sources of dynamic energy by approved devices or procedures.

Limited Approach Boundary – an approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Note: *The limited approach boundary is to be crossed only by an electrically qualified person and is not to be crossed by a task qualified person unless advised of the hazards and continuously escorted by an electrically qualified person.*

Non-exposed – No electrical conductors showing, either insulated or having a barrier so that no person or tool can come in contact with.

Normal operation – operating equipment in the manner it was intended for.

Prohibited Approach Boundary – an approach limit at a distance from an exposed energized conductor or circuit part within which work is considered the same as making contact with that conductor or part.

Note: *Only voltage rated tools and probes are permitted to cross the prohibited approach boundary; at no time may any part of the employee's body cross the prohibited approach boundary.*

Qualified Person

(a) Electrical – a person who has skills and knowledge related to the construction and operation of the electrical equipment and installations to be worked on and has received safety training to recognize and avoid the hazards involved.

(b) Task – a person who has the knowledge related to the operation of the electrical equipment and has received safety training to recognize and avoid the hazards involved.

Note: *For more information see CSA Z462-08 Section 4.1.6.4.2.*

Restricted Approach Boundary – an approach limit at a distance from an exposed energized conductor or circuit part within which there is an

increased risk of shock requiring the use of shock protection techniques and equipment when crossed, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

Note: *Shock protection techniques, equipment and PPE must be used when crossing the restricted approach boundary.*

Shock Hazard – a dangerous condition associated with the possible release of energy caused by contact or approach to exposed energized conductors or circuit parts.

Standard Issue Clothing – PPE available for distribution to PCS employees that provides appropriate and adequate protection for daily activities and tasks. The minimum Arc Rating for standard issue clothing shall be 8 cal/cm^2.

Step Potential – a ground potential gradient difference that can cause current flow from foot to foot through the body.

Total system arc rating – the rating obtained when all clothing layers worn by a worker are tested as a multi-layer sample in accordance with ASTM F 1959. An example of a clothing system is an FR coverall worn over an FR shirt and FR pants. For this two-layer FR clothing system, the arc rating is typically greater than the sum of the two arc thermal performance value (APTV) ratings.

Note: *Total system arc rating <u>cannot</u> be determined by adding the arc ratings of the individual layers. Multi-layer systems must be tested to the ASTM F 1959 standard.*

Touch Potential – a ground potential gradient difference that can cause current flow from hand to hand or hand to foot through the body.

Voltage

(a) Extra-Low – any voltage up to 50 volts.
(b) Low – any voltage from 50 to 750 volts inclusive.
(c) High – any voltage above 750 volts.
(d) Nominal – a nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/208 volts, 480 volts, 600 volts, etc.).

Worker In Charge – when working in a group of two or more, one qualified person shall represent the worker in charge.

Working on Energized Conductors or Circuit Parts – work that is performed in the limited approach boundary where the possibility of induced voltages or stored electrical energy exists. Any work within the limited approach boundary with a voltage greater than or equal to 50 V is considered to be working on energized conductors and circuit parts.

3 Responsibility/Authority

3.1 Managers/Supervisors

Managers and Supervisors have the primary responsibility for implementation of the PotashCorp Workplace Electrical Safety program in accordance with the CSA Z462 standard. That responsibility includes,

(a) Conducting workplace hazard analysis to determine the presence of hazards which necessitate the use of PPE.
(b) Provide the personal protective equipment required by this program.
(c) Provide training for employees in the safety-related work practices contained in this program.
(d) Maintaining records of rubber insulating gloves, relay settings, all changes to relay settings, employee training, Arc Flash energy levels and Arc Flash/Shock Protection boundaries.
(e) Ensuring that appropriate PPE is being properly used and that the protection boundaries are being observed by all employees.
(f) Ensuring that soiled or damaged PPE is removed from service and not used.
(g) Ensuring that all required testing of protective devices and PPE is conducted, and that labelling of equipment is kept current.
(h) Audit (utilizing internal/external resources) and ensure compliance with the safety related work practices required by this program.

3.2 Employees

Employees are responsible for following the requirements of the PotashCorp Workplace Electrical Safety program in accordance with the CSA Z462 standard. That responsibility includes,

Electrically Qualified

(a) Wearing the appropriate PPE as indicated on the equipment labels.
(b) Marking the Arc Flash/Limited Approach protection boundary when working on equipment considered to be live.
(c) Inspection of PPE to ensure that it has not been compromised.
(d) Attending required training sessions.
(e) Informing their supervisor of the need to repair or replace PPE.
(f) Escort non-Electrically qualified employees though protection boundaries using appropriate PPE if required.

Task Qualified

(a) Attending the required training sessions.
(b) Observing the Hazard analysis Protection Boundaries.
(c) Wearing the appropriate PPE suitable for the task.

3.3 Steering Committee

A Steering Committee shall be formed to,

(a) Maintain the Workplace Electrical Safety Guidance Document.
(b) Stay abreast of standard, codes, or regulations associated with electrical safety.
(c) Participate in sites audits of the electrical safety program.
(d) Be actively involved in the implementation and interpretation of the electrical safety program.

The Steering Committee shall consist of,

(a) Facility representation (Surface/Underground operations)
(b) Safety and Health representation
(c) A Corporate representative with knowledge in electrical safety practices and standards.

4 Training

4.1 General

Training on electrical safety procedures related to arc-flash/shock hazards shall be given to all employees. The level of training will depend on the exposure to electrical hazards. Two categories shall be given for levels of training. Employees not exposed to electrical hazards will be given the task qualified training program and employees exposed to electrical hazards (electrical workers) will be given the qualified training program.

Task qualified persons shall be trained to recognize electrical hazards to which they may be exposed and the proper methods of avoiding the hazard.

Electrically Qualified persons shall be trained to work within the hazard working boundaries.

4.2 Safety Training

Workers shall be trained to understand the specific hazards associated with electrical energy in the tasks they perform, as follows:

(a) they shall be trained in the safety-related work practices and procedural requirements necessary to provide protection from the electrical hazards associated with their job or task assignments; and
(b) they shall be trained to identify and understand the relationship between electrical hazards and possible injury.

4.3 Types of Training

The training required shall be classroom and displayed practical as well as on-the-job training. The training provided should be in accordance with the tasks undertaken and the potential hazards that will be encountered.

4.4 Qualified (Electrical) Persons Specific Training

Qualified (electrical) persons shall be trained in and knowledgeable about the construction and operation of equipment or a specific work method and trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method. The following requirements shall also apply:

(a) Such workers shall be familiar with the proper use of the applicable special precautionary techniques and personal protective equipment, including arc flash, insulating and shielding materials, and insulated tools and test equipment.

Note: *A person can be qualified for certain tasks and in the use of certain equipment and methods and yet be unqualified for other tasks and in the use of other equipment and methods.*

(b) Electrical workers permitted to work within the limited approach boundary of exposed energized electrical conductors and circuit parts operating at 50 V or more shall, at a minimum, be additionally trained in the following:

- the skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment;
- the skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts;
- the approach distances and the corresponding voltages to which the qualified person will be exposed; and
- the decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.
- knowledge and interpretation of CSA Z462-08 Table 4 for various jobs/tasks performed.

(c) A worker who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those duties.

(d) When a task has not been performed by a worker for more than a year, the worker shall be retrained in the task before performing it again.

(e) Workers shall be trained to select an appropriate voltage detector and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the worker to understand all of the limitations of every voltage-detecting device that might be used.
(f) Electrically Qualified workers who undertake high voltage (750 volts or greater) work shall receive approved training in high voltage safety.

4.5 Task Qualified Persons Specific Training

Task qualified persons shall be trained to recognize electrical hazards to which they may be exposed and the proper methods of avoiding the hazard.

4.6 Retraining

A qualified (electrical) person shall receive annual training to maintain an appropriate level of awareness and receive additional training if

(a) supervision or annual inspections indicate that the worker is not complying with the safety-related work practices;
(b) new technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that the worker would normally use; or
(c) the worker needs to employ safety-related work practices that are not normally used during his or her regular job duties.

4.7 Training Documentation

To successfully complete Qualified or Task Qualified Persons Specific Training each person will be required to take and pass a test on the electrical safety procedures related to arc flash/shock hazards. This test must be kept on file as documented proof that the individual has understood the electrical safety procedures per the records retention procedure.

4.8 Emergency Procedures

Qualified (electrical) persons exposed to energized electrical conductors or circuit parts shall be trained in methods of release of victims from contact with exposed energized conductors or circuit parts. The qualified (electrical) person must know that the first action in responding to an electrical contact incident must be to remove the source of the electricity.

Qualified (electrical) persons shall regularly receive training in methods of first aid and emergency procedures, e.g., each worker must know the procedure necessary to reach emergency assistance. Training of qualified (electrical) persons in approved methods of resuscitation, including cardiopulmonary resuscitation, shall be verified by the employer as required.

5 Electrical Job Briefing

5.1 General

Before starting each job, the worker in charge shall conduct a job briefing with the workers involved. The briefing shall cover such subjects as hazards associated with the job, work procedures involved, special precautions, energy source controls, and personal protective equipment requirements.

5.2 Repetitive or Similar Tasks

If the work or operations to be performed during the workday or shift are repetitive or similar, at least one job briefing shall be conducted before the start of the first job of the day or shift. Additional job briefings shall be held if significant changes that might affect the safety of workers occur during the course of the work.

5.3 Routine Work

A brief discussion shall be satisfactory if the work involved is routine and if the worker, by virtue of training and experience, can reasonably be expected to recognize and avoid the hazards involved in the job.

5.4 Job Briefing Form

An Electrical Job Briefing Form (Annex B) must be completed if the work is complicated or particularly hazardous; or worker cannot be expected to recognize and avoid the hazards involved in the job.

Note: *Documentation of Job Briefing Forms shall be maintained as per PotashCorp Record Retention policy.*

5.5 Electrical Shock and Arc Flash Hazard Pre-Check Sheet

Before performing any electrical work, Electrically Qualified Workers are required to complete an “Electrical Shock and Arc Flash Hazard Pre-Check Sheet” (see Annex G for a sample form). Pre-Check sheets ensure a complete assessment of the job has been undertaken and that all necessary PPE and tools are in adequate condition to perform the work.

In addition, Pre-Check sheets provide documentation that the Workplace Electrical Safety Program has been followed.

5.6 Switching Sequence Form

Complete the Switching Sequence Form (see Annex B for a sample form) whenever complex switching/grounding is involved in performing a lockout procedure. Include the necessary steps both to isolate and de-energize the equipment as well as to re-energize the equipment.

6 Establishing an Electrically Safe Work Condition

6.1 General

All electrical circuit conductors and circuit parts shall be considered energized until an Electrically Safe Work Condition is established.

The following process achieves an electrically safe work condition,

(a) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
(b) After properly interrupting the load current, open the disconnecting device(s) for each source.
(c) Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that draw-out-type circuit breakers are withdrawn to the fully disconnected position.
(d) Apply lockout devices in accordance with a documented and established policy.
(e) Test before touch. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify that they are de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.
(f) Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it can be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground-connecting devices rated for the available fault duty.

6.2 Electrical Lockout Principles

Only qualified (electrical) persons shall perform *electrical* lockout procedures. Electrical lockout is a lockout for the purpose of doing electrical service or repair. This is not to be mistaken for a general lockout which may be performed by task qualified persons in accordance with site specific lockout procedures.

An electrically safe work condition must be established before servicing or repairing electrical equipment that could produce injury from the energy release.

6.3 An Electrically Safe Working Condition – Removing PPE

After an Electrically Safe Working Condition has been established to ensure there is no reasonable arc flash or shock hazard present the electrician may dress-down to the standard issue level of PPE to complete the task.

Once the task is completed the electrician shall dress to the appropriate level of PPE to remove any guards and re-energize.

Example 1: Reducing PPE to standard issue after achieving an electrically safe work condition

Electrician changing a component (located on the secondary side of the main disconnect) in a 600-V MCC bucket after an "Electrically Safe Work Condition" has been established inside the bucket.

Note: *Main MCC bus remains energized.*

In this example the worker must confirm the following conditions are established, and conform to restricted work activities as identified below before reducing PPE,

- Confirm an "Electrically Safe Work Condition" has been established inside the MCC bucket.

  Note: *in order to confirm an electrically safe work condition the electrically qualified person must dress to the cal level indicated on the equipment.*

- Confirm "no" energized parts are exposed (Example: No exposed energized parts on the line side of Main Disconnect or Breaker). In the event that permanent guards (such as finger guards) are inadequate, properly classed insulating blankets may be used to barricade energized parts if necessary.
- Restricted work activity only! Activities that could possibly bring you into contact with energized parts shall not be permitted. For example, activities such as drilling and fishing are not permitted.

6.4 Anticipating Equipment Failure

When there is evidence that electric equipment could fail and the failure could cause injuries, the equipment shall be de-energized. Until the equipment is de-energized or repaired, employees shall be protected from hazards associated with the impending failure of the equipment.

6.5 Safe Installations

Engineering efforts shall be made to minimize arc flash incident energy levels, such as engineering studies to change protective relay settings, equipment replacement or upgrading, etc.

An arc flash analysis shall be performed prior to the installation of new equipment to determine any arc flash hazards that may exist. Where practicable all new equipment shall be arc rated as specified by the manufacturer. In addition, all new equipment will meet the requirements set out in the CEC Part I and the CSA M421, “Use of Electricity in Mines”.

7 Exposed Energized Conductors or Circuit Parts

7.1 Prohibited and Permitted Activities

Prohibited Activities

(a) Other than work that is infeasible in a de-energized state or as listed below in Permitted Activities, work on or near exposed energized conductors or circuit parts is prohibited.
(b) In no cases shall work be performed where the incident energy exceeds 40 cal/cm^2.
(c) Any activity expressly prohibited by the equipment manufacturer shall not be performed on that equipment.

Permitted Activities

(a) Only qualified (electrical) workers shall be permitted to perform work on or near energized parts.
(b) Only tasks such as; voltage or current measurements, performing diagnostics (such as infra-red thermography or system data collection, commissioning of equipment, troubleshooting, or activities required to place the equipment in an electrically safe condition shall be permitted to be performed on or near energized parts.
(c) Permitted activities on or near energized parts shall be done only after an electrical hazard analysis has been completed and appropriate safe work practices, tools and personal protective equipment suitable for the conditions and the voltage level involved and in accordance with this program are provided and used.
(d) The work practices shall protect persons from contact with the energized circuit parts directly with any part of their body or indirectly through some other conductive object.
(e) Subject to proper work practices, work can be performed on de-energized portions of equipment while other parts of the equipment are energized if it can be demonstrated that de-energizing all of the equipment introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Example: Where work is performed in a de-energized section of switchgear and the adjacent section of switchgear has exposed energized parts, the proper work practice would be to guard the opening to the energized section with a rubber blanket rated for the voltage of the energized parts.

7.2 Energized Electrical Work Permit

For work on energized electrical conductors or circuit parts that are not placed in an electrically safe work condition the work to be performed shall be considered energized electrical work and shall be performed only after a Energized Electrical Work Permit (see Annex A for a sample Energized Electrical Work Permit) specific to the work has been obtained by the workers. Energized electrical work permits must be kept on file as determined by the document retention policy.

Required information on energized electrical work permit is:

- Permit number
- Description of circuit/equipment
- Job location
- Description of work to be done
- Justification of why the circuit/equipment cannot be de-energized or work deferred until the next schedule outage
- Description of safe work practices to be employed
- Results of the shock hazard analysis
- Determination of shock protection PPE
- Determination of the shock protection boundaries
- Results of the Arc Flash hazard analysis
- Determination of Arc Flash PPE
- Determination of the Arc Flash Protection Boundary
- Evidence of completion of a job briefing including discussion of any job related hazards and names of persons briefed.
- Means employed to restrict the access of unqualified persons
- Approval signatures (management or safety officer)

Note: *Annual Energized Electrical Work permits may be issued for routine work performed on low voltage equipment (i.e. PLC/DCS I/O cards, lighting (under 347V, etc.). On expiration of the annual permit routine work must be reassessed to ensure the validity of the annual Energized Electrical Work permit.*

7.3 Exemptions to Energized Electrical Work Permit

Work performed by qualified persons within the limited approach boundary of energized electrical conductors or circuit parts related to tasks such as testing, troubleshooting, diagnostics, and voltage measuring may be performed without an energized electrical work permit, provided that appropriate safe work practices and personal protective equipment are provided and used.

7.4 Appropriate Lighting

Employees shall not enter a space containing energized conductors or circuit parts, unless lighting is provided that enables the employees to perform the work safely. Where lack of lighting or an obstruction precludes observation of the work to be performed, employees shall not perform any task near energized conductors or circuit parts or where an electrical hazard exists.

7.5 Small or Enclosed Work Spaces

When working in a small or enclosed space (such as a manhole, vault, or small electrical room) where an electrical hazard exists, employees shall use protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with energized conductors or circuit parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized conductors or circuit parts.

7.6 Removal of Bolted Covers on Energized Equipment

(a) Removal of bolted covers from high voltage (greater than 750 volts) energized equipment is prohibited. Exception: High voltage equipment bolted covers are permitted to be removed during a lockout procedure in order to test isolated conductors provided documented safe work procedures are followed.
(b) Removal of bolted covers from energized low voltage equipment is permitted only if documented safe work procedures are followed.

7.7 Working Near Un-insulated Overhead Lines

(a) **Uninsulated and Energized.** Where work is performed in locations containing uninsulated energized overhead lines that are not guarded or isolated, precautions shall be taken to prevent workers from contacting such lines directly with any unguarded parts of their body or indirectly through conductive materials, tools, or equipment. Where the work to be performed is such that contact with uninsulated energized overhead lines is possible, the lines shall be de-energized and visibly grounded at the point of work, or suitably guarded.

(b) **De-energizing or Guarding.** If the lines are to be de-energized, arrangements shall be made with the person or organization that operates or controls the lines to de-energize them and visibly ground them at the point of work. If arrangements are made to use protective measures, such as guarding, isolating, or insulation, these precautions shall prevent each worker from contacting such lines directly with any part of his or her body or indirectly through conductive materials, tools, or equipment.

(c) **Approach Distances for Task Qualified Persons.** When workers without electrical training are working on the ground or in an elevated position near overhead lines, the location shall be such that the employee and the longest conductive object the employee might contact cannot come closer to any unguarded, energized overhead power line than the Limited Approach Boundary or as specified in Provincial Regulations, whichever is furthest.

Note: *Objects that are not insulated for the voltage involved should be considered to be conductive.*

Table 1
Minimum Approach Distance to Overhead Lines

PHASE TO PHASE VOLTAGE	TASK QUALIFIED DISTANCE	ELECTRICALLY QUALIFIED DISTANCE
Up to 750 V	3 m	0.6 m
750 V – 15 kV	3 m	0.9 m
16 kV – 25 kV	3 m	1.2 m
26 kV – 69 kV	4.6 m	1.5 m
70 kV – 138 kV	4.6 m	1.8 m
139 kV – 230 kV	6.1 m	2.1 m

7.8 Safety Interlocks

Only qualified (electrical) workers following the requirements for working inside the Restricted Approach Boundary shall be permitted to defeat or bypass an electrical safety interlock over which that person has sole control, and then, only temporarily while that person is working on the equipment. The safety interlock system shall be returned to its operable condition when the work is completed.

8 Reclosing Circuits after Protective Device Operation (Faults/Trips)

8.1 General

After a circuit is de-energized by a circuit protective device, the circuit shall not be manually re-energized until it has been determined that the equipment and circuit can be safely energized.

The repetitive manual reclosing of circuit breakers or re-energizing circuits through replaced fuses shall be prohibited.

When it is determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, examination of the circuit or connected equipment shall not be required before the circuit is re-energized.

8.2 Operations Policy/Procedures

Overload – An overload occurs when equipment is operated in excess of normal, full load rating, or a conductor is operated in excess of full load ampacity that, when it persists for a sufficient length of time, will cause damage or dangerous overheating**.** If the operating personnel can safely determine the cause of the overload and rectify the cause, no electrical assistance is required (provided the overload reset button is not located in an enclosure where the worker may be exposed to energized electrical conductors or circuit parts). Assistance from an Electrically Qualified worker may be required to verify the overload condition or to determine if the protective equipment is faulty**.**

Under-Voltage – an under-voltage condition occurs when equipment is operated at a voltage significantly below the equipment's full rated voltage. Assistance from an Electrically Qualified worker may be required to determine the cause of the under-voltage.

Loss of Pilot – Loss of the pilot circuit voltage may occur due to cable/connection failure. It may also be caused by a zener diode component failure. Loss of the pilot circuit voltage will require assistance from an Electrically Qualified worker.

Overcurrent – an overcurrent trip may occur when the current is in excess of the rated current of the equipment or the ampacity of a conductor. It can result from an overload, short-circuit, or ground-fault. Trips resulting from overcurrent conditions will require the assistance of an Electrically Qualified worker to determine the source of the overcurrent before resetting.

Note: *A current in excess of rating can be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.*

8.3 Specialized Equipment

Each site will be responsible for development of site-specific procedures for dealing with specialized equipment.

8.4 Surface/Underground Communications

Each site will be responsible for development of site-specific policies to ensure that proper communications are in place, when electrical problems occur that involve both the surface and underground operations.

9 Shock Hazard Analysis

9.1 When Required

If energized conductors or circuit parts to which an employee may be exposed are not placed in an electrically safe work condition, a shock hazard analysis shall be performed to determine what safety related work practices are required to protect the employee. The shock hazard analysis shall be included in the job briefing form when required.

Note: *Refer to CSA Z462-08 4.1.8.2.2.*

9.2 Purpose of Shock Hazard Analysis

A shock hazard analysis shall determine,

(a) the voltage to which personnel will be exposed;
(b) boundary requirements;
(c) safety related work practices; and
(d) personal protective equipment necessary in order to eliminate the possibility of electric shock to personnel.

9.3 Shock Protection Boundaries

The shock protection boundaries, identified as Limited, Restricted, and Prohibited Approach Boundaries, are applicable to the situation in which approaching personnel are exposed to energized conductors or circuit parts.

Figure 1
Approach Boundaries

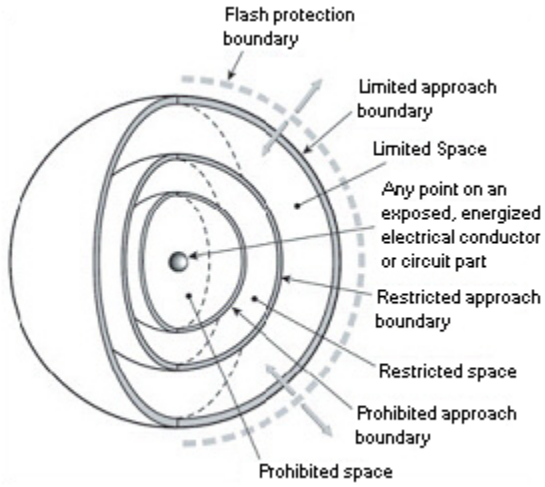


Table 1
Approach boundaries to energized electrical conductors or circuit parts for shock protection (distance from energized electrical conductors or circuit part to worker)

(1) NOMINAL SYSTEM VOLTAGE RANGE, PHASE TO PHASE	(2) LIMITED APPROACH BOUNDARY (EXPOSED MOVABLE CONDUCTOR)	(3) LIMITED APPROACH BOUNDARY (EXPOSED FIXED CIRCUIT PART)	(4) RESTRICTED APPROACH BOUNDARY	(5) PROHIBITED APPROACHED BOUNDARY
Less than 30 V	not specified	not specified	not specified	not specified
30-300 V	3.05m (10 ft 0 in)	1.07m (3 ft 6 in)	avoid contact	avoid contact
301-750 V	3.05m (10 ft 0 in)	1.07m (3 ft 6 in)	304.8mm (1 ft 0 in)	25.4mm (0 ft 1 in)
751 -15 kV	3.05m (10 ft 0 in)	1.53m (5 ft 0 in)	660.4mm (2 ft 2 in)	177.8mm (0 ft 7 in)
15.1 – 36 kV	3.05m (10 ft 0 in)	1.83m (6 ft 0 in)	787.4mm (2 ft 7 in)	254mm (0 ft 10 in)
361. – 46 kV	3.05m (10 ft 0 in)	2.44m (8 ft 0 in)	838.2mm (2 ft 9 in)	431.8mm (1 ft 5 in)
46.1 – 72.5 kV	3.05m (10 ft 0 in)	2.44m (8 ft 0 in)	991mm (3 ft 3 in)	660mm (2 ft 2 in)
72.6 – 121 kV	3.25m (10 ft 8 in)	2.44m (8 ft 0 in)	1.02m (3 ft 4 in)	838mm (2 ft 9 in)
138 – 145 kV	3.36m (11 ft0 in)	3.05m (10ft 0in)	1.17m (3 ft 10 in)	1.02m (3 ft 4 in)
161 – 169 kV	3.56m (11 ft 8 in)	3.56m (11 ft 8 in)	1.29m (4 ft 3 in)	1.14m (3 ft 9 in)
230 - 242 kV	3.97m (13 ft 0 in)	3.97m (13 ft 0 in)	1.73m (5 ft 8 in)	1.57m (5 ft 2 in)
345 – 362 kV	4.68m (15 ft 4 in)	4.68m (15 ft 4 in)	2.79m (9 ft 2 in)	2.64m (8 ft 8 in)
500 – 600 kV	5.8m (19 ft 0 in)	5.8m (19 ft 0 in)	3.61m (11 ft 10 in)	3.45m (11 ft 4 in)
765 – 800 kV	7.24m (23 ft 9 in)	7.24m (23 ft 9 in)	4.85m (15 ft 11 in)	4.70m (15 ft 5 in)

Note: *Refer to CSA Z462-08 Annex C for additional information.*

9.4 Approach to Exposed Energized Conductors or Circuit Parts

Note: *Refer to CSA Z462-08 4.3.2.3 for more information*

No person shall approach or take any conductive object closer to exposed energized conductors or circuit parts than the Restricted Approach Boundary described in Table 1, unless:

(a) The qualified person is insulated or guarded from the energized conductors or circuit parts, and no un-insulated part of the person's body crosses the Prohibited Approach Boundary set forth in Table 1, or
(b) The energized conductors or circuit part is insulated from the person and from any other conductive object at a different potential

9.5 Working Close to the Limited Approach Boundary (Task Qualified Persons)

Task qualified persons working close to the Limited Approach Boundary shall be advised of the electrical hazard and warned to stay outside of the Limited Approach Boundary. Barriers shall be erected as necessary to ensure the safety of unqualified persons.

9.6 Entering the Limited Approach Boundary (Task Qualified Persons)

Where there is a need for a task qualified person(s) to cross the Limited Approach Boundary, a qualified (electrical) person shall advise him or her of the possible hazards and continuously escort the task qualified person(s) while inside the Limited Approach Boundary. Under no circumstance shall the escorted task qualified person(s) be permitted to cross the Restricted Approach Boundary.

Note: *Refer to CSA Z462-08 4.3.2.4.*

10 Arc Flash Hazard Analysis

10.1 When Required

An arc flash hazard analysis shall be done in order to protect personnel whenever there is the possibility of being injured by an arc flash.

Note: *Local disconnects not labelled with an incident energy level will be assumed to be the same level as the MCC they are fed from*

10.2 When Not Required

An arc flash hazard analysis shall not be required when ***all 3*** of the following conditions are met:

(a) circuit is rated 240V or less;
(b) circuit is supplied by one transformer; and
(c) transformer supplying the circuit is rated less than 125kVA

10.3 Purpose of Arc Flash Hazard Analysis

The analysis shall determine the Arc Flash Protection Boundary and the Personal Protective Equipment that personnel within the arc flash protection boundary shall use.

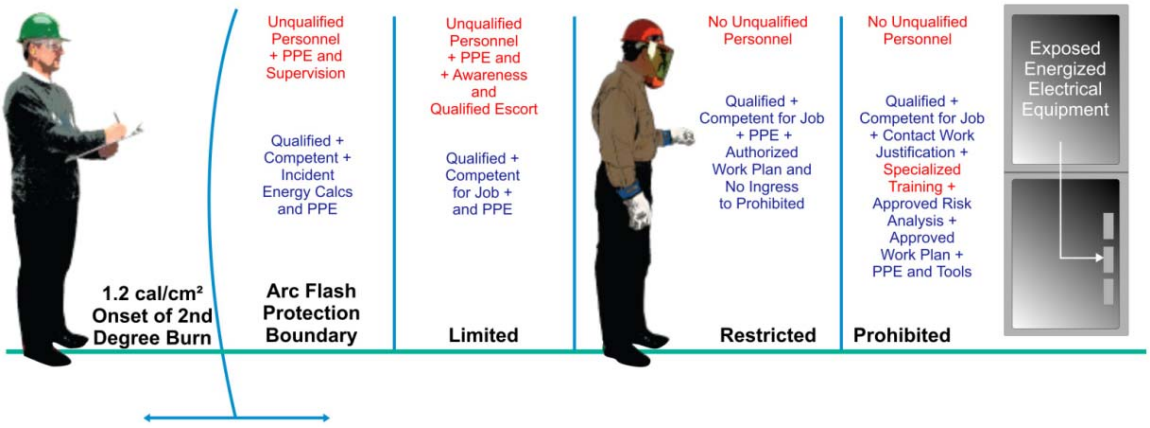
Note: *A detailed incident energy analysis shall be conducted if Method 1 (see section 11.6) is used to determine the protective clothing and personal protective equipment for application with arc flash hazard analysis.*

10.4 Arc Flash Protection Boundary

The Arc Flash Protection Boundary is the distance from a prospective arc source at which the incident energy equals 1.2cal/cm^2 when an arc flash hazard exists. This is enough energy that a person could receive a second degree burn if an electrical arc flash were to occur.

All personnel not wearing appropriate PPE shall be kept away from the Arc Flash Protection Boundary.

Figure 1
Boundaries for Arc Flash Protection and Shock – Approach Limits



10.5 Selecting Protective Clothing and Personal Protective Equipment

When it has been determined that work will be preformed within the arc flash protection boundary a worker shall use the appropriate protective clothing and personal protective equipment determined by either the incident energy analysis method or the hazard/risk category method.

Note: *If available, the incident energy analysis must be used instead of using the hazard/risk category method.*

10.6 Method 1: Selection Based on Incident Energy Analysis

10.6.1 General

Where it has been determined that work will be performed within the Arc Flash Protection Boundary, the arc flash hazard analysis provides documentation for the incident energy exposure of the worker (in cal/cm^2).

The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed.

Personal protective equipment (PPE) shall be selected and used by the employee based on the incident energy exposure.

Arc rated (AR) PPE (clothing, face shields, hoods, etc.) shall have an arc rating that exceeds the anticipated incident energy exposure. Work shall

not be performed where the anticipated incident energy exceeds the arc rating of the employee's PPE.

Note: *When the incident energy is just equal to the arc rating of the AR PPE, there exists a 50% chance of second-degree burns. Second-degree burns are considered "just curable."*

10.6.2 Software and Settings to Determine Incident Energy Levels

- **Software:** ETAP, Electrical Power System Analysis Software.
- **Calculations:** IEEE Std 1584-2002, IEEE Guide for Performing Arc-Flash Hazard Calculations.
- **Default Settings.** Motor contribution per normal operating conditions (if it is suspected that incident energy levels would be higher in a no-load scenario calculations shall be run with alternative settings), buss and transformer differential, symmetrical RMS fault current, and through fault current for protective device.

Note: *Documentation of analysis shall be maintained as per PotashCorp Record Retention policy.*

10.6.3 Maintaining Arc Flash Analysis

The analysis shall be updated when a major modification or renovation takes place (examples: changed relay setting, changes to electrical system design, utility fault capacity changed, etc). The analysis shall be reviewed on a yearly basis, to account for changes in the electrical distribution system that could affect the results of the analysis.

10.7 Method 2: Selection Based on Hazard/Risk Categories

The Hazard/Risk Category Method may be used only if an Incident Energy Analysis has not been completed.

Note: *See Annex C - Arc Flash Hazard/Risk Analysis Tables*

Table 4
This table lists a number of common work tasks with a Hazard/Risk Category identified for each task. The assumed "normal" short circuit current capacities and fault clearing times for various tasks conducted on low-voltage (750 V, and below) equipment are listed in the notes to Table 4. For tasks not listed, or for power systems of greater than the assumed

"normal" short circuit current capacity or for longer than assumed fault clearing times, an incident energy analysis is required.

Notes:

(1) *The work tasks and protective equipment identified in Table 4 were identified by a task group of the NFPA-70E Technical Committee and the protective clothing and equipment selected was based on the collective experience of the task group. The protective clothing and equipment is generally based on determination of estimated exposure levels. In several cases where the risk of an arc flash incident is considered low, very low, or extremely low by the task group, the hazard/risk category number has been reduced by 1, 2, or 3 numbers, respectively. The collective experience of the task group is that in most cases closed doors do not provide enough protection to eliminate the need for PPE where the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out). Before accepting the risk assessment reduction assumptions of the task group the following and any other factors that could affect the reliable operation of the electrical equipment should be considered:*

- *The age and state of maintenance of the electrical equipment*
- *Wear due to the frequency of the operations (closing, opening, inserting, removing)*
- *Re-closing a circuit breaker or switch after it has interrupted an electrical fault*
- *The environment in which the equipment is located*

(2) *Both larger and smaller available short-circuit currents could result in higher available arc flash energies. If the available short-circuit current increases without a decrease in the opening time of the overcurrent protective device, the arc flash energy will increase. If the available short-circuit current decreases, resulting in a longer opening time for the overcurrent protective device, arc flash energies could also increase.*

Once the Hazard/Risk Category has been identified for a task or tasks; refer to Table 5 to determine the FR clothing and other protective equipment.

Table 5

This table lists the requirements for protective clothing and other protective equipment based on Hazard/Risk Category numbers 0 through 4. This clothing and equipment shall be used when working within the Arc Flash Protection Boundary.

Note: *Due to the explosive effect of some arc events, physical trauma injuries may occur. The PPE requirements of this do not provide protection against physical trauma.*

Table 6
This table lists examples of protective clothing systems and typical characteristics, including the degree of protection, for various clothing.

The protective clothing selected for the corresponding Hazard/Risk Category number determined from Table 4 (including associated notes) and the requirements of this program shall have an arc rating of at least the value listed in the last column of Table 6.

11 Electrical Specific PPE, Tools and Equipment

11.1 General

Employees, contractors and service providers working in areas where shock and arc flash hazards are present shall use protective equipment that is appropriate to the nature and severity of the hazard.

Workers performing tasks considered to be “normal operation of the equipment” require only standard issue PPE.

Tasks considered to be “normal operation of the equipment” include,

(1) Lockout of 480/600 V disconnect on MCC including field disconnect.
(2) Lockout of 480/600 V molded case, secondary breaker (i.e. non-main breaker).
(3) Resetting overload on a 480/600 V starter.
(4) Lockout of 4160 V starter (on disconnect only).
(5) Operating 4160 V borer disconnect.
(6) Operation of breakers and fused disconnects rated below 25 kV (this does not include operation under a fault condition).

Note: *operation of specific equipment may be limited to authorized personnel. Refer to site policy for listing of authorized personnel.*

Interacting with equipment in a manner that is not considered to be “normal operation of equipment” (i.e. resetting of a faulted breaker) or exposes the worker to an arc flash hazard will require PPE as specified by the arc flash analysis.

Note: *Annex F provides a detailed checklist of common questions to ask when determining the risk of an Arc Flash while performing a specific task.*

If the condition or status of the electrical equipment to be operated cannot be identified or is unknown, one of the following steps shall be taken,

(1) Inform his/her supervisor of the concern and reasons for the concern.
(2) Dress to the posted incident energy level on the equipment (worker must be trained and have access to PPE suitable for the task).
(3) Have an Electrically Qualified worker validate the condition or make it safe.

11.2 Personal Protective Equipment

11.2.1 General PPE

Head Protection - employees shall wear CSA Z94.1-1992 Class E Type I or Type 2 or ANSI Z89.1-1997 Class E Type I or Type II approved hard hat at all times within the Restricted Approach Boundary or Flash Protection Boundary – whichever is greater.

Face, Neck, and Chin Protection - employees shall wear non-conductive protective equipment for the face, neck, and chin with an arc rating suitable for the incident energy whenever there is a danger of injury from exposure to electric arcs or flashes or from flying objects resulting from electrical explosion. Eye protection (safety glasses or goggles) shall always be worn under face shields or hoods.

Eye Protection – employees shall wear CSA Z94.3 or ANSI Z87.1 approved protective equipment for the eyes whenever there is danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion. It is recommended that safety glasses shall have non-conductive frames when worn within the Restricted Approach Boundary.

Hearing Protection – employees shall wear hearing protection (ear canal inserts) wherever there is possible exposure to an electric arc flash hazard.

Body Protection – employees shall wear FR shirt and pants at all times with a minimum of 8 ATPV (Arc Thermal Performance Value). All clothing must be manufactured of materials with inherent protection rather than of chemically treated materials.

Hand and Arm Protection (Shock) – employees shall wear insulating rubber gloves with leather protectors at all times within the Restricted Approach Boundary.

The glove used shall be of a class appropriate for the voltage level and activity. See table below.

Table 1
Voltage Requirements for Rubber Electrical Protective Equipment

CLASS OF GLOVE	00	0	1	2	3	4
Maximum Use AC	500	1000	7500	17000	26500	36000

Voltage						
Maximum Use DC Voltage	750	1500	11250	25500	39750	54000

Hand and Arm Protection (Arc Flash) – employees shall wear leather or FR gloves whenever there is a danger of injury from exposure to electric arcs or flashes.

Note: *Heavy-duty leather (e.g., greater than 12 oz/yd2) gloves provide protection suitable up to 8.0 cal/cm^2. If rubber insulating gloves with leather protectors are required for shock protection, additional leather or arc-rated gloves shall not be required up to 50 cal/cm^2. During high arc flash exposures leather can shrink and cause a decrease in protection.*

Foot Protection – toe and shank protective (green patch) dielectric (ohm symbol) safety shoes or boots shall be worn at all times during field operations and in designated facility shop areas. Insulated soles shall not be used as primary electrical protection.

Arc Flash Suits – Arc Flash suit design shall permit easy and rapid removal by the wearer. The entire flash suit, including the hood's face shield, shall have an arc rating that is suitable for the arc flash exposure.

Note: *Lab Coat style Arc Flash Suits are not considered to be an acceptable form of PPE while performing work within the Arc Flash Boundary.*

11.2.2 Factors in Selecting Protective Clothing

Layering – layering of arc rated FR clothing is an effective approach to achieving a required arc rating.

The total system arc rating is the arc rating obtained when all clothing layers worn by a worker are tested as a multi-layer sample (in accordance with ASTM F 1959). An example of a clothing system is an arc rated coverall worn over arc rated shirt and pants.

Note: *The total system arc rating cannot be determined by adding the arc ratings of the individual layers.*

Outer Layers – garments worn as outer layers over FR clothing, such as jackets or rainwear, shall also be made from FR material.

Under-Layers – melting fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric under layers (underwear) next to the skin.

Note: *An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted.*

Coverage – clothing shall cover potentially exposed areas as completely as possible. Shirtsleeves shall be fastened at the wrists, and shirts and jackets shall be closed at the neck.

Fit – tight-fitting clothing shall be avoided. Loose- fitting clothing provides additional thermal insulation because of air spaces. FR apparel shall fit properly such that it does not interfere with the work task.

The following table gives examples of common PPE systems that may be used,

Table 2
Common PPE Systems

PPE SYSTEM	CAL/CM^2
4.5 oz Cotton	2
12 oz Cotton	4
7 oz 301 Indura UltraSoft Navy Blue	8.7
7 oz 301 Navy Blue, Cotton Underwear, Balaclava	10
9 oz 451 Indura Ultrasoft Royal Blue	12.4
9 oz Royal Blue and 7 oz 301 Navy Blue, 31 cal Hood	31
Cat 4 Jacket, Overalls and Hood	40

Table 3 illustrates the clothing requirements for qualified workers working on energized equipment.

Table 3
Clothing Requirements for Qualified Workers Working on Energized Equipment

REQUIRED RATING OF PPE (CAL/CM^2)	CLOTHING REQUIREMENTS
Up to 1.2	Non-melting, flammable material (i.e. untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight of at least 4.5 oz/yd^2, safety glasses, hard hat, leather gloves.
1.2 to 4	7 oz/yd^2 FR shirt and FR pants or FR coveralls or 12 oz/yd^2 cotton coveralls, hard hat, safety glasses,

	leather gloves, leather work shoes or boots.
4.1 to 8	7 oz/yd^2 FR shirt and FR pants or FR coveralls, arc rated face shield, hard hat, safety glasses, voltage rated gloves, leather gloves, leather work shoes or boots, hearing protection.
8.1 to 10	7 oz/yd2 FR shirt and FR pants plus 9 oz/yd2 FR coveralls, or 2 FR coveralls (7 oz/yd2 and 9 oz/yd2), or cotton underwear and FR rated clothing, arc rated face shield and balaclava or flash suit hood, hard hat, safety glasses, voltage rated gloves, leather gloves, leather work shoes or boots, hearing protection.
10.1 to 25	7 oz/yd2 FR shirt and FR pants plus 9 oz/yd2 FR coveralls or 2 FR coveralls (7 oz/yd2 and 9 oz/yd2) and flash suit hood or cotton underwear plus suitably rated flash suit, hard hat, safety glasses, voltage rated gloves, leather gloves, leather work shoes or boots, hearing protection.
25.1 to 40	Cotton underwear plus 40 cal flash suit, hard hat, safety glasses, flash suit hood, hearing protection, voltage rated gloves, leather gloves, leather work shoes or boots.

11.2.3 Care and Maintenance of Personal Protective Equipment

Protective equipment shall be maintained in a safe, reliable condition. The protective equipment shall be visually inspected before each use.

Work clothing or flash suits that are contaminated, or damaged to the extent their protective qualities are impaired, shall not be used. If AR clothing is repaired, the AR materials (including FR thread) used to manufacture the clothing shall be used to provide the repairs. Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.

Table 4
Electrical Specific PPE, Tools and Equipment Recommended Care, Use & Maintenance

PPE, TOOLS OR EQUIPMENT	CARE, USE AND MAINTENANCE
Hard Hat	▪ Do not paint hard hat as paint can cover up cracks/damage. ▪ Solvents and other harsh cleaners should be avoided. ▪ Use manufacturer's instructions for proper cleaning guidelines. ▪ If hard hat has expired remove from use.

	▪ Replace suspension as per manufacturer's requirements.
Safety Glasses & Arc Rated Face Shield or Arc Flash Hood and Hood Lens	▪ Mild soap or detergent and warm water are the best solution for cleaning safety glasses or lenses. ▪ Solvents should not be used. ▪ For special lenses such as those with an anti-fog coating, a standard lens cleaner or a solution of mild detergent and warm water may be used. ▪ For drying, a soft lint-free cloth is the best choice. ▪ To avoid scratches, a dry lens never should be cleaned with a paper towel or untreated paper. ▪ Check with manufacturer who may supply cleaning materials for their specific apparatus. ▪ Consider anti-fog solutions for winter use.
Rubber Insulating Line Hose and Covers	▪ Check for damage. ▪ Clean as required.
Rubber Insulating Mats	▪ Check for damage. ▪ Clean as required.
Rubber Insulating Blankets	▪ Check for damage. ▪ Clean as required.
Rubber Insulating Gloves	▪ Check to ensure rubber insulating gloves are date stamped with last test date and ensure current to within the last 6 months. ▪ Check to ensure size is appropriate. ▪ Ensure that leather protector is correct for the associated rubber insulating glove Class, that minimum distance between leather protector cuff and rubber insulating gloves cuff is acceptable. ▪ Complete an air test by rolling up the glove or using a glove inflator. Listen for any air leaks along the length of the glove. ▪ Thoroughly check the rubber insulating glove both visually and by feeling the surface of the rubber insulating glove for any damage. Look for abrasions, scratches, age cracks, cuts, hard spots, nicks, snags, ozone cracking, puncture, soft spots, tracking, any abnormal irregularity in the gloves which should have a smooth finish. ▪ Ensure gloves are stored in manufacturer's recommended storage bag or case. Store flat, do not store folded, creased, inside out or compressed. ▪ Store the gloves in storage bag with the glove openings down into the bag. ▪ Store the gloves in a cool, dry, and dark location. ▪ Do not store near large power generators or other sources of ozone. ▪ When stored inside trucks, keep in the storage bag, and away from windows, batteries, heat sources, fuel supplies or container. Glove bags should be hung. ▪ Wash the rubber insulating gloves as per

	manufacturer's requirements in mild soap and warm water not to exceed 71°C. ▪ Ensure leather protector gloves are not contaminated or damaged. The leather protector is required to protect the rubber insulating gloves from damage, and also provides arc flash protection which could be compromised if the leather is damaged or contaminated.
Leather Protectors	▪ Must be worn over the rubber insulating gloves. ▪ Should not be used alone for shock protection. ▪ Should not deform the shape of the rubber insulating gloves when worn. ▪ If they are used for any other purpose than with the rubber insulating gloves they cannot be re-used with the rubber insulating glove. ▪ Keep them clean from oil, grease, chemicals, and similar materials. ▪ Cannot be used if they have holes, are torn, are contaminated or other damage.
Rubber Insulating Sleeves	▪ Check for damage. ▪ Clean as required.
Dielectric Footwear	▪ Use a protective coating to make the footwear water-resistant. ▪ Repair and replace worn or defective footwear. ▪ Since an effective retest is not viable and recommended as per standard, dielectric footwear should not be considered as a primary protection against electrical shock.
Arc Rated Clothing	▪ Launder and repair arc rated (e.g. FR) clothing as per ASTM F 1449/NFPA 2112. ▪ Do not mix arc rated (e.g. FR) garments with items made of other materials in the same wash. ▪ Do not use bleaches, fabric softeners or other treatments unless recommended by the manufacturer. Use mild detergent only. ▪ Observe manufacturer's recommendation for laundering instructions. ▪ The PPE should not be washed in temperatures over 74°C or 165°F. ▪ For arc flash suits after washing, dry on low heat and remove immediately. Do not line dry. ▪ Car should be taken when putting on an arc flash suit, ensure you zip up all openings, close the Velcro collar and other Velcro straps are secured, and that the arc flash hood flaps are lying flat overtop of the jacket, do not tuck into the jacket.
Insulated and Insulating Hand Tools	▪ Store insulated hand tools separate from normal tools. ▪ Keep tools clean from contamination. ▪ Wash with mild soap in warm water. ▪ Store in separate tool box, hard case or wrap to

	protect the tools from damage to insulation. ▪ Only use the insulated hand tools for energized electrical work.
Hot Sticks (Live-Line Tools)	▪ Check for identification tag. ▪ Check for sticker for proof of tested current. ▪ Clean as per manufacturer's recommendations. ▪ Keep free of contamination. ▪ Ensure mechanically fit for use. ▪ Ensure stored in manufacturer's approved bag or tube.
Temporary Protective Grounds	▪ Check for identification tag, and indication of fault current carrying capacity at assumed clearing time. ▪ Check for sticker for proof of tested current. ▪ Store in protective box. ▪ Clean as per manufacturer's recommendations. ▪ Keep free of contamination. ▪ Ensure clamps are intact and operate. ▪ Ensure appropriate hot stick for application is available.

11.2.4 Testing of Personal Protective Equipment

Table 5
Electrical Specific Tools & Equipment Frequency of Test Intervals

PPE, TOOLS AND EQUIPMENT	TESTING FREQUENCY
Arc Flash Protective Clothing	▪ No in service tests can be applied.
Arc Rated Face Shields for Arc Flash Hoods	▪ No in service tests can be applied.
Rubber Insulating Gloves	▪ Before first use and every 6 months.
Leather Protectors	▪ No in service tests can be applied.
Rubber Line Hose	▪ Upon indication that insulating value is suspect.
Rubber Insulating Covers	▪ Upon indication that insulating value is suspect.
Rubber Insulating Sleeves	▪ Before first use and every 12 months.
Rubber Insulating Blankets	▪ Before first use and every 12 months.
Temporary Protective Grounds	▪ Before first use and every 36 months. If used frequently then decrease test frequency. ▪ Should be subjected to the 3-cycle or 15-cycle voltage-drop tests defined in the ASTM F 855 standard on a regular basis as determined by condition of use. However, the test interval must not exceed three years. ▪ Repaired or modified ground clusters must be tested to ensure that the repaired equipment will pass the standard 30-cycle or 15-cycle voltage-drop values

	permitted by ASTM F 855.
Hot Stick, Rescue Hot Stick, or Static Discharge Hot Stick (Live-Line Tools)	▪ Before first use and every 24 months. If used frequently then decrease test frequency.
Digital Multi-meter or Voltage Proximity Detector	▪ No in service test frequency is provided. Test at discretion. Inspection and function testing by user before every use.
Insulated Hand Tools	▪ No in service testing. Inspection for certification and damage only.

Note: *Testing frequency of equipment that is not in use and has been stored according to the manufacturer's specifications may be decreased. For example, a pair of rubber insulating gloves which have not been used (since the last test cycle) and have been stored correctly may only require an annual testing interval.*

11.2.5 Conductive Articles Being Worn

Conductive articles of jewellery and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metal aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed energized conductors or circuit parts.

11.3 Tools and Equipment

11.3.1 General Tools and Equipment

Equipment Rating – test instruments, equipment, and their accessories shall be rated for circuits and equipment to which they will be connected. Low Voltage test devices in service shall be minimum Category (CAT) III – 1000 Volt or CAT IV – 600 Volt (able to withstand 8000 Volt transients based on a test resistance of 2 ohms).

Visual Inspection – equipment shall be visually inspected for external defects and damage before the equipment is used on any shift. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use a defective tool until repairs and tests necessary to render the equipment safe have been made.

Equipment Handling – portable equipment shall be handled in a manner that will not cause damage. Flexible electric cords connected to equipment shall not be used for raising or lowering the equipment. Flexible cords shall not be fastened with staples or hung in such a fashion as could damage the outer jacket or insulation.

Connecting Attachment Plugs – neither the equipment nor the employees' hands shall be wet when plugging and unplugging flexible cords and cord-and-plug - connected equipment. Locking-type connectors, when used, shall be inspected after connection to ensure they are properly connected to prevent accidental disconnection.

Insulated Tools and Equipment – employees shall use insulated tools and/or handling equipment when working inside the Limited Approach Boundary where tools or handling equipment might make accidental contact. Insulated tools shall:

- be protected from damage to the insulating material;
- be rated for the voltages on which they are used; and
- designed and constructed for the environment to which they are exposed and the manner in which they are used.

A sample standard insulated Electricians tool list may include the following:

- 9" LINEMAN PLIER
- 8" HD SLIP JOINT PLIER WITH CUTTING SHEAR
- CRIMPING TOOL
- 10" TONGUE AND GROOVE PLIER (WATERPUMP)
- SLOTTED SCREWDRIVERS: 3/16" X 4", 1/4" X 4", 1/4" X 6", 5/16" X 6", 3/8" X 8", 3/16" X 6";
- PHILLIPS SCREWDRIVERS: #1 X 3", #2 X 4"
- NUT DRIVERS: 1/4" X 3", 5/16" X 3", 3/8" X 3", 7/16" X 3", 1/2" X 3", 3/16" X 3", 11/32" X 3";
- 8" LONG NEEDLE NOSE PLIER WITH SIDE CUTTER
- 7" BOX JOINT CUTTING PLIER
- 9-1/2" PLIER CUTTING PLIER
- 12" TOUNGE AND GROOVE (WATERPUMP)
- 6" FLAT NOSE PLIER
- LONG ARM, TYPE "T" HEX WRENCHES: 3/16" 6", 1/4" 6", 5/16" 6", 3/8" 6", 7/16" 6", 1/2" 6"
- IDEAL SAFE-T-GRIP FUSE PULLER: small, medium, large

Note: *tool lists are site specific. The above example illustrates what may be required by a Qualified Electrical Worker.*

Vented Equipment – the placement of work stations or congregating around vented equipment is prohibited.

Ground Fault Protection – extension cords and cord connected power tools used out doors or used in damp or wet environments shall be protected by a Class 1 (5mA) Ground Fault Circuit Interrupter (GFCI).

Interrupting Rating of Equipment – should a piece of equipment be found operating in excess of its safe interrupting and bracing ratings, engineering solutions to bringing equipment within the defined interrupting rating parameters shall be defined.

11.3.2 Specific Tools and Equipment Information

Cable Handling Hotstick – an insulated cable handling hotstick shall be used when handling live trailing cable. The cable handling hotstick shall be rated for the voltage of the trailing cable.

Extension Cords – all extension cords shall be minimum three-wire cords with all conductors and connectors intact.

Fuse Handling Equipment – insulated fuse handling equipment shall be used to remove or install fuses where exposed fuse terminals may be energized. The fuse handling equipment shall be rated for the circuit voltage.

Guards – all equipment in use must have all its supplied guards in place.

Hand Tools – hand tools shall be used for their intended purpose and where used on energized circuits shall be insulated and rated for the voltage level of the circuit being worked on.

Portable Ladders – portable ladders shall have non-conductive side rails. The side rails, steps, and rubber footings shall be in good condition.

Power Tools – unless they are double insulated, all cord connected power tools shall have a three-wire cord with the ground-pin intact.

Ropes and Hand-lines – ropes and hand-lines used where an electrical hazard exists shall be non-conductive.

Welders – electrically supplied welding equipment shall be bonded to ground when in use.

11.4 Temporary Protective Grounds

11.4.1 General

Temporary protective grounding equipment is installed to mitigate the hazards of induced voltages and currents, as well as to provide an additional barrier of protection from accidental re-energization. The equipment can also be used to dissipate stored energy in a long cable or bus-duct run.

Temporary protective grounding equipment shall never be viewed as a primary level of protection from accidental re-energization. Lockout and

other procedures are the primary barriers to prevent accidental re-energization.

Note: *Refer to CSA Z462-08 4.2.3 – Temporary protective grounding equipment.*

11.4.2 Rating

Ensure the temporary protective ground cables, clamps and grounding trucks are rated for the greatest available fault current and the clamps are suitable for the size and shape of conductors being grounded.

Temporary protective grounding equipment shall meet the requirements of CAN/ULC-D61230 or ASTM F 855.

Table 6
Worst Case Current Carrying Capabilities of Copper Grounding Conductors
ASTM F 855

Cable Size (AWG)	Nominal Cross Section (mm^2)	Cable Current Carrying Capabilities (kA) Upstream Device Interrupting Rating			Cont. Current Rating (Amps)
		6 Cycles (100ms)	15 Cycles (250ms)	30 Cycles (500ms)	
#2	33.63	23	17	13	200
1/0	53.48	36	26	20	250
2/0	67.42	46	33	26	300
3/0	85.03	57	42	32	350
4/0	107.2	72	53	41	400
250 kcmils	126.65	86	63	48	450
350 kcmils	177.36	120	88	67	550

11.4.3 Types of Grounding Cables and Clamps

Table 7
Types of Grounding Cables – ASTM F 855

TYPE	DESCRIPTION
I	Cables shall have stranded soft drawn copper conductor with stranding of 665 wires or more #30 AWG or #34 AWG wire, and elastomer jacket rated by the manufacturer, flexible for installation and serviceable for continuous use at temperatures rating from -40°C (-40°F) through +90°C (+194°F).
II	Cables shall have stranded soft drawn copper conductor with stranding of 133 wires or more for size #2 or 259 wires or more for size 1/0 and larger, and elastomer jacket rated by the manufacturer, flexible for installation and serviceable for continuous use at temperatures ranging from -25°C (-13°F) to +90°C (+194°F).

III	Cables shall have stranded soft drawn copper conductor with stranding of 665 wires or more #30 and thermoplastic jacket rated by the manufacturer, flexible for installation and serviceable for continuous use at temperatures ranging from -10°C (14°F) to +60°C (+140°F).

Table 8
Clamp Types – ASTM F 855

TYPE	DESCRIPTION
I	Clamps for installation on de-energized conductors equipped with eyes for installation with removable hot sticks.
II	Clamps for installation on de-energized conductors having permanently mounted hot sticks.
III	Clamps for installation on permanently grounded conductors or metal structures with tee handles, and eyes or square or hexagon head screw(s), or both

11.4.4 Lock and Tag

A lock and tag shall be installed at the disconnecting device on the supply side of the grounded conductors to identify when temporary grounds are installed to ensure the temporary protective grounds are removed prior to re-energizing.

The tag shall indicate name, time & date, location grounds installed with equipment number.

11.4.5 Location Grounds are Applied

Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent personnel from being exposed to hazardous differences in electrical potential.

11.4.6 Excess Length Secured

Temporary protective grounds shall be placed at such locations and their excess length secured such that when exposed to fault currents their inadvertent movement will not pose a hazard to personnel.

11.4.7 Equipment Required to Install Temporary Protective Grounds

Temporary protective grounds shall be applied to isolated high voltage conductors using a suitably rated live line tool (hot-stick) and suitably classed rubber gloves. Temporary protective grounds shall be applied to isolated low voltage conductors using suitably classed rubber gloves.

Note: *See Clause 11.2.1 – Table 1 for selection of rubber insulating gloves.*

11.5 Conductive Materials, Tools, and Equipment Handling

Conductive materials, tools, and equipment that are in contact with any part of an employee's body shall be handled in a manner that prevents accidental contact with energized conductors or circuit parts. Means shall be employed to ensure that conductive materials approach exposed energized conductors or circuit parts no closer than that permitted by Clause 9.3 -Table 1.

11.6 Conductive Cleaning Supplies

Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicone carbide, as well as conductive liquid solutions) shall not be used inside the Limited Approach Boundary unless procedures to prevent electrical contact are followed.

11.7 Testing and Maintenance of Protective Equipment

Maintenance of equipment shall be done on a regular basis in accordance with site policy. As a minimum, the following testing of equipment shall be performed,

(4) Thermal Imaging – Annually
(5) Visual Inspections,
    - Surface: MCC's, switchgear – Annually
    - Underground: MCC's, subs – Annually
(6) Protective Relay/Breaker (including molded case) – testing done to a minimum of OEM standard and as approved by PCS underwriter (i.e. protective relays should be tested on a 3 year cycle).

12 Alerting Techniques

12.1 Labels

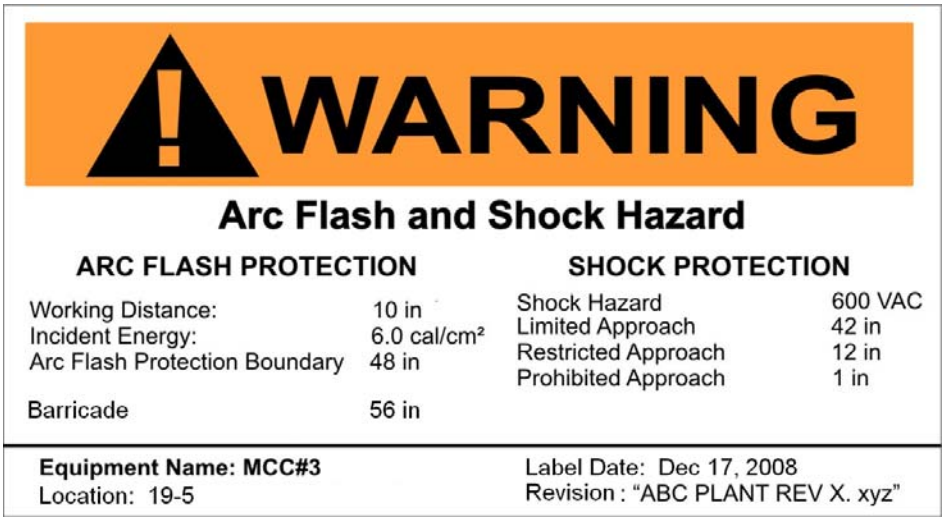
All equipment that has had a hazard analysis completed on it must have a label reflecting the results of that analysis.

Mandatory information required on an equipment label includes,

- Incident energy level
- Arc Flash protection boundary
- Date of evaluation/calculation
- Working Distance
- Barricade (distance to the working Barricade)
- Voltage level
- Limited approach boundary
- Restricted approach boundary
- Prohibited approach boundary
- Equipment name
- Equipment location
- Revision Number (or File Number)

Figure 1 is a sample label which includes all mandatory information.

Figure 1
Mandatory Information Required on an Equipment Label



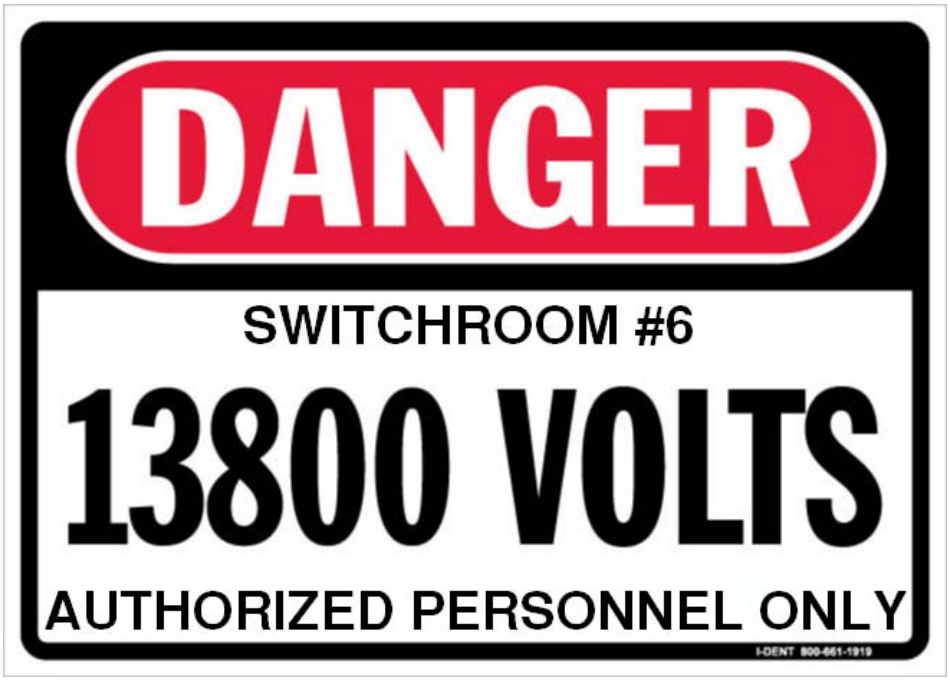
12.2 Safety Signs and Tags

Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards that might endanger them.

As a minimum all electrical room entrances must display a sign in a visible location indicating “Danger” and the highest voltage present within the room.

A typical “Danger” sign is illustrated below,

Figure 2
Sample “Danger” Sign Posted on Electrical Room Entranceway



12.3 Barricades

Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing exposed energized conductors or circuit parts. Conductive barricades shall not be used where it might cause an electrical hazard. Barricades shall be placed at a minimum distance which addresses both the Limited Approach Boundary and the Arc Flash Boundary.

12.4 Stand-by Attendants

If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signalling and alerting shall be to keep unqualified personnel and qualified personnel without sufficient PPE and/or knowledge of the work area at a distance such that they will not be exposed to an electrical shock, arc flash, or other electrical hazard. An attendant shall remain in the area as long as there is a potential for personnel to be exposed to the hazards.

13 Service Providers

13.1 General

All service providers are required to conform to the requirements of CSA Z462 and this document. This includes electrical contractors and anyone who may be potentially involved with electrical equipment (i.e. air conditioning contractors, crane contractors, etc.). It is the responsibility of the PotashCorp Project Coordinator to ensure all requirements are adhered to.

13.2 Training

Electrical service providers must train their employees as per CSA Z462-08 clause 4.1.6.4.1. They are required to submit proof of this training upon PotashCorp's request.

13.3 Personnel Protective Equipment

Electrical service providers are required to have their own PPE to protect from shock and arc flash hazards.

Electrical service providers must submit their PPE for inspection by PotashCorp upon request.

Note: *When requested, records of PPE life, inspections, and testing must be submitted. Records provided by contractors must be kept while the contractor is on site.*

13.4 Service Provider Job Briefing

Before starting each job, the worker in charge shall conduct a job briefing with the workers involved. The briefing shall cover such subjects as hazards associated with the job, work procedures involved, special precautions, energy source controls, and personal protective equipment requirements.

An Electrical Job Briefing Form (Annex B) must be completed.

13.5 Tours

Tours are not exempt from the requirements of this document. It is the responsibility of the tour guide to abstain from taking the tour into hazardous situations.

14 References

- CSA Z462-08 Workplace Electrical Safety
- CSA Workplace Electrical Safety Training Course Handbook
- New Brunswick Occupational Health & Safety Regulations
- Saskatchewan Occupational Health & Safety Regulations
- ASTM F 1506 Standard, *Performance Specification for Textile Material for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards*
- ASTM F1959 Standard, *Test Method for Determining Arc Thermal Performance Value of Material for Clothing*
- IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations
- Canadian Electrical Code (CEC) Part I, C22.1-09.
- CSA M421-00 Use of Electricity in Mines

Annex A
Energized Electrical Work Permit

PotashCorp
Energized Electrical Work Permit

Part 1: Completed by Electrical Supervisor

Names of Workers	Training Received

Description of circuit/equipment/job location:	
Justification for why the work needs to be performed in an energized condition:	
Description of the safe work practices to be employed:	
Completed Job Briefing Form Attached?	**Y / N**

Part 2: Completed by Qualified Employee doing the work

Results of the Shock Hazard Analysis:	
Exposed Voltage	
Limited Approach Boundary	
Restricted Approach Boundary	
Prohibited Approach Boundary	
Results of the Arc Flash Hazard Analysis:	
ATPV Rating of PPE needed	
Arc Flash Protection Boundary	
Type of barricade used to restrict the access of unqualified persons to the work area:	

Necessary PPE/Tools/Equipment to safely perform the assigned task:	
Arc rated long-sleeve shirt and pants or coverall	**Y / N**
Arc rated face-shield with balaclava or arc flash suit hood	**Y / N**
Hard hat	**Y / N**
Safety glasses or goggles	**Y / N**
Hearing Protection	**Y / N**
Insulating rubber gloves with leather protectors	**Y / N**
Leather work shoes	**Y / N**
Hot Stick	**Y / N**
Insulated Tools	**Y / N**

Approval Signatures		**Date**
Electrical Supervisor		
Superintendent		

Annex B
Electrical Job Briefing Form
Switching Sequence Form

PotashCorp
Electrical Job Briefing Form

Date:

Work Order: _____ Supervisor: _____

Location: _____

Attendees

Name (print)	Signature	Name (print)	Signature

Scope of Work

Shock Hazard Analysis

Task: _____ Voltage: _____ Class of Gloves: _____ Approach Boundary: _____

Task: _____ Voltage: _____ Class of Gloves: _____ Approach Boundary: _____

Flash Hazard Analysis

Task: _____ Incident Energy: _____ Flash Protection Boundary: _____

Task: _____ Incident Energy: _____ Flash Protection Boundary: _____

Review

- ☐ Emergency response procedures discussed
- ☐ One line diagram consulted/sketched
- ☐ All hazards identified and discussed
- ☐ PPE selected to match the hazards
- ☐ Lockout/Tag Out discussed
- ☐ Personal protective grounding discussed
- ☐ Required tooling/equipment available for job
- ☐ Pertinent MSDS available and consulted

PotashCorp
Switching Sequence Form

Date:

Sequence	Device	Operation	Completed
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

Prepared By: _____ Checked By: _____

Pre-Energization Check List

☐ Jumpers and test leads removed

☐ Cables and bus connections tight

☐ Down stream loads isolated (all interlocks satisfied)

☐ Personnel clear of system – locks removed, permits submitted

☐ Isolation of men working on other feeders proven;/verified

☐ Bus, feeders and/or cables insulation resistance tested

☐ All grounds removed and counted

☐ All persons outside of substation fence or switch room during energization

☐ Appropriate PPE being utilized

Check By: _____ Verified By: _____

Annex C
Arc Flash Hazard/Risk Analysis Tables

Table 4
Hazard/risk category classifications and use of rubber insulating gloves and insulating hand tools

Task (Assumes equipment is energized, and work is done within the arc flash protection boundary)	Hazard/Risk Category	Rubber Insulating Gloves	Insulated Hand Tools
Panelboards rated 240 V and below – Note 1	–	–	–
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Electrical measurements, performing diagnostics, testing or troubleshooting	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
Electrical measurement, calibration, trouble shooting of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
Panelboards or Switchboards rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) – Note 1	–	–	–
Electrical measurement, calibration, trouble shooting of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Electrical measurements, performing diagnostics, testing or troubleshooting	2*	Y	Y
Electrical measurement, calibration, trouble shooting of utilization equipment fed directly by a branch circuit of the panelboard	2*	Y	Y
600 V Class Motor Control Centers (MCCs) – Note 2 (except as indicated)	–	–	–
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with	1	N	N

Task (Assumes equipment is energized, and work is done within the arc flash protection boundary)	Hazard/Risk Category	Rubber Insulating Gloves	Insulated Hand Tools
enclosure doors open			
Electrical measurements of energized parts or performing diagnostics, testing or troubleshooting on or near those parts	2*	Y	Y
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts ≤120 V exposed	0	Y	Y
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts >120 V exposed	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts) Note 3	2*	N	N
Opening hinged covers (to expose bare, energized parts) Note 3	1	N	N
Electrical measurement, calibration, trouble shooting of utilization equipment fed directly by a branch circuit of the MCC	2*	Y	Y
600 V Class Switchgear (with power circuit breakers or fused switches) – Note 4	–	–	–
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts ≤120 V exposed	0	Y	Y
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts >120 V exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	2	N	N
Other 600 V Class (277 V through 600 V,	–	–	–

Task (Assumes equipment is energized, and work is done within the arc flash protection boundary)	Hazard/Risk Category	Rubber Insulating Gloves	Insulated Hand Tools
nominal) Equipment – Note 2			
Lighting or small power transformers (600 V, maximum)	–	–	–
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N
Electrical measurements of energized parts or performing diagnostics, testing or troubleshooting on or near those parts	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Revenue meters (kW-hour, at primary voltage and current)	-	-	-
Insertion or removal	2*	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Electrical measurements, performing diagnostics, testing or troubleshooting	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
NEMA E2 (fused contactor) Motor Starters, 2.3 kV through 7.2 kV	–	–	–
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2*	N	N
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts ≤120 V exposed	0	Y	Y
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts >120 V exposed	4	Y	Y
Insertion or removal (racking) of starters from cubicles, doors open or closed	a4	N	N
Application of safety grounds, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N

Task **(Assumes equipment is energized, and work is done within the arc flash protection boundary)**	Hazard/Risk Category	Rubber Insulating Gloves	Insulated Hand Tools
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Metal Clad Switchgear, 1 kV and above through 38 kV	–	–	–
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
CB or fused switch operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	4	N	N
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts ≤120 V exposed	2	Y	Y
Electrical measurements or diagnostics, testing or troubleshooting of control circuits with energized parts >120 V exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N
Arc Resistant Switchgear Type 1 or 2 (For clearing times of < 0.5 sec with a perspective fault current not to exceed the Arc Resistant rating of the equipment)			
CB operation with enclosure door closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	0	N	N
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage	0	N	N

Task (Assumes equipment is energized, and work is done within the arc flash protection boundary)	Hazard/Risk Category	Rubber Insulating Gloves	Insulated Hand Tools
transformers on or off the bus door closed			
Other Equipment 1 kV and above through 38 kV	–	–	–
Metal clad load interrupter switches, Fused or Unfused	–	–	–
Switch operation of arc-resistant type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on energized parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	N	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.

Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, Standard Specification for Insulated and Insulating Hand Tools.

Y = yes (required), **N** = no (not required).

For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.

For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.

For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1⁄2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Notes:

(1) Maximum of 25-kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
(2) Maximum of 65-kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
(3) Maximum of 42-kA short circuit current available, 0.33 second (20 cycle) fault clearing time.
(4) Maximum of 35-kA short circuit current available, up to 0.5 second (30 cycle) fault clearing time.

Table 5
Hazard/risk categories of protective clothing
and personal protective equipment

Hazard/Risk Category 0	
Protective clothing, Non-melting (according to ASTM F 1506) or Untreated Natural Fibre	Shirt (long sleeve) Pants (long)
Other Protectivie Equipment	Hard hat Safety glasses or Safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 1	
FR Clothing, minimum arc rating of 4 cal/cm^2 (Note 1)	Arc-rated long-sleeve shirt and pants (Note 3); or Arc-rated coverall (Note 4) Arc-rated faceshield or arc flash suit hood (Note 7)
Other protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)
Hazard/Risk Category 2	
FR clothing, minimum arc rating of 8 cal/cm^2 (Note 1)	Arc-rated long-sleeve shirt and pants (Note 5); or Arc-rated coverall (Note 6) Arc-rated faceshield or arc flash suit hood (Note 7)
Other protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 2*	
FR clothing, minimum arc rating of 8 cal/cm^2 (Note 1)	Arc-rated long-sleeve shirt and pants (Note 5); or Arc-rated coverall (Note 6) Arc-rated arc flash suit hood (Note 10)
Other protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 3	
FR clothing, minimum arc rating of 25 cal/cm^2 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 8) Arc-rated pants (AR) (Note 8) Arc-rated coverall (AR) (Note 8) Arc-rated arc flash suit hood Arc-rated gloves (Note 2)
Other protective equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes
Hazard/Risk Category 4	
FR clothing, minimum arc rating of 40 cal/cm^2 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9)

	Arc-rated arc flash suit jacket (AR) (Note 9) Arc-rated arc flash suit pants (AR) (Note 9) Arc-rated arc flash suit hood Arc-rated gloves (Note 2)
Other protective equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes

AN = As needed (optional)
AR = As required
SR = Selection required

Notes:

(1) See Table 5. Arc rating for a garment or system of garments is expressed in cal/cm^2.
(2) If rubber insulating gloves with leather protectors are required by Table 1, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
(3) The FR shirt and pants used for Hazard/ Risk Category 1 shall have a minimum arc rating of 4cal/cm^2.
(4) Alternate is to use FR coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
(5) FR shirt and FR pants used for Hazard/ Risk Category 2 shall have a minimum arc rating of 8.
(6) Alternate is to use FR coveralls (minimum arc rating of 8) instead of FR shirt and FR pants.
(7) The face shields required for Hazard/Risk Category 0 through 2 shall have wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, an arc-rated arc flash suit hood shall be used).*
(8) An alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk Category 3.
(9) The total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.
(10) Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas.

Table 6
Protective clothing characteristics

Typical Protective Clothing Systems		
Hazard/Risk Category	**Clothing Description** (Required Minimum)	**Arc Rating of PPE** [J/cm^2 (cal/cm^2)]
0	Non-Melting, flammable materials (i.e. untreated cotton, wool, rayon, silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd^2	N/A
1	FR shirt and FR pants or FR coverall	16.74 (4)
2	Arc-rated FR shirt and FR pants or FR coverall	33.47 (8)
3	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	104.6 (25)
4	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	167.36 (40)

Notes:

(1) Arc rating can be either ATPV or E_{bt}. ATPV is defined in ASTM F 1959-99 as the incident energy on a fabric or material that results in sufficient heat transfer through the fabric or material to cause the onset of a second-degree burn based on the Stoll curve. E_{bt} is defined in ASTM F 1959-99 as the average of the five highest incident energy exposure values below the Stoll curve where the specimens do not exhibit break-open. E_{bt} is reported when ATPV cannot be measured due to FR fabric break-open.

(2) See Table 5 for other PPE required for the specific tasks listed in Tables 2.

(3) Table 6 does not specify a minimum arc rating for Hazard/Risk Category 0 clothing. The clothing is not required to be made of FR materials provided it is made of non-melting materials as described in the Table.

Annex D
Sample Site Audit Form

Item No.	Inspection Items	Compliant		Comments or Observations
		Yes	No	
1. Electrical Safe Operating Practice Issues				
1.1	Is the Electrical Safety Program available?			
1.2	Arc Flash and Shock Hazard warning labels attached to all switchgear and MCCs?			
1.3	Electrical Specific PPE, Tools & Equipment readily available and are they suitably rated?			
1.4	Electrical Specific PPE, Tools & Equipment properly stored e.g. individual bags, cases, lockers used etc.?			
1.5	Class "C" fire extinguishers in SWGR and MCC buildings and tested current?			
1.6	Rubber insulating gloves for low voltage < 750 V work available, stored properly, not damaged, clean, tested current and at least Class 0, 1000 V rated?			
1.7	Rubber insulating gloves for use on > 750 V work available, stored properly, not damaged, clean, tested current, rated for at least Class 1 (7.5 kV) and Class 2 (17 kV) as required?			
1.8	All rubber insulating gloves have current test certification?			
1.9	Portable barriers and warning tape available?			
1.10	Temporary Protective Grounding cables on-site and if yes are they rated for maximum fault current, at the assumed clearing time? Have they been tested in the last 36 months?			
1.11	Insulated hand tools for use on equipment < 750 V available, rated for 1000 V, and stored properly in wrap or protective case? Not stored in the same tool box or pouch with normal tools?			
1.12	Ladders approved for electrical use are available and made of non-conductive material?			
1.13	Digital Multi-Meters and other electrical test equipment for < 750 V work certified to at least 600 V, Category III? Stored in protective case?			

1.14	Everyday wear clothing is arc rated, indicated on the clothing collar tag or on the inside of the garment?			
1.15	Standard written switching and isolation procedures available?			
1.16	Are lock readily available and controlled, lock out board available or logbook?			
1.17	Clear access in and around SWGR and MCCs?			
1.18	Current Single Line Diagram available in SWGR and MCC buildings?			
1.19	Inventory list of all Electrical Specific PPE, Tools & Equipment available?			
1.20	Arc rated face shield is available and fit for use, and stored in protective bag?			
1.21	If an Arc Flash Suit is available does it include an Arc Flash Hood? Does the hood have a circulating air fan installed? Is the arc flash suit a lab coat style?			
1.22	Is the Arc Flash Hazard Analysis readily available for review and is it current to within the last 5 years?			
1.23	Are hot sticks (live line tools) available for use? Is there evidence of testing in the last 24 months? Are the hot sticks stored properly?			
1.24	Is a high voltage proximity or direct contact tester onsite? Which manufacturer and approved?			
1.25	Are MCC building man-doors labelled with a unique identification tag, and Danger signs?			
1.26	Are the appropriate safety procedures in place to minimize dangers where exposure cannot be avoided (i.e. Energized Electrical Safe Work Permit)?			
1.27	Have all personnel working on or near energized equipment undergone specific training in the hazards of working on energized equipment, and the use and proper application of PPE?			

1.28	Have all personnel working on high voltage (> 750 V) been training on high voltage safety?			
General Comments:				
2. Electrical Engineering Analysis/Documentation Review				
2.1	Ensure Single Line Diagrams are current.			
2.2	Ensure hazardous area classification drawings, are current.			
2.3	Is there a Neutral Ground Resistor (NGR) present and is it shown on the Single Line Diagram for LV and HV (e.g. 4160V, 13800V)?			
2.4	Has the MCC or SWGR been sized correctly, what is the fault withstand capacity of the bus, is it noted on the single line drawing?			
2.5	Are the as-built single lines adequately posted in MCC buildings or available in MCC buildings?			
2.6	Is the utility fault current noted on the single line diagram with a date?			
2.7	Have protective devices been tested/checked to verify performance per the arc flash study?			
2.8	Is there a procedure in place to assure studies are updated and testing is performed when system or electrical source changes are made (Management of Change)?			

General Comments:				
3. Electrical Installation				
3.1	Are all electrical buildings or areas clean and free of non-essential items?			
3.2	Is minimum working space provided around electrical equipment?			
3.3	Electrical equipment properly closed and protected. No exposure to energized conductors or circuit parts?			
3.4	Is all electrical equipment protected against mechanical damage?			
3.5	Junction boxes properly labelled?			
3.6	Is all electrical equipment, including JB's, properly supported and provided with required access?			
3.7	Are Panel Schedules located inside panels and as-builts?			
3.8	Is all electrical equipment marked with CSA or equivalent?			
3.9	Are all unused wires and cables properly terminated and labelled?			
3.10	Where NGR devices are used are appropriate warning signs provided (e.g. on transformer, Main Breaker, and the NGR)?			
3.11	Is all electrical equipment properly grounded?			
3.12	Are all electrical equipment openings closed off and all bolts and screws in place?			
3.13	Physical protection and clearance provided around all power transformers?			
3.14	Are cable trays filled to within design capacity, i.e. not overfilled?			
3.15	Are lighting panel schedules available in lighting panels and			

	are they as-built and legible?			
3.16	Are cable trays properly installed, e.g. adequately supported?			
3.17	All cables and conductors must be properly supported and secured.			
3.18	Are cable trays properly bonded and connected to ground if required?			
3.19	Do cable trays have cover where needed?			
3.20	Where electrical equipment is fed from multiple sources are warning signs appropriately provided?			
3.21	Equipment installed in hazardous areas must be approved and labelled for the location.			
3.22	Check seals are provided and properly installed where necessary.			
3.23	Are receptacles in the hazardous area approved for the location?			
3.24	Does high voltage equipment have proper signage?			
3.25	Are high voltage cables identified?			
3.26	Is piping with electrical heat tracing properly labelled?			
3.27	Does any electrical equipment show signs of excessive heating?			
3.28	Are illumination levels adequate at electrical equipment?			
General Comments:				
4. Grounding Systems				
4.1	Is the service transformer ground grid connected to the plant ground grid?			

4.2	Is the plant ground grid network continuous, i.e. no isolated ground systems?			
4.3	Is the system ground conductor properly sized?			
4.4	Is an NGR provided and properly installed?			
4.5	Is a NGR warning sign provided at all appropriate locations, e.g. transformer, incoming breaker, and on NGR?			
4.6	Is the cable tray system continuously bonded?			
4.7	Are subs (skids) properly grounded?			
4.8	Is all electrical equipment, e.g. MCC's bonded to the plant ground system?			
4.9	Are ground resistance tests routinely done for the grounding system to check integrity?			
General Comments:				

Annex E
Electrical Specific PPE, Tools and Equipment Specifications

PPE, TOOLS OR EQUIPMENT	MINIMUM SPECIFICATION
Head Protection	▪ Non-conductive, CSA/ANSI approved Class E head protection complying with CSA-Z94.1-05 or ANSI Z89.1 (e.g. rated for 20kV). ▪ Type I or Type II as per company requirement. ▪ Suspension system – four or six points of support. ▪ Color, size and design will vary from location to location. ▪ Winter hard hat liner to be made from FR materials.
Safety Glasses and Arc Rated Eye and Face Protection	▪ Fit properly and offer the least possible resistance to movement and cause minimal discomfort while in use. ▪ Should be made of polycarbonate material. No metal parts. ▪ Consider “Anti-Fog”, “Anti-Glare”, “Scratch-Resistant” and “UV-Proof” features when selecting the face-shields. ▪ Arc rated face shields or arc flash hoods shall always be used with the same or greater cal/cm^2 incident energy rating as arc rated clothing. ▪ Arc rating of the face shields should comply with ASTM F 2178. ▪ Fleece interior cotton canvas storage bag for arc rated face shield with hard hat attached, w/ drawstring closure or suitable storage bag for arc flash hood. ▪ Safety glasses shall be antifogging, anti-scratch and antistatic with 99.9% UV protection, and meet CSA Z94.3 Standard.

Rubber Insulating Gloves with Leather Protectors	▪ Rubber insulating gloves must combine high dielectric, flexibility and physical strength.
	▪ A glove system consists of two main elements and an optional third element:
	  o Rubber insulating gloves.
	  o Leather protector gloves.
	  o Liner gloves (optional)
	▪ Type II-Ozone resistant.
	▪ Glove dust can be used (e.g. optional).
	▪ ASTM F 496 specifies voltage class of gloves (e.g. voltage rating of the glove must be at least equal to or higher than the maximum circuit voltage to be worked on).
	▪ Gloves should be sized for the individual that is to wear them (e.g. palm measurement is the size that should be ordered).
	▪ Cuff design (e.g. default design is the straight cuff; other designs have advantages in specific circumstances).
	▪ Gloves shall always be purchased with leather protectors and manufacturer’s approved storage bag

	(e.g. canvas bag or equivalent). Place gloves separated from leather protectors with the opening of the gloves into the storage bag. ▪ Leather protectors shall meet the requirements of ASTM F 696. Should match the size of the rubber insulating gloves for proper fit. ▪ Recommend that each pair of gloves be assigned a unique tag that is marked on the gloves and storage bag. This tag can be used for tracking in preventative maintenance scheduling and referenced in procedures. ▪ At least two pairs of rubber insulating gloves should be ordered for each worker where individually issued to allow for one set to be sent out for dielectric testing. ▪ Reference Section 11.2.1 - Table 1 for Classes of rubber insulating gloves.
Rubber Insulating Sleeves	▪ Sleeves must comply with all the requirements of ASTM D 1051. ▪ Type II-Ozone resistant. ▪ Voltage Class of Sleeves (e.g. assigned to the same voltage class as the gloves). ▪ Construction – molded or dipped. ▪ Style (e.g. Type I is available as straight taper or curved elbow, Type II is available in curved construction only.). ▪ Size and Color to be specified as per specific requirements. ▪ Both Type I and Type II sleeves are constructed with holes to accept buttons with which to fasten the straps to the sleeves. ▪ Sleeves shall always be purchased with a storage bag or box. ▪ Other accessories to be specified are: o Harness (one required per pair of sleeves) o Buttons (four required for each pair of sleeves) o Straps with buttons (two required for each pair of sleeves)
Rubber Insulating Mats and Matting	▪ Mats and Matting must comply with all the requirements of ASTM D 178. ▪ Type IIA-Ozone resistant or Type IIB-Flame resistant. ▪ Voltage Class of Mats and Matting (e.g. assigned to the same voltage class as the gloves). ▪ Mats and Matting are available in widths of 24, 30, 36 and 48 inches. ▪ Mats are provided in pre-cut dimensions and Matting is provided as rolls in lengths as requested. ▪ Color to be specified as per specific requirements.
Rubber Insulating Blankets	▪ Blankets must comply with all the requirements of ASTM D 1048. ▪ Type II-Ozone and Ultraviolet resistant or Type IIB-

	Flame resistant. ▪ Voltage Class of Blankets (e.g. assigned to the same voltage class as the gloves). ▪ Construction style (e.g. with or without eyelets). Specific sizes are available with Voltage Class 2 and Class 4 ratings. Color to be specified as per specific requirements.
Dielectric Footwear	▪ Dielectric Footwear must comply with all the requirements of CSA Z195.1-02/ASTM F 1117. ▪ Voltage rating should be marked (e.g. manufacturers test them to a predetermined voltage level of 20kV or 14kV). ▪ Premium quality ozone-resistant rubber. ▪ Description to be specified – boots (e.g. including height) or overshoes. ▪ Sizes to be specified as per specific requirements. ▪ The symbols, or markings, will help you determine which footwear is appropriate for the job. ▪ Labels should be on the tongue of the right shoe at ankle height. ▪ Labels may also appear at ankle height (e.g. 6 inches minimum) on the shoe itself for electrical protection footwear.
Arc Rated Clothing	▪ Shall meet the requirements of ASTM F 1506. ▪ Materials shall be - inherently flame resistant fabric or cotton and other fabrics treated with chemical agent. ▪ The incident energy rating (e.g. arc rating) of FR clothing should be determined by testing in accordance with ASTM F 1959. ▪ Store in manufacturer's approved storage bag or storage locker in a clean dry environment. Never store with sharp objects, or in dusty areas. ▪ Arc rated clothing must be labeled as follows: o Manufacturer o Arc Thermal Performance Value (ATPV) or EBT rating in calories per square centimeter o Care instructions o Fabric fiber content (e.g. oz weight/sq yard) o Garment size o Manufacturer tracking code ▪ Layering – single layer or it might consist of two or more layers. Consult the manufacturer to determine the Total System Arc Rating of the multi-layer protective system (e.g. you need to confirm the equivalent ATPV or EBT by reviewing manufacturer's ASTM F 1959 test results). You CANNOT just add the ATPV values of the layers of clothing. ▪ Tight fitting clothing should be avoided. Loose fitting clothing provides additional thermal insulation by ensuring the air gap between the skin and clothing,

	and layers of clothing is provided. ▪ An arc flash suit should fit properly such that it does not interfere with the intended task. ▪ All company requirements for additions to the garment (e.g. name tags, company logos) should be applied with FR thread, check with garment manufacturer. Any damage will be repaired using FR materials and threads. ▪ Undergarments should be made of 100% cotton, arc rated, or other non-meltable fabric (Note: This applies to workers of both genders). ▪ Clothing made from flammable synthetic materials that melt at temperatures below 315°C (600°F), such as acetate, nylon, polyester, polypropylene, and spandex, either alone or in blends, shall not be used.
Hearing Protection	▪ Class A rated. ▪ Hearing Protection must be worn when working on energized electrical conductors or circuit parts and particularly when the calculated arc flash incident energy exposure is greater than 1.2 cal/cm^2 (e.g. onset of a second degree burn, worker inside the Arc Flash Protection Boundary). ▪ Ear plug styles – cylindrical, tapered, hex, etc. ▪ Earmuffs are to be made of a mixture of plastics and foam, non-conductive. Soft ear cushions.
Raingear	▪ Shall meet the requirements of ASTM F 1891. ▪ For performing energized electrical work in inclement weather, the outer layer must be FR material with an arc rating (e.g. ATPV or EBT) appropriate for the task. This includes rain gear and winter wear. ▪ Raingear shall include reflective material for increased visibility as per ANSI/ISEA 107-2004, Performance Class 3. ▪ Style – full-length raincoats and rain jackets with detachable hoods, and rain pants. ▪ ASTM 1506, arc rated clothing must be labeled as follows: o Manufacturer o Arc Thermal Performance Value (ATPV) rating in calories per square centimeter o Care instructions o Fabric fiber content (e.g. oz weight/sq yard) o Garment size o Manufacturer tracking code
Insulated and Insulating Hand Tools	▪ Shall meet the requirements of ASTM F 1505. ▪ Approved insulated hand tools shall be rated for 1000 VAC and 1500 VDC. ▪ Covered with two layers of material – inner layer provides the electrical insulation and the outer layer provides mechanical protection for the electrical

	insulation. ▪ Recommended Journeyman Electrician Kit – Side Cutting Linesman Pliers, Diagonal Cutting Pliers w/ angled head, Long-Nose Pliers, Tongue and Groove Pliers, High-Leverage Cable Cutter, screwdrivers: flat head, Robertson, Phillips, and fuse puller. ▪ Heavy-duty soft tool case or hard plastic case should be provided for storing and transporting tools.
Hot Sticks (Live-Line Tools)	▪ Meets the requirements of ASTM F 711. ▪ Constructed from Fiberglass-Reinforced Plastic (FRP). ▪ Hot Sticks should be equipped with hook ends that will accept both hi-voltage testers and temporary protective ground cable clamps (e.g. custom hot sticks may be supplied with temporary protective grounds). ▪ Special attachment means are to be specified when these hot sticks are used for replacing fuses or operating disconnection means. ▪ Length and diameter are to be specified as per specific work tasks requirement and design of the equipment/electrical distribution system. ▪ All hot sticks must be tested by the manufacturer to conform to ASTM F711 (e.g. 100kV per foot of length for FRP material). ▪ Recommend that a unique tag be assigned to each hot stick to be referenced for tracking in preventive maintenance scheduling and referenced in procedures. ▪ Storage container of appropriate size shall be purchased and used.
Low Voltage Proximity Detectors	▪ CSA approved. ▪ Rated to CAT III or IV, 1000 V. ▪ Dual Sensitivity. ▪ LED indicating light. ▪ Audible annunciation. ▪ Detects from 90 to 600 V AC. ▪ Should be equipped with convenient pre-use test feature. ▪ Suitable for indoor and outdoor applications. ▪ Required ambient temperature operation should be specified.
High Voltage Proximity Detectors	▪ CSA approved. ▪ Typical Range 240VAC to 500kVAC. ▪ Visual and an audible annunciation. ▪ Sensor detects the radiated field which surrounds energized conductors. Radiated field strength increases with voltage and decreases quickly with distance or earth shielding. ▪ The radiated field from a cable of closely bunched conductors supplied by three phase power tends to

	cancel. ▪ Typical detecting distances for various voltage levels and configurations of electrical circuits should be consulted with the manufacturer's instructions for use. ▪ Follow manufacturer's instructions for use included with the detector.
Digital Multi-meter	▪ CSA approved. ▪ All meters must be at a minimum Category III, 600V rated. Use Category IV where required. User to determine appropriate Category for transient overvoltage protection. ▪ Recommend equipped with fused leads. ▪ The banana plug that connects the leads to the meter must be shielded to prevent contact with a grounded surface in case either of the plugs slips out of the receptacle. ▪ Probes should contain a knurled section near the end to help prevent the worker's hand from slipping and contacting the energized conductor. ▪ Must be stored in protective storage bag/case provided by the manufacturer.
Temporary Protective Grounds	▪ Shall meet the requirements of ASTM F 855. ▪ Temporary protective grounds that are installed on an electrical circuit must have a fault duty rating at least equal to the available fault-current capacity at the point in the circuit where the grounds will be installed and for the assumed clearing time. ▪ Temporary protective grounds must be tagged/marked to indicate the rating assigned by the manufacturer. ▪ Temporary protective grounds shall have an impedance low enough to cause immediate operation of protective devices. ▪ Temporary protective grounds shall have ground clamps that are designed specifically for grounding the intended equipment, i.e. ball style ground studs installed in the switchgear or equipment. ▪ Recommend that a unique tag be created and placed on the temporary protective ground cables for reference in preventive maintenance and procedures. ▪ When installed and left in service the equipment should be marked with a sign indicating that temporary protective grounds are installed (e.g. magnetically applied sign on the outside of MCC or SWGR).

Annex F
Arc Flash Risk Assessment Checklist

ARC FLASH RISK ASSESSMENT CHECKLIST			
Item	**Question**	**Yes**	**No**
1	Upon visual inspection does the equipment appear to be in good shape?		
2	Have the manufacturer's recommended maintenance for the equipment been followed?		
3	Is the frequency of equipment operation within the manufacturer's recommendations?		
4	Has the equipment been interrupted under a fault condition? ***Note:*** *Reclosing a device onto a fault condition may compromise the integrity of a device to a point where it may no longer safely operate.*		
5	Has the equipment been operated outside its designed capacity (i.e. a switch operated under load when it has not been designed as a load-break switch)?		
6	Is the equipment designed to operate in its installed environmental conditions?		
7	Are any environmental contaminants (i.e. oily deposits, metallic dust) present?		
8	Are all exposed energized conductors or circuit parts properly shielded or barricaded?		
9	Are all safe operating procedures for the equipment being followed?		
10	Have all loads been shed that are supplied by the equipment (if performing a disconnect)?		
11	Have any safety interlocks been defeated/bypassed in order to operate the equipment?		

Note: *All shaded boxes must be checked off in order to proceed. If a shaded box has not been checked off, PPE with an ATPV rating above the associated incident energy rating of the equipment shall be worn to protect the worker from a potential Arc Flash.*

Annex G
Electrical Shock and Arc Flash Hazard Pre-Check Sheet

PotashCorp — **Electrical Shock and Arc Flash Hazard Pre-Check Sheet**

Name	**Date**	**Equipment**
Location	**Task**	

Arc Flash and Shock Hazard Label	**Necessary PPE Check**	**Condition Pass/Fail**[ii]	**Task and Equipment Check**
Incident Energy (cal/cm^2) ________	☐ Site minimum PPE[i]	☐ P ☐ F ☐ N/A	☐ Single-Line Diagram
Protective Boundary (ft) ________	☐ Rubber Insulating Glove	☐ P ☐ F ☐ N/A	☐ Arc Flash & Shock Hazard Label
Shock Hazard Present (V) ________	☐ Class 0 – 1,000V		☐ Insulated Tools & Task-Rated Equipment
Limited Approach (ft) ________	☐ Class 1 – 7,500V		☐ Area Barricaded
	☐ Class 2 – 17,000V		☐ Test-Before-Touch
	☐ Class 3 – 26,500V		☐ Abnormal Condition[iii]
	☐ $40 cal/cm^2$ AF gear	☐ P ☐ F ☐ N/A	
	☐ Hot stick	☐ P ☐ F ☐ N/A	
	☐ Other, explain below	☐ P ☐ F ☐ N/A	

Comments
Signature

[i] Site minimum PPE are (Gloves, $8 cal/cm^2$ AF/FR clothing, Hard hat, Safety glasses, Hearing protection)

[ii] Refer to Clause 11.2.3 of the Workplace Electrical Safety Guidance Document to determine condition of equipment

[iii] Refer to Section 2 (Definitions) of the Workplace Electrical Safety Guidance Document.