ConocoPhillips Canada

Electrical Work
(CPC-ALL-HSE-PRC-167)

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Current Revision Notes are available in the revision record found on the last page.

Task Summary: The following is an overview of the Electrical Work Safe Operating Practice. Additional information can be found by using the hyperlinks {page#} provided.

1. CPC expects all electricians and their apprentices (including contractors) to have an overview of this SOP prior to beginning any electrical work.
2. Prior to starting any electrical work, a hazard or risk analysis must be completed by a Qualified Electrical Person and a Pre-Job Hazard Assessment (PJHA) issued – {p12}

   Note: Whenever practical, CPC expects its electrical workers to utilize other options or methods so they will not have to work directly on energized electrical equipment or be exposed to the possibility of contact with energized parts by inadvertent action.
3. Only qualified and certified Journeyman Electricians or an Electrical Apprentice under the direct supervision of a Journeyman shall work on electrical systems or equipment. A required ratio is 1:1. A second Electrical Apprentice may be used with one Electrical Journeyman where the work being performed is general labour required for the electrical work but not directly electrical work (e.g., digging, driving ground rods, supporting equipment during installation by a Journeyman, etc.).
4. Jewelry, necklaces, earrings, rings or watches shall **NOT** be worn while performing electrical work.
5. In the case of electrical systems over 750 volts – {p15}
   a) A detailed work plan must be written and approved by the CPC Chief Electrical Person.
   b) A Person in Charge must be appointed and present during the work – {p15}
6. Prior to starting any work all:
   a) Isolation, lockout and tagout {p18} and grounding requirements must be completed – {p19}
   b) All tools, electrical equipment, and specialized PPE shall be used and/or worn – {p22}
7. Work on overhead lines will be contracted to qualified companies – {p25}
8. Temporary facilities shall be kept in service for the shortest possible time. Maximum duration of a temporary installation is 1 year. If the installation is to be continued beyond 1 year, then it shall be re-approved – {p26}

Primary Hazards: Shock (Electrocution) and Arc Flash

Required Forms, Checklists & Attachments	ConocoPhillips Reference Documents
1. Pre-Job Hazard Assessment Form 2. Energized Electrical Work Permit	1. Lockout and Tagout SOP, CPC-ALL-HSE-PRC-179, Oilsands-CPC-OLS-OPS-PRC-7072 2. **Hot Work** SOP, CPC-ALL-HSE-PRC-175

Table of Contents

1.0 Electrical Work

1.1 Application

This SOP is used to ensure worker safety and protection from electrical shock and arc flash hazards when performing electrical work on:

- **Systems of 750 volts and lower**
- **Systems over 750 volts**
- **Systems with overhead power lines**
- **Temporary power systems for construction and shutdowns**

Instrument and control systems operating at less than 50 volts are excluded from this document. Any person completing work on systems operating below 50 volts must be trained and competent.

This document does not cover hazards associated with electricity in hazardous locations. Requirements for hazardous locations are covered in Electrical Specifications, other Safe Operating Practice documents (particularly **Hot Work** SOP, Document No.175) and Site Operating Procedures.

These requirements are meant to be supplementary to any federal, provincial or local regulatory requirements.

As a minimum, the requirements of Canadian Electrical Code, Part 1, Rules 2-300 to 2-322 shall be followed.

1.2 Hazards

- Shock/Electrocution
- Fire and toxic smoke inhalation
- Arc flash/extreme heat
- Pressure wave/concussion from explosion
- Injury from tools or equipment
- Falling
- Confined space
- Noise from explosion/arc flash
- Electrical burns

1.3 Additional PPE Requirements

- Safety eyewear/arc flash rated face shield/ arc flash rated hood with UV/IR protection
- Protective footwear (CSA and Ohm rated)
- Hearing protection
- ATPV (arc thermal protective value) rated flame resistant clothing with reflective tape or FR reflective vest
- Appropriate hand and arm protection (rated for expected voltage levels)
- Personal monitor (H_2S, LEL, etc.)
- Personal keyed lock and tags for equipment lockout
- Arc flash protective clothing

Note: Jewelry, necklaces, earrings, rings or watches shall not be worn while performing electrical work.

Refer to **Section 7.3** for greater description of PPE requirements and Attachment D for job-specific PPE requirements.

1.4 Reference Documents

The references to be used in conjunction with this Standard are the latest, or referenced, editions of:

- ASTM D120, Standard Specification for Rubber Insulating Gloves
- ASTM F696, Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens
- ASTM F1449, Standard Guide for Care and Maintenance of Flame Resistant and Thermally Protective Clothing
- ASTM F1505, Standard Specification for Insulated and Insulating Hand Tools
- ASTM F1506, Standard Performance Specification for Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards
- CSA C22.1, Canadian Electrical Code
- IEC 61010-1, Safety requirements for electrical equipment for measurement, control, and laboratory use
- CSA Z462, Workplace electrical Safety
- NFPA 70B, Recommended Practice for Electrical Equipment Maintenance

- IEEE Std. 1584, IEEE Guide for Performing Arc Flash Hazard Calculations

1.5 Definitions

Boundaries:

Arc Flash Protection Boundary: The boundary around an item of equipment beyond which electrical arc flash burns will be curable (80º C skin temperature). It is determined by the system voltage, the available fault level and the fault interrupting time. Depending on the system, the arc flash protection boundary may be inside or outside some or all of the approach boundaries.

Limited Approach boundary: The boundary around an exposed energized conductor representing the outermost shock hazard distance from the conductor, and is the line which may only be crossed by qualified electrical persons. It encompasses the working clearances around the conductors and provides space for qualified electrical persons to position their bodies.

Restricted Approach boundary: An approach limit at a distance from an exposed energized electrical conductors or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit.

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

Chief Electrical Person: The authorized electrical person appointed by ConocoPhillips Canada to be responsible for the overall functioning of the electrical system.

Disconnecting/connecting: Opening or closing a switch that feeds the breaker or contactor.

Electrical Live Work: Work on equipment and systems which are either energized, or in a situation where there is nothing to prevent them being energized. The voltage may be present due to direct connection to a power source, induction from a source or not having been discharged after disconnection.

Electrical Work: The installation, alteration, repair, testing or maintenance of electrical equipment or system.

Grounding (Safety): Making a direct, low-impedance, physical connection between the normally energized, but presently isolated, parts of devices or systems and ground. The connection has sufficient capacity to carry the expected fault currents until protection operates. Before grounding, the fact of de-energization is verified.

Instrument Technicians/ Mechanics: Instrumentation work is defined as “installing (not wiring), calibrating, testing and maintaining instruments”. Qualified and competent instrument mechanic or technicians shall only be permitted to trouble shoot, calibrate, test, disconnect and re-connect wiring (in-kind) to instruments. Instrumentation personnel SHALL NOT be permitted

to work on the power circuit of electrical systems such as lighting panels and lighting circuits, motor control centers, VFD's, contactor panels, power system transformers, heat trace circuits, etc. Any wiring modifications or installation of wiring shall be performed by a Journeyman Electrician.

Hazardous Energy: This includes electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, gravitational, or any other form of energy that could cause injury due to the unintended motion, energizing, start-up or release of such stored or residual energy in machinery, equipment, piping, pipelines, or process systems.

Hazardous Location: A place where fire or explosion hazards may exist due to flammable gases or vapours, flammable or combustible liquids, combustible dust or ignitable fibres or flyings, as described in the *Canadian Electrical Code Section 18.*

Isolation (electrical): Physically disconnecting a device or system from sources of supply in such a way that inadvertent re-energization cannot take place.

Lockout (electrical): Placing locks on power isolating devices in the de-energized position to prevent these or other devices or systems from being operated and energized.

Low Risk Live Work: Electrical live work where there is minimal risk to an authorized electrical person. Examples of low risk live work are checking energized control circuits in a motor starter or performing infrared scanning on certain equipment. Generally if an acceptable meter is used by a competent worker on circuits below 750 V, the work is considered low risk but the use of tools is not low risk. Trouble shooting a circuit <750 volts with a meter and inferred scanning, on electrical equipment < 750 volts, do not require an energized electrical work permit, but work must be documented on a PJHA. Proper PPE per the Arc flash analysis is still required.

Example of low risk work would be the following;

- Voltage and current measurements
- IR scanning

Person in Charge: A qualified and certified electrical person who has been approved by the Chief Electrical Person to supervise specific work on electrical equipment and systems. Any work on a power system that operates at voltages above 750 V requires a Person in Charge and a work plan approved by the Chief Electrical Person. It is recommended that a Person in Charge be appointed for work on systems operating below 750 V, particularly if high arc flash energy is present.

PPE: Personal Protective Equipment.

Qualified Electrical Person: A Journeyman Electrician, who has training, proven technical knowledge, competency and experience in order to safely carry out operations in power systems and work on electrical equipment.

Factors that shall be considered for qualification are:

a) The degree of general training in electrical work (i.e., Journeyman Electrician, Power System Electrician, technologist or engineer) and legal requirements,
b) Experience, both in electrical work and at the present site,
c) First aid training, and
d) Familiarity with and training on the particular equipment and system.

Qualified Electrical Testing Person: A person who has sufficient technical knowledge, competency and experience with the particular equipment in order to carry out operations in power systems and work on electrical equipment specifically for purposes of maintenance and testing.

Racking Out/In: Physical movement of a circuit breaker or removable contactor from or to the connected position from an energized electrical source inside a switchgear cell.

Tagout (electrical): Attaching an identifying marker to a locking device that identifies the worker(s) who attached the lock, the date and time of placing the lock, the purpose of the lock, and as a warning to other persons not to remove the lock.

Withdrawing/Inserting: To physical removal of a circuit breaker or removable contactor from a switchgear cell or replacement into a cell.

2.0 Hazard Boundaries

The risk of electrical shock or arc flash increases as the distance between a person and/or un-insulated piece of equipment and an energized piece of electrical equipment decreases.

Please note with overhead power line or other electrical equipment, contact is not required to have personal injury or equipment damage. Once the air gap can no longer sufficiently insulate the voltage level, crossing this boundary is the same as making direct contact.

Sections 2.1 and 2.2 deal with the requirements for hazard boundaries for each, overhead power line, electric shock and electric arc flash boundaries.

2.1 Overhead Power Lines

There are significant hazards associated with contact of an energized overhead power line, the most common being electrocution. Protection against injury is to maintain safe distances from the overhead power line. No unqualified persons or equipment shall approach overhead power lines closer than the distances listed in **Attachment B, Table B1 – Exposed Moveable Conductors.**

2.2 Electric Shock and Electric Arc Flash Boundaries

There are two significant hazards associated with working on and around energized electrical equipment. These are electric shock and electric arc flash. Additional hazards arising out of arc flash may be pressure, noise, vaporized metals, shrapnel and various types of radiation (in

addition to infrared). One way to protect against injury from all these hazards is to maintain safe distances from the energized equipment. Safe distances depend on the equipment voltage, the available fault level and the fault clearing time of the protective equipment.

2.3 Electrical Shock - Limited, Restricted, and Prohibited Approach Boundaries

The limited approach boundary is an approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. Dependant on voltage level, this boundary is listed in **Attachment B, Table B1** for both exposed moveable conductors and fixed conductors or equipment parts. Unqualified persons may cross the limited approach boundary only when continuously escorted by a qualified electrical person, if this involves additionally crossing the Flash protection boundary (2.2.2), the proper Arc Flash PPE must be worn. Unqualified persons may not cross the restricted approach boundary.

The restricted approach boundary is only for qualified electrical workers and the distances are listed in **Attachment B, Table B1**. Electrical specific PPE is required to be utilized to approach the restricted approach boundary. Again, Arc Flash PPE must be worn anytime the flash protection boundary is crossed.

The prohibited approach boundary is the boundary at which work is considered the same as making contact with the energized conductor or circuit part.

Further information on these boundaries can be found in CSA Z462, or Attachment B2.

2.4 Electrical Arc Flash – Arc Flash Protection Boundary

The Arc Flash Protection Boundary is the distance from a prospective arc source within which skin could suffer incurable damage. This is generally taken as being a skin temperature of 80º C. The dimensions of the boundary depend on the available energy in the arc and the time required for the protection system to clear the fault. The distances could be calculated for each particular case but it is more practical to base them on the rating of the transformer feeding the equipment and the clearing time of the protection. Tables B2, in **Attachment B** are based on this system and should be used for determining the Arc Flash Protection Boundary.

There is considerable energy in some electric arcs and there is significant pressure built up in them. This pressure can be high enough to damage hearing, throw people away from a fault, propel objects such as relays, switches, etc. in the equipment around the area, and injure people. In addition, vaporized metals may be expelled to condense on skin, and high levels of ultra violet light (and other frequencies) can be radiated which may damage eyes. There are not yet detailed requirements worked out for safe distances from equipment to avoid injury but at present, it appears that as long as basic personal protective equipment is used, the arc flash protection boundaries give suitable spacing.

The arc flash protection boundary many only be crossed with the appropriate Arc Flash PPE.

3.0 Electrical Work on Systems 750 V and Lower

3.1 General

All electrical work on equipment and systems shall be considered energized work until the equipment and systems are proven to be de-energized. All energized electrical work requires an energized electrical work permit (CPC-ALL-ELE-FRM-2121) as identified in section 3.2.

Note: One should not choose to work directly on energized parts or be exposed to the possibility of contact with energized parts by inadvertent action if there is a practicable option of working with the equipment de-energized. Always strive to eliminate the hazard.

Energized work on systems below 750 V can only be done when the risk is minimal, by a fully trained, properly equipped, qualified and certified Journeyman Electrician and continued operation of the system is necessary. “Necessary” means either power is required for circuit troubleshooting or greater overall risk is present in de-energizing/re-energizing the circuit (including the associated process). Required PPE for energized work will be as per Attachment D.

For each task at a location, a “hazard identification” and a “risk assessment” shall be carried out by one or more competent electrical people. This analysis will review the work to be done, and all possible hazards shall be identified. Hazards shall be identified on the Pre-job Hazard assessment (PJHA) and the energized electrical work permit.

3.2 Energized Electrical Work Permit

For energized electrical work below 750V, an energized electrical work permit (CPC-ALL-ELE-FRM-2121) must be completed and attached to the PJHA. The energized electrical work permit must clearly demonstrate the need for the electrical system to remain energized (see definition of “necessary” above). The energized work permit must also list all hazards evaluated and have means such as PPE to mitigate the hazard.

Energized electrical work permits can be signed off at the field level by the Electrical & Instrumentation coordinator/lead (Surmont – include Operations Manager and site HSE representative) and the Journeymen electrician performing the work, provided the work meets the following requirements;

- Electrical system that have a nominal voltage of 600V or less and a hazard /risk category of 2 (incident energy rating equal to or less than 8 cal/cm2); or
- Electrical systems fed from a 112 KVA transformer or less, with a system secondary voltage of 600 volt or 480 volt; or
- Electrical systems fed from a 125 KVA transformer or less, with a system secondary voltage of 240 volt or less.

Note: Removal or insertion of an individual MCC cubicle on a live buss will always require a signed energized electrical work permit with Chief Electrical Persons’ approval.

Energized electrical work permits other than listed above, are required to be signed by the Chief Electrical Person, Operations Maintenance manager and the HSE Production Manager or designates and the journeyman electrician completing the work.

A cubical or disconnect can be considered de-energized provided that the disconnect is in the open position and the line side of disconnect is covered (touch safe) with no exposed energized parts. Work in the cubical is limited to fuse replacements, relay adjustment and repair of existing equipment (excluding disconnecting means). **Any work in a cubical or disconnect with exposed energized electrical equipment will require an electrical energized work permit.**

One should not choose to work directly on energized parts or be exposed to the possibility of contact with energized parts by inadvertent action if there is a practicable option of working with the equipment de-energized. Always strive to eliminate the hazard.

An example Energized Electrical Work Permit can be found in Attachment A See definition of low risk live work. Low risk live work as identified in **Attachment D** are exempt from an energized electrical permit.

3.3 Personnel

A Qualified Electrical Person must take responsibility for any work on energized or potentially energized equipment and systems, rated at 750 V and less, and shall ensure the following:

a) A PJHA and energized electrical work permit (CPC-ALL-ELE-FRM-2121) have been completed and all hazards have been identified. A Qualified Electrical Person must be involved in the PJHA process for the job.

b) Only qualified and certified Journeyman Electricians or an Electrical Apprentice under the direct supervision of a Journeyman shall work on electrical systems or equipment. A required ratio is 1:1. A second Electrical Apprentice may be used with one Electrical Journeyman where the work being performed is general labour required for the electrical work but not directly electrical work (e.g., digging, driving ground rods, supporting equipment during installation by a Journeyman, etc.).

c) All people working on electrical systems or equipment shall follow this Safe Operating Practice and any other site specific requirements established by local Operations.

d) No unnecessary people shall be within the shock protection boundary (Table B1) or the Arc Flash protection boundary (Table B2). People needed for safety reasons shall be clear of any potential arc flash blast area and equipped with the appropriate PPE.

e) Do not work alone on energized equipment except where safe work procedures have been established and approved.(TRA)

3.4 Testing Equipment and Personal Protective Equipment

As a minimum, testing equipment and personal protective equipment should be:

a) Visually inspect the testing equipment for damage before each use,

b) Visually inspect the testing equipment is appropriately rated for the service for which it will be used.

c) Visually inspect all PPE prior to use.

d) Use personal protective equipment as required by the appropriate protective measures matrix, Attachment D.

3.5 Energized Work Procedures Below 750 V

The following general procedures and information shall be applicable to all situations:

a) Anyone, including contractors, on site working on electrical equipment, shall follow this Safe Operating Practice to the necessary level.

b) All energized electrical work, will require a PJHA and Energized Electrical Work Permit (CPC-ALL-ELE-FRM-2121) as defined in section 3.2 with a detailed procedure for the activity.

c) Follow the requirements of the protective measures matrix, Attachment D, for the appropriate voltage.

d) In classified hazardous locations, check for explosive concentrations of gas (or mixture of dusts) before work and during work as appropriate. Refer to CPC Hot Work Safe Operating Practice (HSE Document No. 175). **Energized electric work shall not be done in Zone 0 locations**.

e) Test your tester on a known source before and after each use (three point test).

f) Test for voltage before you touch or ground any electrical equipment. **This shall be every conductor, every circuit, every time.**

g) On equipment fed directly from a utility, ensure that a utility operation, such as re-closing a remote switch, will not re-energize the equipment you are working on. This normally means documented isolation Guarantee of Isolation (GOI), switching, lockout/tagout and grounding procedures.

h) When working on energized equipment, eliminate all distractions such as unrelated conversations.

i) Class “C” fire extinguishers shall be kept in all electrical rooms.

j) Maintain flash protection distances from energized equipment as per Table B.2, Attachment B and shock protection boundaries per Table B.1 Attachment B.

k) Report dangerous equipment or procedures and incidents.

l) Watch for more than one source of voltage or reverse fed feeders.

m) Do not “open-circuit” the secondary of an energized current transformer.

n) Ensure that there is adequate ventilation when using solvents in confined areas.

o) In situations not covered in this Standard, discuss the situation with a supervisor and co-workers or additional technical assistance and develop a plan or procedure consistent with the hazards and risks. **Do not attempt any operation if you have doubts about its safety**.

p) The detailed scope of work for the PJHA shall be developed prior to starting the work. If the scope changes from what is on the PJHA, the PJHA becomes void and must be reissued.. This includes any modification necessary to the energized electrical work permit.

q) Do not re-energize faulted circuits as a means of troubleshooting problems (one reset).

r) An “electrical work zone” shall be set up around any energized work. This zone shall be guarded with barriers, warning signs and/or tape as appropriate to restrict access only to those authorized. Its dimensions shall be sufficient to ensure the worker can perform the tasks safely. The zone shall be adequately illuminated, shall be clear of congestion and shall have easy access and egress.

3.6 Facility Maintenance

Facility electrical equipment must be maintained and left in safe working condition in accordance with manufacturers’ specifications/recommendations, ConocoPhillips maintenance directives, and the requirements of the Canadian Electrical Code.

4.0 Energized Work on Systems Over 750 V

4.1 General

The procedures used for systems 750 V and below shall be used, plus the following extra requirements. A detailed work plan is required for any work on systems 750 volts or greater, when, trouble shooting, maintaining, grounding, de-energization / energization of new or existing equipment.

Note: As with electrical work 750 V and below, one should not choose to work directly on energized parts or be exposed to the possibility of contact with energized parts by inadvertent action if there is a practicable option of working with the equipment de-energized. Always strive to eliminate the hazard.

4.2 When Energized Electrical Work is Permitted

Electrical live work is done on systems over 750 V only when:

a) a detailed work plan has been written and approved by the CPC Chief Electrical Person,

b) an Energized Electrical Work Permit (CPC-ALL-ELE-FRM-2121) has been completed (**Attachment A**) is required when continued operation of portions of the electrical system are necessary. An example of work not requiring an energized work permit would be grounding during isolation for maintenance activities when it is part of the work plan to obtain a Guarantee of isolation (GOI) from the local supply authority.

c) a Person in Charge has been appointed;

d) fully trained and equipped people are available; and,

4.3 Energized Electrical Work Covered

The work covered here includes but is not limited to:

a) Isolation, switching or grounding of electrical equipment in order to perform maintenance; See 4.2 b above for reference.

b) testing synchronizing schemes by measuring voltages across the terminal points of a circuit breaker;

c) verifying phase relationships;

d) checking bushings by measuring voltage to ground at various points;

e) operating or moving equipment with exposed energized parts;

f) verifying the absence or presence of voltage before grounding a circuit; or,

g) testing situations where it may be necessary to meter the terminal voltages of a machine.

4.4 Requirements for Person-in-Charge

Without exception, a Person-in-Charge must be present to supervise the activity. The considerations for approval are:

a) the degree of general training (i.e., master electrician, journeyman electrician, electrical safety codes officer, electrical technologist or electrical engineer);

b) a detailed work plan has been approved by the Chief Electrical Person;

c) special training for live work at these voltages;

d) first aid and other special safety training;

e) government regulations;

f) experience, both in electrical work and at the particular site; and,

g) Familiarity with the equipment and the system.

4.5 Protective Gear

Protective clothing and equipment shall be worn and used, as required by the relevant protective measures matrix, Attachment D, or as specified in an approved procedure which meets the intent of the protective measures matrix.

Detailed requirements for protective gear, tools and metering are covered in **Section 7.0**.

4.6 Energized Electrical Work Procedures Over 750 V

Detailed procedures for live work at these voltage levels shall be worked out in advance and approved for the particular situation. Where modifications to the work plan are required for specific situations they must be approved by the Chief Electrical Person prior to commencing the work.

The step-by-step work plan should include as a minimum:

a) a listing of equipment and personnel needs;

b) obtaining notifications and approvals;

c) relevant updated electrical drawings and studies;

d) gaining access to the energized equipment;

e) verifying what parts are energized;

f) Scope of work to be preformed

g) Step by step isolation and re-energization plan;

h) returning the equipment to the original configuration;

i) revoking the approvals and notifications;

j) discussing the plan in detail with other personnel involved; and,

k) the plan shall take into account ambient conditions such as rain, humidity, and height from the ground, in planning.

Note: A sample of a work plan for isolation/re-connection is shown in Attachment E.

In addition to Chief Electrical Person Approval, obtain approvals for the work from Operations, using site-standard forms such as a PJHA and approved work plan, and notify all groups who may be affected by the work.

Wear appropriate protective clothing and equipment as outlined in the relevant protective measures matrix, Attachment D.

Use equipment and system drawings to confirm which parts are to be worked on. If necessary, produce job-specific drawings.

Check meters for safe condition, test certification and correct range before starting the work.

Maintain Minimum distances, (Shock and arc flash distances), from energized equipment as per Tables B1 and B2 in Attachment B.

Where appropriate, have an extra Qualified Electrical Person available for safety purposes, standing out of line of any potential blast and at least 3 meters from the work.

After the work has been completed, return the system to its normal configuration. If this cannot be done, the equipment shall be tagged with a warning and explanatory sign and physical access shall be prevented. Or after all work is complete and the system is returned to normal, the approval form, such as the PJHA, shall be returned and the relevant groups notified.

Touching or arcing to overhead lines is the most common electrical cause of death; care must be taken when moving equipment near overhead lines. Minimum clearance distances listed in Table B1 (Moveable Conductors), Attachment B must be maintained. This clearance includes items such as ladders, cranes and vehicles. Use an extra person for safety (spotters) and signaling.

In cases where live terminals may be exposed for some time, portable barriers or warning tapes shall be used to limit access.

5.0 Isolation, Lockout and Tagout

5.1 General

All lockout and tagout must meet the requirements of the CPC Lockout / Tagout SOP, CPC-ALL-HSE-PRC-179 or Oil sands CPC-OLS-OPS-PRC-7072.

5.2 When to Isolate, Lockout and Tagout

Isolation and lockout shall be done when the electrical equipment or the equipment being powered by it, is to be worked on. Until it can be verified that the equipment does not have any accessible energized parts, it shall be considered to be energized and the appropriate live work procedures shall be followed.

5.3 Who May Perform Isolation, Lockout and Tagout

The work shall be done by people from the following groups:

a) The initial shutdown of equipment shall be done by site-approved people.

b) Ensuring the device is isolated (e.g., “opening” a circuit breaker or switch and verifying absence of voltage) shall be done by a Qualified Electrical Person.

c) Locks and tags to prevent restoring power shall be put on the equipment by Operations personnel prior to worker access.

d) Locks and tags shall be put on by whoever will be working on the equipment.

e) Do not operate tags shall be attached and identified as to who placed the tag. Tags and locks shall be removed when the work is complete. Follow CPC’s **Lockout/Tagout Safe** Operating Practice.

5.4 Isolation, Lockout and Tagout Procedures

Prior to the work being done, a step-by-step plan shall be developed by Qualified Electrical Persons. This may be a standard procedure that is used in all similar cases in the particular operation, or one that is worked out for the particular case.

Get approvals for the work, using site-standard forms and notify all groups who may be affected by the work.

If a “utility” is involved, coordinate with them to ensure there is no chance of unexpected energization and obtain a Guarantee of Isolation (GOI)from the utility lineman.
When equipment is to be isolated and locked out, isolate all forms of energy such as steam, pressure, etc. Ensure that all test equipment and grounding devices are in safe condition and electrically rated for the maximum expected voltage and current.

Prior to starting work, the Worker in Charge will ensure the machinery or equipment has been de-energized and the energy-isolation devices have been rendered inoperative. This is often referred to as a “bump” test, and it usually involves activating the control switches including permissive signals.

Important Note: CPC expects its workers to refuse work on any equipment until it has been “bump” tested successfully and the Worker in Charge is **certain** that it is safe to proceed with the work.

After the work is complete:

a) all workers shall be accounted for;

b) all grounds shall be removed and accounted for;

c) all tools and test equipment shall be removed and accounted for;

d) surrender the GOI to the utility if applicable,

e) locks and tags shall be removed by the people who applied them, or a formally designated replacement;

f) other affected people shall be notified; and,

g) PJHA and work plan shall be signed off as complete.

6.0 Grounding

6.1 General

Grounding (safety) is only required when electrical work is to be carried out on electrical equipment or systems.

When grounding is required following isolation, lockout and tagout, to permit working on the equipment, the following shall be done:

a) Cables operated at voltages above 750 V shall be grounded when required to be isolated. Consideration will be given to grounding cables operating at voltages under 750 V.

b) Ensure that all test equipment and grounding devices are in safe condition and rated for the maximum expected voltage and current.

c) All equipment is considered energized until proven de energized by testing. In cases such as double-ended substations or auxiliary generation where there may be more than one source of power, all sources shall be checked.

d) If it is necessary to leave portions of the system ungrounded so that work such as testing can be done, the ungrounded portion should be limited to that required. All other portions shall be grounded.

e) Allow capacitors at least 5 minutes to discharge before grounding, allowing internal or external bleed resistors to function. It is also common practice to allow at least 1 minute of discharge per kV of insulation rating in lieu of depending on the 5-minute standard. Note that momentary grounding does not cause permanent discharge of capacitors and as such, ungrounded capacitors should always be treated as live circuit.

f) Before applying grounds, verify by test that the parts of the equipment being grounded are de-energized. In situations where drawout circuit breakers are used, take particular care that the cell stabs to be grounded and worked on are in fact de-energized by seeing them physically disconnected from all sources, and/or by using a voltage indicator.

Apply grounds to as much of the circuit as possible whenever it is practical to do so.

The various types of grounds and their applications are discussed in sub-section 6.2.

6.2 Grounding Devices

For situations where designated ground and test trucks cannot be used or are not available, such as medium voltage contactor cubicles, disconnect switches and motor and transformer terminals, appropriately rated safety grounds shall be used.

Ground cables shall be rated for the electrical system where the cables are installed and be as short as practical for the application.

The general form of construction of temporary grounds, often called a ground cluster, has three relatively short cables running from each phase attachment to a central terminal and a single conductor of whatever length is required going from the central terminal to the substation ground bus.

Cables shall be rated for the expected time and duration of prospective short circuit current, as shown in the Table in Attachment F calculations in Attachment G.

The terminations at both the phase and ground ends shall be chosen to:

a) have sufficient current and time capacity for the prospective fault currents and durations; and,

b) Fastened securely by a screw and clamp action to the phase terminals and ground points. (It shall not be possible to dislodge the conductor from the phase or ground points by merely pulling on the cables. Spring-operated clamps such as battery clips shall not be used.)

6.3 Grounding Procedures

The general sequence for attaching temporary grounds is as follows:

a) Visual inspection of the protective ground cables and clamps is required prior to installation.
b) Keep a record of the number and location of grounds and other items used.

c) Wear protective equipment as listed in the protective measures matrix, Attachment D.

d) Have a qualified and equipped person available out of the line of direct arc flash blast and at least 3 metres away from the worker applying grounds.

e) Isolate, lockout and tagout the equipment.

f) Gain access to the equipment by opening panels or removing covers.

g) Maintain flash and approach clearances as required by the conditions.

h) Check for the absence of potential (voltage).

i) Connect the ground (earth) end of the temporary ground to the main ground connection point.

j) Connect the phase ends of the temporary ground to the phase points on the device, using live line tools whenever possible.

k) If testing work which requires equipment to be ungrounded is going to be performed, only the equipment being tested shall be ungrounded with as much of the rest of the circuit remaining grounded.

l) Upon completion of the required work, reverse the preceding sequence making sure the same number of grounds are removed as were installed, and that all personnel are accounted for and clear of the equipment.

Note on Grounding Medium Voltage MCCs: There may be situations where it is not practical to apply fully rated grounding equipment to the load side of medium voltage contactors. The large cables and clamps cannot always fit on the cable terminations or contactor lugs. In these cases it is permissible to ground the capacitive and induced charges using cables and clamps that are not fully rated for the duty but are practical to mount in place. This non-fully rated equipment shall not be used in situations where it is possible under any circumstances for the equipment to be energized from a power source.

7.0 Equipment for Live Work

7.1 Tools

Unless they have been certified as being safe for use at a particular voltage, tools and equipment shall be considered conductive.

Tools for circuit breaker and contactor removal are usually supplied by the switchgear manufacturer. These must be used, where available, and should always be kept in the switchgear/MCC building.

In general, tools such as wrenches and screwdrivers shall not be used on equipment energized at over 750 V.

For work on equipment energized at less than 750 V, insulated tools shall be rated for the voltages on which they are used. Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used. Tools shall be rated for 1000 VAC per ASTM F1505.

All ladders used shall be non-conductive.

7.2 Meters and Indicators

Below 750 V, voltmeters, ammeters, ohm meters and other test instruments shall be suitable for the power levels involved, and as minimum have the following features:

a) Be rated to IEC 61010-1, 1000 V, Category III or 600 V, Category IV;

   Certain specialized test devices may also be acceptable as 600 V, Category III;

b) Be third-party certified (e.g., CSA, UL, TUV) to IEC 61010-1, 600 V, Category III;

c) Have leads insulated to IEC 61010-1 Overvoltage Category III;

d) Have leads that are held snug in the sockets in the meter, have permanent protective covers over the portion of the plugs which would be exposed when unplugged from the meter, and have barriers to prevent fingers from slipping off the probes onto the item being tested; and,

e) Have HRC fusing on the current functions and varistors or thermistors on the voltage and resistance functions.

Meters and indicators for use on voltages over 750 V shall be insulated for the highest voltage which may be present and provide safe clearance for users. Meters shall be tested regularly to ensure they are in safe condition, can work reliably, and can be read correctly. It is recommended that metering equipment be re-certified annually.

Portable ammeters and ohm meters shall not be used at voltages over 750 V. Clamp-on meters may be used only after appropriate procedures have been developed by Qualified Electrical Persons. Meters and indicators for use over 750 V have a relatively small scale length and are not true RMS sensing, therefore are not always convenient for troubleshooting. In cases where detailed measurements are required, measurements shall be taken with suitable meters on the low voltage side of either the instrument or power transformer.

7.3 Protective Gear

Protective equipment shall be worn in accordance with relevant protective measures matrix, Attachment D. Generally, equipment requirements are as follows:

a) ATPV (arc thermal protective value) Flame-resistant clothing is required to perform electrical work. The whole body, legs and arms shall be covered. The coveralls shall be

fully done up and shall be clean with no oil or grease soiling. They shall not be tight fitting as the air spaces between the outer fabric layer (e.g., coveralls) and inner fabric layer (e.g., clothing) provide extra fire protection. Care must be taken when using the switching coat style of protection as body positioning can cause the coat to open.

b) ConocoPhillips requires that coveralls meet the ConocoPhillips PPE standard.

c) Long-sleeved shirt and pants combination, using cotton material and providing the same coverage as described above, shall be worn under the ATPV coveralls. No conductive material (belt buckles, jewelry), shall be worn under coveralls.

d) For some high energy situations, a “flash suit” is required to provide extra protection when listed in the protective measures matrix, **Attachment D**. A flash suit is comprised of secure fastening at all points such that blast effects will not penetrate through any openings in the suit. It is closed securely at the neck, wrists and feet. The head is protected by hood, a Class E hard hat and ATPV rated face shield. **The clothing system and face shield must always be selected and rated for the expected arc flash energy.**

e) For intermediate energy situations, a “switching coat or equal” shall be used. **The clothing system and face shield must always be selected and rated for the expected arc flash energy.**

f) For work outdoors in poor weather condition, waterproof flame-resistant clothing is available. However, one should always evaluate the risks associated with electrical or any other work in poor weather conditions.

g) ATPV rated clothing shall be laundered in accordance with the manufacturer’s recommendations or ASTM F1449.

h) Nylon, polyester and other similar synthetic materials shall not be used, even under flame-resistant clothing.

Safety glasses are required for all electrical work.

Eyeglasses or goggles with CSA high-impact shaded polycarbonate lenses (e.g., UVEX SCT Lo IR) for indoor or low light applications are recommended to reduce the incidence or infrared radiation arc flashes as listed in the protective measures matrix, Attachment D. Note this protection will reduce eye damage but not necessarily eliminate it. However, it is considered to be a fair compromise between protection and enabling sufficient vision to perform work in a safe manner. Polycarbonate lenses provide nearly 100% protection from ultraviolet radiation.

Approved prescription safety glasses (with side shields) with a 1.2 to 1.3 brown tint are also permitted.

A face shield (with applicable ATPV) attached to a Class E polycarbonate hard hat is required when specified in the protective measures matrix, **Attachment D**.

A Class E hard hat is required meeting the most current version of CAN/CSA – Z94.1 or ANSI Z89.1.

Hearing protection is required.

Work boots must meet all ConocoPhillips safety requirements, but specifically for electrical work, must be ohm-rated per CSA standards and so indicate on the boot (orange omega symbol).

Glove requirements are as follows:

- For live work at 750 V and below, clean leather gloves with extended wrist section shall be worn as a minimum. It is preferred that Class 0 rubber gloves be worn for live work at 750 V and below.

- For live work over 750 V, gloves which meet Class 1 (for use to 7500 V) or Class 2 (for use to 17,000 V) requirements of ASTM D120 are required.

- Voltage rated gloves shall be stored in a dry location away from oil and ozone. They shall be inspected for damage before each use. They shall be tested in a certified laboratory and bear a certification label not exceeding 6 months in age. Leather protectors (outer gloves per ASTM F696) shall be worn over the rubber gloves for protection and shall comply with ASTM F696 for cuff spacing to top of rubber glove. Gloves shall be stored with protectors removed and in a bag designed specifically for the purpose.

Note: Rings, watches, and other body jewelry shall **not** be worn.

All electrical specific PPE, Safety ground cables, ATPV face shields, ATPV (arc thermal protective value) clothing shall be visually inspected prior to use.

Electrical specific PPE shall be tested on the following intervals:
- Gloves – Every 6 Months (Program with a Certified testing agency)
- Hot Sticks – Every 12 Months (Program with a Certified testing agency)
- Voltage Rescue Stick-Certified prior to installation and certified every 3 years.
- High voltage testers recertified every three years.

8.0 Overhead Line Work

8.1 General

Working on overhead lines is considered a specialized trade and it is not expected that ConocoPhillips workers will perform any work on overhead lines unless they have successfully completed the extensive training required for certification in this work.

This work should therefore be contracted out to CPC-approved firms with trained and experienced workers.

All live line work shall be carried out under a ConocoPhillips PJHA, created by ConocoPhillips Qualified Electrical Person.

8.2 ConocoPhillips Involvement

On ConocoPhillips-owned overhead power distribution systems, the responsibility of the ConocoPhillips Qualified Electrical Person is to ensure contractors working on overhead lines have appropriate safety programs for this type of work, and that contractors meet ConocoPhillips minimum electrical safety requirements.

Decide if the work must be done on energized lines or if a shutdown is possible. Work on energized lines shall only be done when:

a) The risk is assessed as minimal;

b) Competent and fully equipped people are available;

c) Continued operation of the system is essential; and

d) A risk assessment has been completed and documented for the live line work.

Make sure the contractor is using adequately trained and equipped workers.

Ensure the contractor understands ConocoPhillips' expectations and their responsibilities.

All workers on the job shall be certified for the work they will be doing. Ask for and obtain copies of their certification before the work commences.

Equipment such as gloves, insulating blankets, hot sticks and bucket trucks shall have passed a hi-pot test within the previous year. Certifications shall be checked for test date stamp.

Other equipment, such as climbing spikes, ladders and tools, shall be in good condition. Meters and indicators as well as test date/certifications shall be inspected before use.

Ensure that conditions are safe at the time of work and workers are not being forced to do something they consider to be unsafe.

Discuss the work plan with the contractor to be sure the procedures will be safe and that all workers know what they are to do.

Arrange for approvals and clearances so that work may be done. This may include other contractors and electric utilities in addition to ConocoPhillips.

Arrange for emergency equipment to be available, if needed, as determined in the PJHA.

9.0 Temporary Systems

9.1 General

The following are the requirements for electrical safety when temporary power supply systems are used such as during construction and shutdowns or while repairs are being made to the regular system.

As a minimum, the requirements of Section 76 of the Canadian Electrical Code shall be met for any temporary facilities, permitting and inspections as per the Electrical Quality Management Plan (QMP).

Temporary facilities shall be kept in service for the shortest possible time. Maximum duration of a temporary installation is 1 year. If the installation is to be continued beyond 1 year, then it shall be re-approved.

9.2 Physical Protection

All equipment used in temporary installations shall be protected by suitable barriers so that damage does not occur due to vehicles, construction equipment and other things.

Temporary cables shall be protected from damage by means such as routing them away from high traffic areas, and where this is not possible, by use of wooden planking and covers. Where cables go into a piece of equipment, movement of the cable or equipment by up to 100 mm shall not place mechanical stress on either the cable or equipment.

Where cables are run overhead, they shall be either high enough to avoid vehicles or be run where vehicles are not permitted to travel.

Wherever possible, overhead lines shall not be run over roads of any type. Where this cannot be avoided, the lines shall be run high enough so that Limited Approach Clearances to conductors listed in Table B1 in Attachment B will be maintained for all types of vehicles and equipment that will be using the roadway. There shall be warning markers placed on the road, on both sides of the line, prior to reaching the lines. If an oversized vehicle has to use the road, the line shall be de-energized.

9.3 Grounds

The frames of all temporary equipment shall be grounded to the ground grid through the ground conductor of the supply cable from the distribution panel or a separate ground cable.

The distribution panel itself shall be grounded to the ground grid.

Welding and portable generators must be grounded. Motor vehicle mounted welding units are not required to be connected to the ground grid.

The star point of the supply transformer shall be grounded either solidly or through a neutral grounding resistor. Ungrounded systems shall not be accepted.

9.4 Protection

Before energizing a temporary system, the protection system shall be checked to ensure that all fuses, relays and circuit breakers are in good condition and suitably rated for the duty, ratings, protection and coordination.

10.0 Switching / Isolation / Re-connection Procedures

Locations shall have written switching, isolation and re-connection procedures developed prior to commencing work for all situations involving systems operating at over 750 V. These procedures may be generic for certain types of equipment or systems but are preferred to be site or job specific.

Consideration should be given to preparing switching, isolation and re-connection procedures ahead of time for systems below 750 V that have high fault capacities or high complexity.

Reference Attachment E for example.

Attachment A – Energized Electrical Work Permit (CPC-ALL-ELE-FRM-2121)

PJHA Number _____

PART I: TO BE COMPLETED BY THE REQUESTER:

(1) Description of circuit/equipment/job location: _____

_____

(2) Description of work to be done: _____

(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:

_____

_____

Start Date: _____ Expire Date: _____

_____

Requester/Title Date

PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS *DOING* THE WORK:

(1) Detailed job description procedure to be used in performing the above detailed work including hazards, conditions, mechanical, environmental, space obstructions, other voltages:_____

_____

_____

_____

(2) Description of the Safe Work Practices: ☐ Work Plan ☐ Electrical SOP ☐ LOTO ☐ Two Workers ☐Safety Watch _____

_____

(3)

HRC (1 to 4)		Shock Hazard (max V)		Glove Class, minimum	
Arc Flash Boundary		Limited Approach			
Incident Energy (cal/cm^2)		Restricted Approach			
		Prohibited Approach			

(4) Protective Equipment

☐ Natural Fiber Clothing	☐ Safety Glasses/Goggles	☐ Ear Plugs	☐ Ohm Rated Boots
☐ FR ATPV Clothing	☐ ATPV Face Shield	☐ Leather Gloves	☐ Class E Hard Hat
☐ Voltage-rated Tools	☐ ATPV Balaclava Hood	☐ Voltage-rated Gloves	☐
☐ Category III or IV Meter	☐ ATPV Switching Hood	☐ ATPV Arc Flash suit	☐ Other

Other _____

(5) Means employed to restrict the access of unqualified persons from the work area: _____

(6) Qualified Electrical Worker (s)_____ _____

_____ _____

PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:

_____ _____

Chief Electrical Person / (EI Lead ,<750V < Cat2) Date HSE Prod Manager/(Site HSE ,<750V< Cat2) Date

_____ _____

Qualified Electrical Worker(s) Date Technical/Operations Manager Date

Return to: HSE Ops Specialist.

Attachment B – Approach Distances

Table B1 – Electric Shock Approach Distances – Exposed Moveable Conductors and Exposed Fixed Circuit Part

Exposed Moveable Conductor (Overhead Power Line) Voltage	Limited Approach Boundary	Restricted Approach Boundary	Prohibited Approach Boundary
Less than 300V	3.05 m	Avoid Contact	Avoid Contact
301V – 600V	3.05 m	305 mm	30 mm
1.0 – 15.0 kV	3.05 m	660 mm	178 mm
15.1 – 36.0 kV	3.05 m	787 mm	254 mm
35.1 – 121.0 kV	4.5 m	1.02 m	838 mm
138 – 145 kV	4.5 m	1.17 m	1.02 m
161 – 169 kV	5.0 m	1.29m	1.14m
230-362 kV	7.0 m	2.79 m	2.64 m
500kV	7.0 m	3.61 m	3.45 m

Exposed Fixed Circuit Part Voltage	Limited Approach Boundary	Restricted Approach Boundary	Prohibited Approach Boundary
Less than 300V	2.5 m	Avoid Contact	Avoid Contact
301V – 600V	2.5 m	305 mm	30 mm
1.0 – 15.0 kV	2.7 m	660 mm	178 mm
15.1 – 36.0 kV	3.2 m	787 mm	254 mm
35.1 – 121.0 kV	3.5 m	1.02 m	838 mm
138 – 145 kV	3.5 m	1.17 m	1.02 m
161 – 169 kV	4.1 m	1.29 m	1.14 m
230 - 362 kV	5.1 m	2.79 m	2.64 m
500 kV	7.24 m	4.85 m	4.7 m

Notes:

1. Only qualified persons shall be permitted within the limited approach boundary. Unqualified persons crossing the limited approach boundary must meet the requirements of 2.2.1.
2. The Flash Protection boundary may be greater than the limited approach boundary. Proper Electrical PPE is required anytime the Limited Approach boundary or the Flash Protection boundary are crossed.

3. Adapted from IEEE Standards.
4. For voltages not listed, use the clearances for the next higher voltage level listed.
5. These distances shall be used in conjunction with distances on the Electrical Flash Table (Tables B2) and Protective Measures Matrix, Attachment D.

6. The approach distances are found in CSA Z462 Table 1, differentiating between fixed and moveable conductors. The Alberta Electrical and Communication Utility Code Table 2-1 (Overhead Power Lines) and Table 8-1 have been used for Minimum Safe Clearance Distances where these distances exceed the requirements in CSA Z462.

Table B2 – Arc Flash Protection Boundary Chart, Bare Skin (1.2 cal/ cm^2), Any Voltage Level

Transformer kVA	15 Cycle Breaker	2 Second Clearing Time
150 kVA	0.48 m	1.36 m
500 kVA	0.88 m	2.48 m
1000 kVA	1.11 m	3.51 m
2000 kVA	1.57 m	4.96 m
5000 kVA	2.48 m	7.84 m
10 000 kVA	3.51 m	11.1 m

Notes:

1. These distances shall be used coupled with distances established in Table B1 and protective measures from the protective measures matrix in Attachment D.

2. Alternatively, flash protection boundaries may be calculated under engineering supervision and application of suitable protective measures. A useful reference for the calculations can be found on the IEEE PCIC Safety Subcommittee Web site where a spreadsheet can be downloaded for calculating incident energies and safe distances.

3. Bare skin can tolerate approximately 1.2 cal/cm^2 applied over a period of approximately 1.0 second or less before second degree burns occur. ATPV rated coveralls per the CPC PPE standard must be worn at a minimum.

4. Depending on the incident energy, clear polycarbonate safety glasses or face shields may not supply sufficient protection to avoid eye or facial skin damage. Therefore, arc flash rated face shields shall be used for incident energies above 1.2 cal/cm^2.

5. For transformer sizes not listed, use the next higher transformer size listed or an engineering calculation is required.

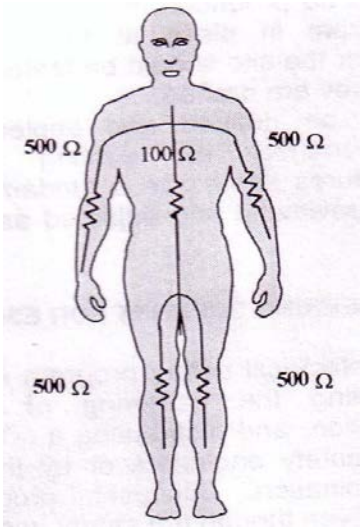
6. Current limiting fuse acts on high currents to initiate the interruption of currents in the first ¼ cycle and completely extinguishes the current in ½ cycle or less. Most circuit breakers clear a fault in 6 cycles, but 15 cycle data is given for delayed operation cases where deliberate time delay may have been introduced for coordination purposes. **For a person not familiar with the interrupting characteristics of a piece of electrical equipment, the two second boundary shall be used.**

7. The calculations assume a transformer impedance of 5% for ratings 750 kVA and higher, and 4% for smaller transformers. This is expected to be the worst case condition (i.e., the safest assumption).

Attachment C – Effect of Electric Current on Human Body

Effect of Current	Current in Men (mA)	Current in Women (mA)
Slight sensation in hand	0.4	0.3
Perception threshold	1.1	0.7
Shock – not painful; Muscular control not lost	1.8	1.2
Shock – painful; Muscular control not lost	9	6
Shock – painful and severe; Muscular contractions, breathing difficult	23	15
Shock – Possible ventricular fibrillation effect from 3-second shocks	100	100

Current Flow Through the Human Body at 120 V



Current Flow from Hand to Hand = 120 V / (500 ohms + 500 ohms) = 120 mA

Current Flow from Hand to Leg = 120 V / (500 ohms + 100 ohms + 500 ohms) = 110 mA

(e.g., a typical cellular phone charger operating at 120 V and 150 mA is potentially lethal.)

Attachment D – Protective Measures Matrix for Electrical Work

Table D1 – Protective Measures for 120/208/240 V

X = Required R = Recommended	Special Equipment							Procedures						Personal Protective Equipment (6)											
														Basic			Shock				FLASH				
TASKS	Hazard / Risk Category (11)	Fall Protection (4)	Low Voltage Tester (1)	High Voltage Detector / Voltmeter / Glow Tester	Live Line Tools (2)	Voltage-rated Fuse Puller	Grounding Clusters	PJHA (3) or TRA	Work Plan Required	Energized Electrical work permit required	De-energize, Lock and Tag	Utility Contacted	Qualified Back-up	Safety Glasses	Class E Hard Hat	Flame Resistant Clothing	Voltage-rated Gloves w/Leather Protectors (10)	Hearing Protection	Rubber Blankets / Line Guards	Insulated Sleeves	Tinted Safety Glasses	Arc Rated Face Shield (9)	Leather Gloves	Flash Suit or Switching Coat (5)
Troubleshooting Controls (7)	1		X					X						X	X	X	R	R			X	X	X	
Inspection with Doors Open (7)	0/1							X						X	X	X	R	R			X	X	X	
Voltage or Current Readings	1		X					X						X	X	X	R	R			X	X	X	
Re-lamping	1	X	X					X			R(5)			X	X	X		R			X	X	R	
Heat Tracing	1		X					X						X	X	X	R	R			X	X	X	
Working on Control Wiring / Instrumentation 50 v – 120 volts	1		X					X						X	X	X	R	R	R		R	R	X	
Installing / removing conduits and cables in an energized lighting / UPS / EHT panel	2		X					X		X	R(5)			X	X	X	X	R			X	X	X	
Installing cables or conduit in a field junction box / control panels	1		X					X			R(5)			X	X	X	X	R			X	X	X	
UPS (12)	1		X					X			R(5)			X	X	X	R	R			X	X	X	
Remove / Install Breaker	2		X					X		X	R(5)			X	X	X	R	R			X	X	X	
Close/Open Breaker or Disconnect Switch	0							X						X	X	X	R	R			R	R	X	
Infrared Scanning	0							X						X	X	X		R			X	R	R	
Replace Fuses after de-energized 0 volts	1		X			X		X						X	X	X	R	R			X	X	X	
Other Live Work	1							X	X	X	R(5)			X	X	X	X	R			X	X	X	
Meggering	1		X					X			X			X	X	X	R	R			X	X	X	
Troubleshoot VFD Power Circuits	1		X			X		X			R(5)			X	X	X	X	R			X	X	X	

Table D1 - cont'd

Category 1	**0 to 4 cal/cm2**
Category 2	**4.1 to 8 cal/cm2**
Category 3	**8.1 to 25 cal/cm2**
Category 4	**25.1 to 40cal/cm2**

Notes:

1. Use voltage sensing tester or clamp-on CT.
2. To include hot stick or shotgun.
3. Where required by local procedure or where a TRA (Task Risk Assessment) exists.
4. Body harness, body belts, safety straps, lanyard; fall protection is required where there is a danger of falling.
5. As required by PJHA, TRA, or Work plan.
6. PPE requirements for the qualified backup are identical to those of the person performing the work. Observers/helpers shall use the basic PPE.
7. Low risk portion of work only.
8. (reserved for future)
9. Use tinted face shield when incident energy exceeds 1.2 cal/cm^2, balaclava is recommended with the use of a face shield.
10. Clean leather gloves with extended cuffs are acceptable.
11. Calculated arc flash hazard values listed on the single lines are to be used to determine PPE requirements. If there is no arc flash hazard values provided then use the values listed in the Hazard /Risk Category Column.
12. When working on UPS battery systems,acid resistant PPE and face shield is required.

Table D2 – Protective Measures for 480 V and 600 V Line to Line (includes 277 V line to neutral and 347 V line to neutral)

X = Required R = Recommended	Special Equipment							Procedures						Personal Protective Equipment (6)										
														Basic			Shock				Flash			
TASKS	Hazard / Risk Category (14)	Fall Protection (4)	Low Voltage Tester (1)	High Voltage Detector / Voltmeter / Glow Tester	Live Line Tools (2)	Voltage-rated Fuse Puller	Grounding Clusters	PJHA (3) or TRA	Work Plan Required	Energized Electrical work permit required	De-energize, Lock and Tag	Utility Contacted	Qualified Back-up	Safety Glasses	Class E Hard Hat	Flame Resistant Clothing	Voltage-rated Gloves w/Leather Protectors (10)	Hearing Protection	Rubber Blankets / Line Guards	Insulated Sleeves	Tinted Safety Glasses	Face Shield & Balaclava(9)	Leather Gloves	Flash Suit or Switching Coat Including Hood (5)
Troubleshooting Controls (7)	2		X					X						X	X	X	R	R			R	X	X	
Inspection with Doors Open (7)	1							X						X	X	X	R	R			R	X	X	
Voltage or Current Readings	2		X					X						X	X	X	R	R			X	X	X	
Re-lamping	2	X	X					X			R(5)			X	X	X		R			X		R	
Heat Tracing	2		X					X						X	X	X	X	R			X	X	R	
Remove / Install Breaker or Bucket	4		X					X	X	X			X (13)	X	X	X	X	R			X		R	X(5)
Installing / removing conduits and cables in an energized MCC	4		X					X	X	X			X (13)	X	X	X	X	R			X	X		X(5)
CB or fused switch operation covers off	1		X					X						X	X	X	X	R			X	X	R	
CB or fused switch operation covers on	0							X						X	X	X		R			X		R	
Rack Breaker In/Out	4							X						X	X	X		R			X		R	X(5)
Add/Remove Grounding (12) after 0V check	2		X				X	X	X		X		X	X	X	X	X	R			X		R	X(5)
Replace Fuses (De-energized) after 0V check	2		X			X		X						X	X	X	R	R			X	X	X	
Infrared Scanning	1							X						X	X	X		R			R	X	R	
Other Live Work	2		X		X			X	X	X			X	X	X	X	X	R			X		R	X(5)
Meggering	0		X					X			X			X	X	X	R	R			R		X	
Troubleshoot VFD Power Circuits	2		X			X		X						X	X	X	X	R			X		R	X(5)

Table D2 - cont'd

Category 1	**0 to 4 cal/cm2**
Category 2	**4.1 to 8 cal/cm2**
Category 3	**8.1 to 25 cal/cm2**
Category 4	**25.1 to 40cal/cm2**

Notes:

1. Use voltage sensing tester or clamp-on CT.
2. To include hot stick or shotgun.
3. Where required by local procedure.
4. Body harness, body belts, safety straps, lanyard; fall protection is required where there is a danger of falling.
5. As required by Risk Assessment.
6. PPE requirements for the qualified backup are identical to those of the person performing the work. Observers/helpers shall use the basic PPE.
7. Low risk portion of work only.
8. (reserved for future)
9. Use tinted face shield when incident energy exceeds 1.2 cal/cm^2.
10. Clean leather gloves with extended cuffs are acceptable.
11. (reserved for future)
12. Grounding of voltages below 750 V is not a minimum requirement.
13. May be a safety person only, i.e., not electrically qualified.
14. Calculated arc flash hazard values listed on the single lines are to be used to determine PPE requirements. If there is no arc flash hazard values provided then use the values listed in the Hazard /Risk Category Column.

Table D3 – Protective Measures for 2000 V to 5000 V

X = Required R = Recommended	Special Equipment							Procedures						Personal Protective Equipment (6)										
														Basic			Shock				Flash			
TASKS	Hazard / Risk Category (11)	Fall Protection (4)	Low Voltage Tester (1)	High Voltage Detector / Voltmeter / Glow Tester	Live Line Tools (2)	Voltage-rated Fuse Puller	Grounding Clusters	PJHA (3)	Work Plan Required	Energized Electrical work permit required	De-energize, Lock and Tag	Utility Contacted	Qualified Back-up	Safety Glasses	Polycarbonate Class E Hard Hat	Flame Resistant Clothing	Voltage-rated Gloves w/Leather Protectors	Hearing Protection	Rubber Blankets / Line Guards	Insulated Sleeves	Tinted Safety Glasses	Face Shield (9)	Leather Gloves	Flash Suit or Switching Coat Including Hood (5)
Troubleshooting Controls 120V (7)	2		X					X	R					X	X	X	R				R		X	
Inside Safe Limit of Approach (Qualified)	4			X	X			X					R	X	X	X	X	R	X	X	X			X(5)
Inside Safe Clearance Distance (Qualified)	3			X	X			X	X				X	X	X	X	X	R	X	X	R			X(5)
Voltage or Current Readings (8)	4			X	X			X	R	X			X	X	X	X	X	R			X			X(5)
Rack Breaker In/Out w/Door Closed	4							X					R	X	X	X			X		R		X	X(5)
Rack Breaker In/Out w/Door Open	4							X	X				X	X	X	X			X		R		X	X (5)
Close/Open Breaker or Disconnect Switch	2							X						X	X	X	R		X		R		X	R
Open/Close Disconnects or Fuses w/Hot Stick	3			X	X			X					X	X	X	X	X	R			R			X (5)
Apply/Remove Grounds	4			X	X		X	X	X		X		X	X	X	X	X				X			X (5)
Replace Fuses (De-energized)	2			X		R		X			X	X		X	X	X	X				R			
Infrared Scanning doors open	3							X	R				X	X	X	X		R	X		R		X	X(5)
Other Live Work	4			X	X			X	X	X		X	X	X	X	X	X	R	X	X	R			X (5)
Live Line Work	4	X		X	X			X	X	X		X	X	X	X	X	X	R	X	X	R			X (5)
Troubleshoot VFD Power Circuits	4			X	X	X		X	X	X			X	X	X	X	X	R	X		R			X (5)
Troubleshooting Controls 240V (7)	3		X					X	R					X	X	X	R				R		X	

Table D3 - cont'd

Category 1	**0 to 4 cal/cm2**
Category 2	**4.1 to 8 cal/cm2**
Category 3	**8.1 to 25 cal/cm2**
Category 4	**25.1 to 40cal/cm2**

Notes:

1. Use voltage sensing tester or clamp-on CT.
2. To include hot stick or shotgun.
3. Where required by local procedure.
4. Body harness, body belts, safety straps, lanyard; fall protection is required where there is a danger of falling.
5. As required by Risk Assessment.
6. PPE requirements for the qualified backup are identical to those of the person performing the work. Observers/helpers shall use the basic PPE.
7. Low risk portion of work only.
8. Use of voltage detector on a hot stick does not count as taking voltage readings. In this case, Safe Limits of Approach and Safe Clearance Distances apply.
9. Use tinted face shield when incident energy exceeds 1.2 cal/cm^2.
10. (reserved for future)
11. Calculated arc flash hazard values listed on the single lines are to be used to determine PPE requirements. If there is no arc flash hazard values provided then use the values listed in the Hazard /Risk Category Column.

Table D4 – Protective Measures for Greater Than 5000 V to Less Than 15,000 V

X = Required R = Recommended	Special Equipment							Procedures						Personal Protective Equipment (6)											
														Basic			Shock				Flash			
TASKS	Hazard / Risk Category (10)	Fall Protection (4)	Low Voltage Tester (1)	High Voltage Detector / Voltmeter / Glow Tester	Live Line Tools (2)	Voltage-rated Fuse Puller	Grounding Clusters	PJHA (3)	Work Plan Required	Energized Electrical work permit required	De-energize, Lock and Tag	Utility Contacted	Qualified Back-up	Safety Glasses	Class E Hard Hat	Flame Resistant Clothing	Voltage-rated Gloves w/Leather Protectors	Hearing Protection	Rubber Blankets / Line Guards	Insulated Sleeves	Tinted Safety Glasses	Face Shield (9)	Leather Gloves	Flash Suit or Switching Coat Including Hood (5)
Troubleshooting Controls 120/240V (7)			X					X	R					X	X	X	R				R		X	
Inside Safe Limit of Approach (Qualified)				X	X			X					R	X	X	X	X	R	X	X	R	X		X(5)
Inside Safe Clearance Distance (Qualified)				X	X			X	X				X	X	X	X	X	R	X	X	R	X		X(5)
Voltage or Current Readings (8)				X	X			X	R				X	X	X	X	X	R			X	X		X(5)
Rack Breaker In/Out w/Door Closed								X					R	X	X	X	R				X		X	
Rack Breaker In/Out w/Door Open								X	X				X	X	X	X	R				X	X	X	X(5)
Close/Open Breaker or Disconnect Switch								X						X	X	X	R				R		X	
Open/Close Disconnects or Fuses w/Hot Stick				X	X			X					X	X	X	X	X	R			R	X		
Apply/Remove Grounds				X	X		X	X	X		X		X	X	X	X	X				X	X		
Replace Fuses (De-energized)				X		R		X			X	X		X	X	X	X				R			
Meggering/Hi-poting				X				X	X		X			X	X	X	R				R		X	
Infrared Scanning								X	R				X	X	X	X		R			R	X	X	X(5)
Other Live Work				X	X			X	X	X		X	X	X	X	X	X	X	X	X	R	X		X(5)
Live Line Work		X		X	X			X	X	X		X	X	X	X	X	X	X	X	X	R	X		X(5)
Troubleshoot VFD Power Circuits				X	X	X		X	X	X			X	X	X	X	X	X	X	X	R	X		X(5)

Table D4 - cont'd

Category 1	**0 to 4 cal/cm2**
Category 2	**4.1 to 8 cal/cm2**
Category 3	**8.1 to 25 cal/cm2**
Category 4	**40cal/cm2**

Notes:

1. Use voltage sensing tester or clamp-on CT.
2. To include hot stick or shotgun.
3. Where required by local procedure.
4. Body harness, body belts, safety straps, lanyard; fall protection is required where there is a danger of falling. Use spurs and climbing/safety belt for climbing wood poles.
5. As required by Risk Assessment.
6. PPE requirements for the qualified backup are identical to those of the person performing the work. Observers/helpers shall use the basic PPE.
7. Low risk portion of work only.
8. Use of voltage detector on a hot stick does not count as taking voltage readings. In this case, Safe Limits of Approach and Safe Clearance Distances apply.
9. Use tinted face shield when incident energy exceeds 1.2 cal/cm^2.
10. Calculated arc flash hazard values listed on the single lines are to be used to determine PPE requirements.

Table D5 – Protective Measures for Greater Than 15,000 V

X = Required R = Recommended	Special Equipment							Procedures						Personal Protective Equipment (6)										
														Basic			Shock				Flash			
Low Voltage Tester (1)	Hazard / Risk Category (10)	Fall Protection (4)		High Voltage Detector / Voltmeter / Glow Tester	Live Line Tools (2)	Voltage-rated Fuse Puller	Grounding Clusters	PJHA (3)	Work Plan Required	Energized Electrical work permit required	De-energize, Lock and Tag	Utility Contacted	Qualified Back-up	Safety Glasses	Class E Hard Hat	Flame Resistant Clothing	Voltage-rated Gloves w/Leather Protectors	Hearing Protection	Rubber Blankets / Line Guards	Insulated Sleeves	Tinted Safety Glasses	Face Shield (9)	Leather Gloves	Flash Suit or Switching Coat Including Hood (5)
Troubleshooting Controls 120/240V (7)			X					X	R					X	X	X	R				R		X	
Inside Safe Limit of Approach (Qualified)				X	X			X					R	X	X	X	X	R	X		X	X		
Inside Safe Clearance Distance (Qualified)				X	X			X	X				X	X	X	X	X	R	X	X	X	X		X(5)
Voltage or Current Readings (8)				X	X			X	X				X	X	X	X	X	R			X	X		X(5)
Rack Breaker In/Out w/Door Closed								X	X				R	X	X	X	R				R		X	
Rack Breaker In/Out w/Door Open								X	X				X	X	X	X	R				R	X	X	X(5)
Close/Open Breaker or Load Break Switch								X					R	X	X	X	R				X		X	
Open/Close Disconnects or Fuses w/Hot Stick				X	X			X	X				X	X	X	X	X	R			X	X		
Apply/Remove Grounds				X	X		X	X	X		X		X	X	X	X	X				X	X		
Replace Fuses (De-energized)				X		R		X			X	X		X	X	X	X				X			
Meggering/Hi-poting				X				X	X		X			X	X	X	R				X		X	
Infrared Scanning								X	X				X	X	X	X		X			R	X	X	X(5)
Other Live Work				X	X			X	X			X	X	X	X	X	X	X	X	X	X	X		X(5)
Live Line Work		X		X	X			X	X			X	X	X	X	X	X	X	X	X	X	X		X(5)

Table D5 - cont'd

Category 1	**0 to 4 cal/cm2**
Category 2	**4.1 to 8 cal/cm2**
Category 3	**8.1 to 25 cal/cm2**
Category 4	**40cal/cm2**

Notes:

1. Use voltage sensing tester or clamp-on CT.
2. To include hot stick or shotgun.
3. Where required by local procedure.
4. Body harness, body belts, safety straps, lanyard; fall protection is required where there is a danger of falling. Use spurs and climbing/safety belt for climbing wood poles.
5. As required by Risk Assessment.
6. PPE requirements for the qualified backup are identical to those of the person performing the work. Observers/helpers shall use the basic PPE.
7. Low risk portion of work only.
8. Use of voltage detector on a hot stick does not count as taking voltage readings. In this case, Safe Limits of Approach and Safe Clearance Distances apply.
9. Use tinted face shield when incident energy exceeds 1.2 cal/cm^2.
10. Calculated arc flash hazard values listed on the single lines are to be used to determine PPE requirements.

Table D6 – Protective Measures for General Activities (To Be Used in Addition to Tables D1 to D5)

X = Required R = Recommended	Special Equipment				Procedures				Personal Protective Equipment (6)					
									Basic			Special		
TASKS	Fall Protection (4)	Battery Voltage Tester (3)	Voltage Rated Tools	Grounding Clusters	PJHA (3)	Confined Space Permit	De-energize, Lock and Tag	Qualified Back-up	Safety Glasses	Polycarbonate Class E Hard Hat	Flame Resistant Clothing	Face Shield (9)	Leather Gloves	Special (10)
Entering Manhole	X				X	X		X	X	X	X		X	
Entering Transformer	X			X	X	X	X	X	X	X	X		X	
Battery Work		X	X		X				X	X	X	X		X

Notes:

1. Use voltage sensing tester.
2. To include hot stick or shotgun.
3. Where required by local procedure.
4. Body harness, body belts, safety straps, lanyard; fall protection is required where there is a danger of falling. Use spurs and climbing/safety belt for climbing wood poles.
5. As required by Risk Assessment.
6. PPE requirements for the qualified backup are identical to those of the person performing the work. Observers/helpers shall use the basic PPE.
7. Low risk portion of work only.
8. (reserved for future)
9. Use tinted face shield when incident energy exceeds 1.2 cal/cm^2.
10. Chemical-rated apron and gloves required.

Attachment E – Example Work Plan for Isolation / Re-connection

ALDER FLATS GAS PLANT LSD 10-9-45-8 W5M

ELECTRIC WORK PLAN – MAIN DISCONNECT SWITCH, TRANSFORMER DISCONNECT SWITCH AND THE INDIVIDUAL MOTOR STARTER

1) PROJECT OVERVIEW

Maintenance and testing on the 4160 volt system at the Alder Flats facility. Maintenance testing will include the Main switch, the individual starter testing of the motor contactor, control relays, motor leads and motor.

2) SYSTEM DESCRIPTION

a) The 4160 volt distribution is fed from a 25 KVA / 480 Volt 1500 KVA transformer which feeds the 600 Amp main load break disconnect switch. There is a 200 amp disconnect that feeds CD-103 1000 hp inlet compressor and a 200 amp load break disconnect that feeds a 750 KVA 4160 /480 Volt 3 phase transformer that that feeds the 480 volt MCC 1.

3) REASON FOR WORK

General maintenance testing, cleaning.

4) SCOPE OF WORK

WORK INVOLVES THE CUBICLES FOR AN INDIVIDUAL COMPRESSOR MOTOR

a) All loads will be shut down and locked out.
b) All possible sources of back-feed will be investigated, including power factor capacitor banks. Such sources of power will be isolated, discharged and grounded, and made safe.
c). All parties listed in the Work Plan will review and sign off on the work plan
d) Upon completion of the work, the 4160 volt system will be re-energized in accordance with the Work Plan.

5) SPECIAL CONSIDERATIONS:

6) TOOLS AND EQUIPMENT

The following tools and equipment shall be provided at site and all such devices shall be rated for the work being performed:

a) High voltage tester
b) Hot stick
c) Voltage rated grounding cluster(s)
d) Testing tools and equipment as required
e) Capacitor shorting stick
f) Voltage rated gloves

g) Tool Log List for Misc. tools required for the Tasks

7) PPE REQUIREMENTS

The following suitably rated PPEs shall be worn while doing any work that is required by the PJHA and this work plan:

a) Safety glasses
b) Polycarbonate E class hard hat c/w chin strap
c) Fire retardant coveralls
d) High voltage gloves (25 kV)
e) Arc flash hood
f) Clean leather gloves
g) Flash suit/coat (maximum rated)
h) Hearing protection

8) PROCEDURES

The following procedures shall be complete, reviewed and understood prior to undertaking any work described herein. Further, such procedures shall be adhered to at all times:

a) Pre-Job Hazard Assessment (PJHA).
b) Detailed written work plan approved by ConocoPhillips Chief Electrical Person.
c) Applicable SOPs shall be reviewed including, but not necessarily limited to, CPC Electrical Work - SOP and CPC Lockout/ Tag out – SOP

9) LIST OF TOOLS USED

a) High voltage tester
b) Hot stick
d) Voltage rated grounding cluster(s)
e) Testing tools and equipment as required
f) Voltage rated gloves
j) Work lights (as required to safely do work in the absence of utility or temporary generator power)
k) Tools as per the tool Log List

10) HIGH VOLTAGE PERSONNEL

Chief Electrical Person: The electrical person appointed by ConocoPhillips management to be responsible for the overall approval of the work scope at a specific location.

Person in Charge: A qualified and certified electrical person who has been approved by the Chief Electrical Person to supervise specific work on electrical equipment and systems. Any work on a power system that operates at voltages above 750 V requires a Person in Charge and a work plan approved by the Chief Electrical Person. It is recommended that a Person in Charge be appointed for work on systems operating below 750 V, particularly if high arc flash energy is present.

Qualified Electrical Person: A qualified electrical person will have demonstrated technical knowledge, competency and experience to complete the prescribed work and avoid the dangers associated with high voltage equipment and training in electrical work (i.e. Journeyman Electrician, Power System Electrician, technologist or engineer) meeting legal requirements. A Qualified Electrical Person cannot perform work on equipment operating over 750 V unless supervised.

WORK PLAN APPROVAL

I _____ approve this work plan.

DATE: _____ TIME: _____ AM / PM

Signature of Chief Electrical Person: _____

11) WORK PLAN

Prior to starting this work involving electrical high voltage, ConocoPhillips Canada requires a Pre-Job Hazard Assessment (PJHA) be completed. This process is in addition to the requirements for all workers to be familiar with ConocoPhillips Canada Safety, Health, Environment and Regulatory (HSE) Policies, Standards and Safe Operating Practices. The PJHA process is the standard used to ensure all workers and visitors receive an HSE orientation, review work plans and potential hazards, and establish job specifics, including those found in applicable Safe Operating Practices (SOP).

All individuals list below shall be familiar with and adhere to the Work Plan.

List names of individuals performing high-voltage work:

1. _____ (Person in Charge)

2. _____ (Qualified Electrical Person)

3. _____ (Electrician)

4. _____ (Electrician)

Date: _____

Pre-Job Hazard Assessment Agreement Number: _____

12) Emergency Response Plan

Alder Flats
LSD 10-09-45-08W5M

In the event of an electrical incident requiring aid:
The on-site medical attendant or the on call operator (Print Name_____) will be notified of the emergency. External emergency services will be notified as required. –If required the main incoming electrical power will be tripped "OFF".

If safe to do so, the backup personnel will provide rescue assistance using electrical rescue gear (appropriate PPE, insulated rescue tools as appropriate).

If personnel are injured, they will be relocated to a safe area, local first aid applied until emergency personnel are at site to take over.

1. **Stars# 1656**
2. **Directions to Locations**

Facility	Directions
Alder Flats 10-09-045-8 W5M Gas Plant	**From Drayton Valley, AB:** • 39.93 km south, east and south on Highway 22 • 6.48 km west on Highway 13 • 12.49 km west on Township Road 460 • 6.87 km southeast on gravel road • West into gas plant

The Person in Charge will be wearing the same PPE for the hazards as the Qualified Electrical Person for rescue purposes during the work process.

Power System Disconnection and Isolation Procedure

The following tasks shall be completed in the listed sequence. Any deviation from the approved sequence may only be undertaken with the prior approval of the Chief Electrical Person.

The Person-in-Charge is responsible for ensuring that the required work is properly completed and shall check or initial each task as it is finished.

Tasks:

1._____ Complete Pre-job Hazard Assessment process.

2._____ Review the power system single line diagram for the present electrical installation. All equipment must be tested before any work takes place on the electrical equipment (test before you touch)

SLD is correct? Yes _____ (proceed to task 4)

No _____ (proceed to task 3)

3._____ Stop the work and correct SLD discrepancies between with the electrical installation and resubmit the corrected SLD and work plan to the Chief Electrical Person for approval. Upon receipt of the approval the work can re-commence from task 1.

4._____ Person-in-Charge will instruct the Qualified Electrical Person to secure the work area with flagging.

5._____ Operations will shutdown loads served from existing 4160 Volt from their respective remote control stations.

_____C-103

6._____ Person-in-Charge will instruct the Qualified Electrical Person to open all the loads on MCC 1, shutting the loads down first by the tail switch then opening the 480 volt cubical disconnects.

7._____ Once it has been confirmed all 480 volt loads have been shed from the 480 volt MCC . The Person in Charge will instruct the Qualified Electrical Person to Open the 480 Volt - main breaker using all the required PPE. Person In Charge will lockout tag out the 480 volt main breaker.

8._____ The Person in Charge will instruct the Qualified Electrical person to open the 200 amp load break switch that feeds the 4160-480 volt transformer Point - 3 shown on the single line diagram CPC DRG # ADR-002-ELE-004-0002..

9._____Person-in-Charge will instruct the Qualified Electrical Person to open 4160 Volt - disconnect switches using all the required PPE. Visual confirmation the disconnects are in the open position shall be confirmed. Apply locks and tags.

____4160 Volt motor C-103 Disconnect OPEN / Locked & Tagged (Point 2 on Single line)

____4160V/480V Transformer Disconnect OPEN / Locked & Tagged (Point 3 on Single line)

____4160-600 Amp Main load break Disconnect OPEN/ Locked & Tagged (Point 1 on Single line)

10._____ Operations and all persons involved shall apply locks and tags to the 3 4160 volt disconnect switches.

11._____ Operations must record the time that task 6 was done in the facility log book. The Person-in-Charge will record the time below

_____AM/PM

12._____ Person-in-Charge will instruct the utility FORTIS POWER that all loads have been shed and to open the Fortis fused disconnects and apply safety grounds on the secondary

side of the Fortis Service Transformers. Person-in-Charge and the Qualified Electrical Person will ensure grounds are acceptably applied.

13._____Person-in-Charge will obtain the utility's Guarantee of Isolation (GOI) the GOI will place in the care and control of the Person in Charge.

14._____ Confirm on a known 120 volt service that the high voltage detector (TIC Tracer) is functioning properly.

15._____ After waiting at least five minutes to allow for the system to discharge using all the required PPE the Person in Charge will instruct the Qualified Electrical Person to open **4160 Volt Main Disconnect** cabinet and check for absence of voltage. This is considered live work

16._____ Confirm on a known 120 volt service that the high voltage detector (TIC Tracer) is functioning properly.

17._____ With the confirmation of the absence of potential. The Person in Charge will instruct the Qualified Electrical Person to pull the fuses for the PT transformer to prevent the possibility of back feed. Using the required PPE as per the Electrical SOP. Point 1 A on drawing ADR-002-ELE-004-0002.

18._____With the confirmation of the absence of potential the Person in Charge will instruct the Qualified Electrical Person to install a set of safety ground chains on the load side of the Main Disconnect Switch (Point 4 on the single line diagram) using all the required PPE. This is considered live work.

19._____With the confirmation of the absence of potential the Person in Charge will instruct the Qualified Electrical Person using all the required PPE to discharge and ground the Capacitors & Lightning arrestors using a discharge stick and grounds. This is considered live work.

- **Guarantee of Isolation – 4160V Main Disconnect Switch Cubical**

Signature of Person-in-Charge: _____

Date:_____ Time : _____ AM/PM

The Qualified Electrical Person(s) may now commence with performing the required work on 4160 V main Switch

At this point the 4160 Volt Main Disconnect Switch and the 4160 Volt bus has been isolated and grounded. The individual starter will have to be grounded for any work to proceed in the cabinets.

The following steps 20 thru 27 are for the isolation and grounding of C-103 Compressor

20._____ Confirm on a known 120 volt service that the high voltage detector (TIC Tracer) is functioning properly.

21._____ Person-in-Charge will visually inspect the disconnect switch to ensure the disconnect is in the open position The Person in Charge will instruct the Qualified Electrical Person to open 4160 Volt disconnect switch using all the required PPE and test for voltage.

22. _____Confirm on a known 120-volt service that the high voltage detector (TIC Tracer) is functioning properly.

23. ____ After waiting at least five minutes using all the required PPE as per the Electrical SOP, the Person in Charge will instruct the Qualified Electrical Person to open **C-103** Starter cabinets and check for absence of voltage. This is considered live work.

24._____ Confirm on a known 120-volt service that the high voltage detector (TIC Tracer) is functioning properly.

25._____The Person in Charge will instruct the Qualified Electrical Person using the required PPE to discharge the power factor capacitors using a shorting stick and ground the power factor capacitors. This is considered live work. Point 6 on the single line diagram ADR-002-ELE-004-0002.

26.____The Person in Charge will instruct the Qualified Electrical Person to pull the fuses for the PT transformer 4160-120V to prevent the possibility of back feed. Using the required PPE as per the Electrical SOP

27._____With the confirmation of the absence of voltage the Person in Charge will instruct the Qualified Electrical Person using the required PPE to install set of safety ground chains on the load side of the contactor (Point 7 on the single line ADR-002-ELE-004-0002). This is considered live work.

Guarantee of Isolation **C-103** motor contactor compartment

Signature of Person-in-Charge: _____

Date:_____ Time : _____ AM/PM

The Qualified Electrical Person(s) may now commence with performing the required work on PM-510A

<u>Additional notes pertaining to the work:</u> Ground cables are to remain in place except when testing requirements require their removal. Ground cables will be replaced when testing complete.

At this point C-103 had been grounded and isolated

The following steps 28 thru 34 are for the isolation and grounding of the 4160-480 Volt Transformer Disconnect Compartment.

28.____ Confirm on a known 120 volt service that the high voltage detector (TIC Tracer) is functioning properly.

29.____ Person-in-Charge will visually inspect the disconnect switch to ensure the 4160/480 Volt transformer disconnect is in the open position. The Person in Charge will instruct the Qualified Electrical Person to open the 4160/480 Volt transformer feed disconnect switch door using all the required PPE and test for voltage.

30. ____Confirm on a known 120-volt service that the high voltage detector (TIC Tracer) is functioning properly.

31. ____ After waiting at least five minutes using all the required PPE as per the Electrical SOP, the Person in Charge will instruct the Qualified Electrical Person to open **the Transformer Disconnect Compartment** and check for absence of voltage. <u>This is considered live work</u>.

32._____Confirm on a known 120-volt service that the high voltage detector (TIC Tracer) is functioning properly.

33.____The Person in Charge will instruct the Qualified Electrical Person to check that the 480 volt breaker is open and apply all personal locks to the 480 volt main breaker.

34._____With the confirmation of the absence of voltage the Person in Charge will instruct the Qualified Electrical Person using the required PPE to install a set of safety ground chains on the load side of the Disconnect Switch (Point 8 on the single line ADR-002-ELE-004-0002). <u>This is considered live work.</u>

Guarantee of Isolation of the **Transformer Disconnect** compartment

Date:_____ Time : _____ AM/PM

The Qualified Electrical Person(s) may now commence with performing the required work on the Transformer Disconnect Switch

Additional notes pertaining to the work: Ground cables are to remain in place except when testing requirements require their removal. Ground cables will be replaced when testing complete.

At this point the transformer disconnect has been grounded and isolated

Reconnection of Power System

A. ____Person-in-Charge shall inform Operations work has been completed.

B. ____Person-in-Charge must account for all tools and equipment used during the work.

C. ____Person-in-Charge must discuss the end of the guarantee of isolation with all the workers listed above.

D. ____The Person-in-Charge will instruct the Qualified Electrical Person using all the required PPE to remove and account for all safety grounds. Where practicable a hot stick shall be used to remove grounds. Check off that the following grounds have been removed. Note some of the safety ground chains may remain installed as additional maintenance is required on the individual starters. The ground chains will be removed prior to the re-energization of the individual starters.

_____Point 4 - 4160 volt Main (as per the single line diagram ADR-002-ELE-004-0002)

_____Point 6 CD-103 PF Caps (as per the single line diagram ADR-002-ELE-004-0002)

_____Point 7 CD-103 motor feeder (as per the single line diagram ADR-002-ELE-004-0002)

_____Point 8 4160/480 volt transformer feeder (as per the single line diagram ADR-002-ELE-004-0002)

E. ____ The Person in Charge will instruct the Qualified Electrical Person to remove the personal lock from the 480 volt main breaker and the breaker is to remain OPEN.

F.____ The Person in Charge will instruct the Qualified Electrical Person with all the required PPE to Close the 4160 / 480 volt Transformer Disconnect Switch.

G. ____The Person-in-Charge and the Qualified Electrical Person must come to an agreement that it is safe to energize the **4160 Volt MCC**.

Agreed/Yes _____ (Proceed to task I and continue with reconnection procedure)

Disagree/No_____ (Proceed to task H).

H._____ Ensure the 4160 Volt main disconnect is locked and tagged out and contact the Chief Electrical Peron before proceeding.

I.____ The Person in Charge will coordinate the removal of Personal and Ops Control Locks from the 4160 volt Main Disconnect.

J._____ The Person in Charge will surrender the GOI to the Utility Fortis Power and witness the removal of the utilities Safety ground chains.

K. _____ The Person in Charge will inform Operations that it is ready to energize the 4160 Volt MCC and return the facility to normal power supply service

_____AM/PM

L.____ Using all the required PPE, the Person in Charge will instruct the qualified Electrical Person to Close the 4160 volt main Disconnect and restore station service.

_____AM/PM

M.___ The voltage shall be checked by utilizing the existing voltmeters located on the metering section of the 4160 Volt MCC.

Vab / Vbc / Vca_____

Note: The re-energization of the individual starters are not going to be energized at the same time. Each of the following steps are required to be followed as the individual compressors are started.

N.____ The Person in Charge will instruct the Qualified Electrical Person to remove the locks and tags from the 480 volt MCC1 main breaker and close the 480 volt main breaker.

O._____ The Person in Charge will instruct the Qualified Electrical Person to remove the locks and tags from the 4160/480 volt transformer load break switch (Point 3) and close the load break switch. The Person in charge will verify the voltage at the 480 volt MCC 1.

P._____ Operation must be notified that the following CD-103 motor is ready to be re- energized

Q._____ Upon Agreement with Operations, the Person in Charge, and the Qualified Electrical Person, will remove their lock and tag from all the disconnect (C-103), on the **4160 Volt MCC.**

_____ C-103, Lock and tag removed

R._____ The Person-in-Charge will instruct the Qualified Electrical Person to close the disconnect switch for the CD-103 **MOTOR** using all the required PPE. Operations must record the time of the switch closure in the facility logbook. Person-in-Charge will note the time below.

_____ C-103 _____AM/PM

S.____ Operations shall start (remotely) the motor as required

T.____ Update the SLD to reflect all changes to equipment, including relay settings.

W._____ubmit all appropriate documents (completed work plan, updated SLD, and Pre-job Hazard Assessment Agreement) to Operations individual in charge.

X._____ Person-in-Charge must retain and file the completed work plan, and PJHA form.

Date all tasks completed (through task X): _____

DATE: _____ TIME: _____ AM / PM

Update power system single line diagram (SLD). Adjustments or changes to protective devices must also be recorded on the SLD.

Submit appropriate documents (completed work plan, completed SLD, Pre-job Hazard Assessment Agreement) to Operations individual in charge. Store the completed work plan in the QMP logbook.

Person in Charge must enter work plan, this Schedule and PJHA form into Electrical Quality Management Plan (QMP) logbook.

Attachment F – Faults Currents and Times for Grounding Cables

Cable Size (AWG)	Fault Time (cycles)	RMS Current (amperes) (Cu)
2	6	16,800
	15	12,000
	30	8,600
	60	5,300
1/0	6	25,300
	15	18,500
	30	13,000
	60	8,000
2/0	6	31,000
	15	21,000
	30	15,000
	60	10,000
3/0	6	41,000
	15	29,000
	30	21,000
	60	13,000
4/0	6	47,000
	15	37,000
	30	26,000
	60	15,000
250 kcmil	6	68,000
	15	43,000
	30	32,000
	60	21,500

Attachment G – Simplified Fault Current Calculations

This method assumes an “infinite bus” power supply upstream of the supply transformer and no cable or other impedance between the transformer and the deliberately applied short circuit. It ignores DC offset and rotating machine contribution. The results will generally be conservative for the case of the system being re-energized onto the grounds.

Information Required: Upstream transformer kVA rating and impedance; System voltage in kV.

Calculation:

1. Divide transformer kVA rating by transformer percent impedance. This gives the fault level in kVA.

2. Divide the fault level in kVA by voltage in kV and the by 1.73. This gives the fault current in amperes.

Example 1: Upstream transformer rating = 5,000 kVA

Impedance = 6% = 6/100 = 0.06

System voltage = 4.16 kV

5,000 kVA / 0.06 = 83,333 kVA fault level

83,333 kVA / 4.16 kV / 1.73 = 11,580 amperes fault current

Example 2: Upstream transformer rating = 1,000 kVA

Impedance = 5.5% = 5.5/100 = 0.055

System voltage = 600 V = 0.6 kV

1,000 kVA / 0.055 = 18,182 kVA fault level

18,182 kVA / 0.6 kV / 1.73 = 17,516 amperes fault current

If current limiting fuses are used upstream of the grounds, the fault time will be significantly less than 6 cycles. If there is an instantaneous trip relay on the 4.16 kV upstream breaker, the fault can be taken as being 6 cycles. If there is no instantaneous trip relay, or if it is set to operate at some level above the expected current, the time will be more than 6 cycles and the fault time must be calculated from the coordination study.

Attachment H – Revision Record

Page #	Aug 28,2014 Revisions	Previous Information
	Minor editorial word changes	
Attachment E	**Updated example of a work plan**	