Oil Sands and In Situ – OEMS Element 9A – Electrical Safety Risk Management Business Process Manual

Revision: **2**
Revision Cycle: **3 years**
Owned by: **General Manager, EH&S Oil Sands & In Situ**

Contents

Summary of Changes

This section helps reviewers and authorizers learn about the revisions.

The table details, by revision number:

- the sections changed
- the changes made
- the reasons behind each change, if appropriate

Rev.	Section Changed	Revisions Made
1	—	New draft to meet SUN-00115 standard
2	—	Requested Revision
	3.6 / 5.1	Updated reference for LMS0092A to SUN-00175

1. Purpose

This business process section details how the Oil Sands and In Situ (OSIS) business unit complies with the corporate Electrical Safety Risk Management Standard (SUN-00115).

The purpose of this document is to ensure personal safety when performing electrical work on energized electrical equipment, conductors or circuit parts and when exposed to electrical hazards.

1.1 Scope

All Suncor and contractor personnel performing work at Regional Wood Buffalo sites must comply with the minimum requirements contained in this document when they are working on or near energized electrical equipment, conductors or circuit parts.

1.2 Terms AND Definitions

The following terms, definitions and acronyms are used in this document:

Term	Definition
Approved (Electrical Equipment)	Tools, test equipment and electrical equipment / components are tested and certified to an applicable CSA standard(s) and bear a label of a certification testing body accredited by the Province or Standards Council of Canada.
Arc Flash Hazard	A dangerous condition associated with the release of energy caused by an electric arc.
Arc Flash Hazard Analysis	A study determining the potential exposure to workers of arc flash energy, conducted for the purpose of injury prevention and determination of safe work practices, arc flash protection boundary, and the appropriate level of personal protective equipment.
Arc Flash PPE Category	Categories defined by CSA Z462 for arc flash protection clothing levels needed when performing energized tasks with values ranging from 0 to 4 (0 to 40 cal/cm^2).
Barricade	A physical obstruction, such as tapes, cones, or A-frame-type wood or metal structures, intended to provide a warning about, and to limit access to, a hazardous area.
Barrier	A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts or to prevent unauthorized access to a work area.
Competent Person	A person who has knowledge related to the construction and operation of the electrical equipment and installations, has received safety training on the hazards involved, and has demonstrated skill.
De-energized	Free from any electrical connection to a source of potential difference and free from electrical charge. Not having a potential different from that of the earth.
Electrical Hazard	A dangerous condition where contact with equipment or equipment failure can result in electric shock or arc flash burn.
Electrical Safety	The state of being able to recognize hazards associated with the use of electrical energy and taking precautions so that hazards do not cause injury or death.

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Term	Definition
Electrically Safe Work Condition	A state in which an electrical conductor or circuit part has been disconnected from energized parts, isolated (locked out) and tested to ensure the absence of voltage, and grounded if deemed necessary.
Incident Energy	The amount of energy impressed on a surface at a certain distance from an electrical arc source. A commonly used measure of incident energy is calories per centimetre squared (cal/cm^2).
Injury	Personal injury from electrical shock, electrical burn, or arcing initiated by electrical energy.
Isolated (from power sources)	Equipment/locations having secure physical separation or blocking with non-conductive material sufficient to ensure equipment cannot be energized by identified power sources.
Lockout	Placement of a lock on an energy-isolating device in accordance with an established procedure. The lock indicates that the energy-isolating device is not to be operated until removal of the lock or in accordance with an established procedure.
Limited Approach Boundary	A distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.
Personal Protective Equipment (PPE)	Equipment or clothing designed to provide protection against specific hazards.
Restricted Approach Boundary	A distance from an exposed energized electrical conductor or circuit part within which there is 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 part.
Shock Hazard	A dangerous condition associated with the possible release of energy caused by contact or approach to energized electrical conductors or circuit parts.
Standby Worker	A standby person must be competent for the intended tasks and must meet all the requirements and responsibilities indicated in this document.
Shock Hazard Analysis	An analysis to determine the voltage to which personnel will be exposed, the boundary requirements for a task/equipment, and the personal protective equipment necessary to minimize the possibility of electric shock to personnel.
Working Distance	The dimension between the possible arc location and the head and torso of the worker positioned to perform the assigned task.
Working On (energized electrical conductors or circuit parts)	Coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment a person is wearing. There are two categories of “working on”: 1. **Diagnostic (testing)** – taking readings or measurements of electrical equipment with approved test equipment. This type of work does not require making any physical change to the equipment. 2. **Repair** – any physical alteration of electrical equipment such as making or tightening connections, removing or replacing components, etc.

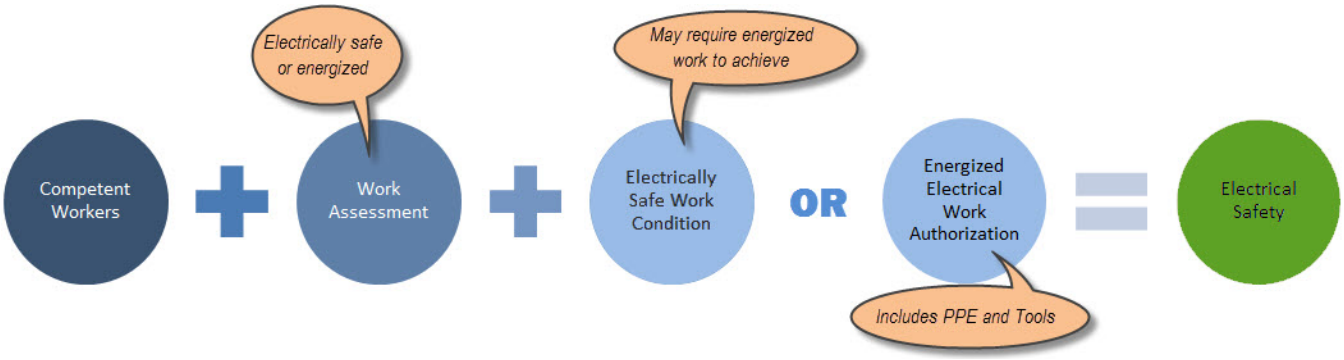
2. Roles

The following individuals and groups have the following roles and responsibilities:

Role	Accountabilities/Responsibilities
Maintenance Senior Vice President	Accountabilities include ensuring these tasks are complete: • Implement this business process manual. • Track corrective actions relating to electrical safety incidents to reduce overdue items. • Report monthly on overdue electrical safety items to OSIS Senior Leadership.
Managers/ Supervisors	Responsibilities include: • Own the function of electrical safety. • Ensure workers are aware and knowledgeable of this business process manual and electrical safety in general. • Audit workers' training credentials annually. • Ensure periodic effectiveness assessments / audits are conducted. • Ensure workers are competent for assigned tasks. • Perform an annual audit to ensure a sufficient level of competency to perform the assigned tasks. • Ensure proper application of the Energized Electrical Work Authorization (EEWA) forms. • Ensure consistency and quality in risk assessments. • Perform a quarterly audit on hazard assessment, risk assessment EEWA forms. • Track and steward electrical safety incidents having a Risk Rank I or II and potential incidents having Risk Rank I, II or III in the Incident Management tool
Engineering	Responsibilities include: • Perform arc flash hazard analysis for new and existing installations.
Electrical Workers	Responsibilities include: • Comply with this business process and all safe work procedures and practices. • Report all electrical incidents including shock and arc flash to the Manager/Supervisor. • Participate in hazard and risk assessments as required. • Wear the appropriate Electrical PPE for the task. • Maintain PPE and tools in proper working condition.

3. Processes for Electrical Safety Risk Management

To meet SUN-00115 Electrical Safety Risk Management Standard, electrical workers at OSIS must follow the processes and information detailed in this section.



3.1 Understand Principles and Practices Around Electrical Hazards

There are two main electrical hazards addressed in this document:

1. Shock
2. Arc flash

Safely addressing shock and arc flash hazards requires that workers employ the principles and practices listed below to safety manage electrical hazards.

At OSIS, workers must apply the following principles and practices to protect themselves from hazards of electricity:

- Fully understand all tasks and be comfortable that risks are appropriately identified and managed.
- Eliminate the hazard by de-energizing wherever possible. There are cases where the act of de-energizing coupled with other potential hazards render de-energizing infeasible.
- Consider all electrical equipment energized until it is proven to be de-energized. Use the Test-Before-Touch principle.
- Check that the meter functions before and after conducting the intended test when testing voltage.
- Carry out planning and executing electrical work in a careful and unhurried manner.
- Stand to the side, away from the front of electrical panels when operating equipment where applicable.
- Ensure that tools used are properly insulated and approved.
- Do not work on electrical circuits where the area is damp or wet until appropriate mitigation measures have been put in place such as insulated rubber matting.

3.2 Sustain Electrically Safe Installations

Suncor's facilities are designed and built with safety in mind and in line with regulatory requirements and corporate Technical Standards.

Maintenance groups must sustain these performance levels, and workers must assess equipment conditions before starting work tasks.

3.3 Achieve Electrically Safe Work Conditions

Achieve an electrically safe work condition by following these processes. Each Electrical Worker at OSIS performs the following steps:

Step	Actions
1	Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date single line drawings, diagrams, and identification tags. Consider stored energy in circuit capacitance along with possible induction from adjacent, energized systems.
2	After properly interrupting the load current, open the disconnecting device(s) for each source.
3	Where it is possible, visually verify that all blades of the disconnecting devices are fully open or draw out type circuit breakers are withdrawn to the fully disconnected position.
4	Apply lockout/tag out devices in accordance with Suncor Procedure RGP0005A.
5	Use an adequately rated voltage detector to test each phase conductor or circuit part to verify that each is de-energized. Before and after each test, determine that the voltage detector is operating satisfactorily.
6	If the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

3.4 Obtain an Energized Electrical Work Authorization

Electrical workers must fill out an EEWA Form (see Appendix 1 – Energized Electrical Work Authorization) for all energized electrical work inside the Restricted Approach Boundary including testing above 50 V.

Each EEWA must include the required approvals.

Workers must not cross the Restricted Approach Boundary, or take any conductive object closer to exposed energized electrical equipment, conductors or circuit parts, operating at 50 V of more. The following exceptions apply to this requirement: Refer to (CSA Z462-2015 4.3.4.4)

- The Worker is insulated or guarded from the energized electrical equipment, conductors or circuit parts operating at 50 V or more. Insulating gloves or insulating gloves and sleeves shall be considered insulation only with regard to the energized parts on which work is being performed.
- The energized electrical equipment, conductor or circuit part operating at 50 volts or more is insulated from the Worker and from any other conductive object at a different voltage potential.

Procedures can be used for EEWA purposes provided they meet all the requirements in the EEWA process.

3.5 Perform Hazard Assessment

Detailed Arc Flash Hazard Analyses and labelling are required to provide information about shock and arc flash hazards following LMS0091A Label and Schedule for Arc Flash and Shock Warning. When a detailed engineering Arc Flash Hazard Analysis is not available, the CSA Z462 ‘table method’ must be used to determine the Arc Flash PPE category and the requirements for appropriately rated rubber gloves and insulating hand tools.

The assumed maximum short-circuit current capacities and maximum fault clearing times for various energized electrical work tasks are listed in CSA Z462 Table 4B. An EEWA and a detailed engineering Arc Flash Hazard Analysis or alternate calculation must be used for tasks:

- Not listed or for power systems with greater than the assumed maximum short circuit current capacity
- With longer than the assumed maximum fault clearing times in the notes.

3.6 Verify AND Obtain Tool AND PPE Requirements

Reference SUN-00175 Corporate Electrical Personal Protective Equipment Standard, which provides requirements for electrical PPE and tools.

All electrical workers must regularly check all tools and equipment that they are working with, and must remove from service any tools or equipment that poses a hazard or needs repair.

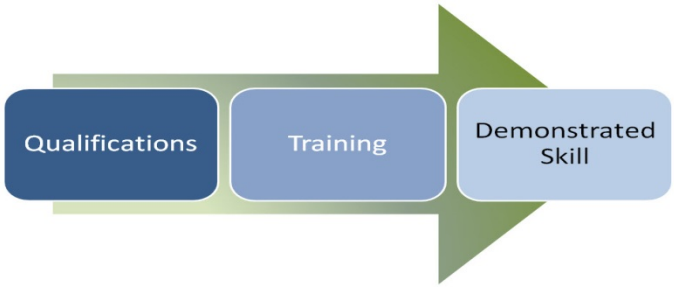
Individuals must be responsible for issued PPE and ensure tests, checks or maintenance are conducted as necessary and recorded.

All electrical workers must ensure personal safety grounds are installed where applicable. Detailed maintenance procedures must indicate where and when personal safety grounds are to be applied.

At the completion of the job, all electrical workers must ensure all tools and equipment are accounted for and must inspect the electrical equipment that was worked on to ensure no tools or other materials have been left inside the equipment.

3.7 Be Competent

Supervisors / front line leaders must ensure that at least one worker is competent to carry out assigned tasks.



Competency includes the following:

- Qualifications (Journeyman Electrician, Power System Electrician, Power Line Technician, Electrical Engineering Technologist, Electrical Engineer, etc.)
- Knowledge of equipment / systems / procedures
- Electrical safety training for the corporate Electrical Safety Risk Management standard and this business process manual
- Demonstrated experience with application of the above.

Workers who have not been deemed competent can work under the supervision of a competent person.

4. Compliance

This business process complies with the Operational Integrity Audit process, which defines the number and frequency of periodic audits on the Element documentation for completeness, quality and process effectiveness.

4.1 Business Process Accountabilities

The Element Owner, Representative, Community of Practice and Safety Manager, Reliability Engineering / Maintenance must review this business process in relation to the corporate Electrical Safety Risk Management Standard (SUN-00115) and revise this document as necessary within at least 3 years from the date of the last review. The Safety Manager, Reliability Engineering/Maintenance obtains the approval of the Director, Environment, Health for OSIS through the electronic review and approval workflow process and managed by DMS .

As changes in process occur, the OEMS element representative must update this business process and obtain the required approval.

Retain all business process archives for 6 years.

4.2 Metrics

The Manager/Supervisors track electrical safety incidents having a Risk Rank I or II and potential incidents having Risk Rank I, II or III in the Incident Management tool (as detailed in Element 15 - Incident Management). Monthly, report this information to the Maintenance Vice President. Quarterly the Maintenance VP reports this information to senior leadership.

Business Area (BA) Senior Leaders track corrective actions relating to electrical safety incidents to reduce overdue items. Monthly, report on overdue electrical safety items to OSIS Senior Leadership with Element 15 data and track trends.

4.3 Audits

Periodically, the Managers/Supervisors audit the hazard assessments, risk assessments and the EEWA forms for completeness, quality and effectiveness.

Once every three years, BA Senior Leaders audit their site based on the corporate Electrical Safety Risk Management standard SUN-00015 and report the results to OSIS Senior Leadership. It is anticipated that these audits will address this standard as well.

Annually, Managers/Supervisors audit the competency of electrical workers to ensure a sufficient level of competency to perform the assigned tasks. Report the results of this audit to OSIS Senior Leadership.

Annually, Managers/Supervisors audit the status of electrical workers' training credentials to ensure each worker's record is up to date. Report the results of the audit and discrepancies to OSIS Senior Leadership.

5. References

Refer to the latest version or revision of these documents, as required.

5.1 Oil Sands Standards

- SUN-00115 Corporate Electrical Safety Risk Management Standard
- SUN-00175 Corporate Electrical Personal Protective Equipment Standard
- LMS0091A Label and Schedule for Arc Flash & Shock Warning
- RGS0009A Personal Protective Equipment
- RGP0004A Safe Work Permit (SWP)
- LMS0057A Fire Resistant Workwear
- RGP0005A Control of Hazardous Energy (CHE)
- RGM12001 Oil Sands and In Situ Emergency Preparedness Plan Manual
- LMS0073A Incident Reporting and Investigation
- RGP05001 OS&IS Management of Change
- LMS0082A Field Level Risk Assessment

5.2 Provincial and Federal Regulations

- Alberta Occupational Health and Safety Code 2009
- Alberta Electric Utility Code 2013

5.3 Canadian Standards Association (CSA)

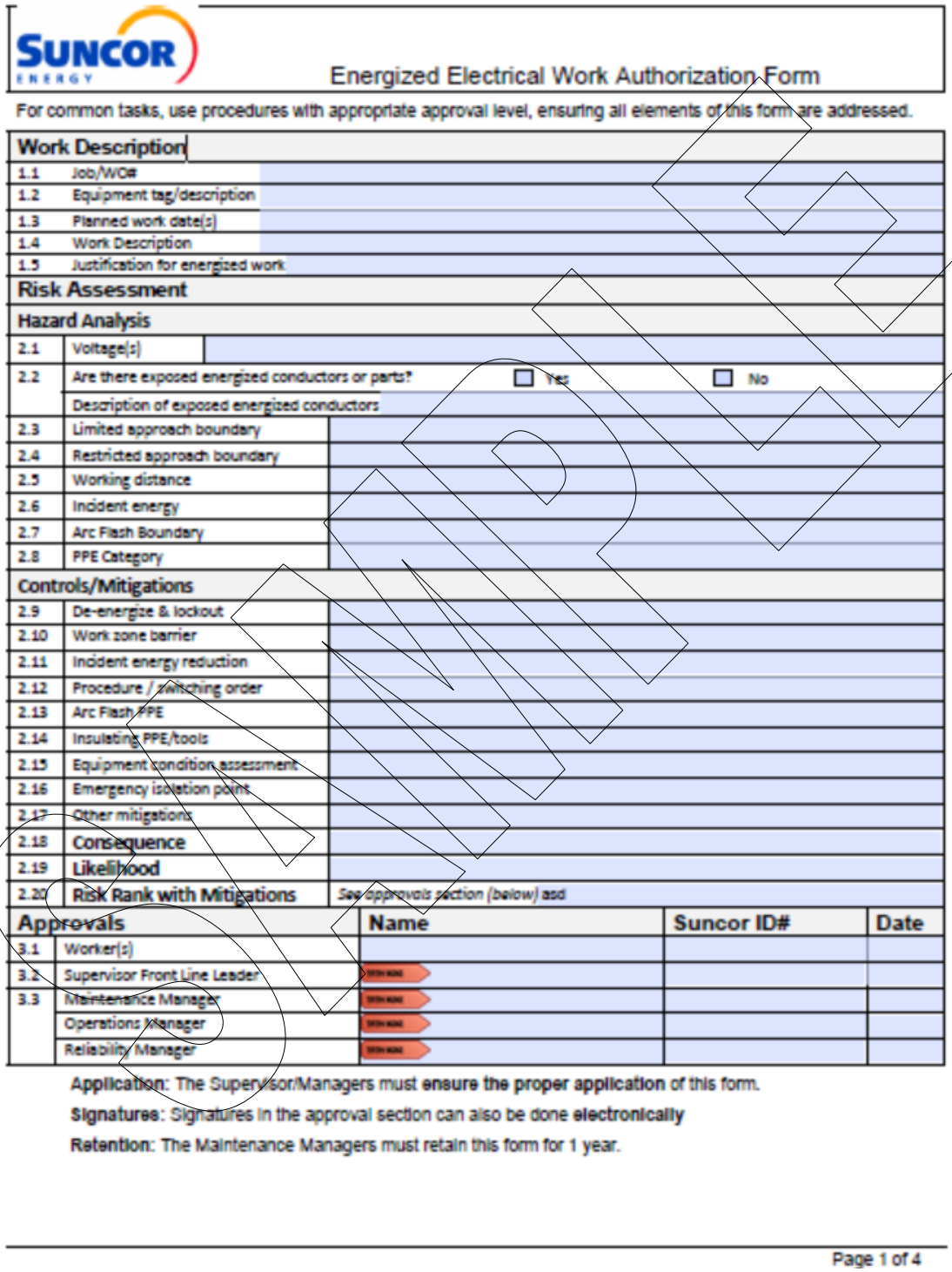
- CAN/CSA-C22.1 Canadian Electrical Code (CEC) Part 1
- CAN/CSA-Z460 Control Of Hazardous Energy – Lockout And Other Methods
- CAN/CSA-Z462 Workplace Electrical Safety
- CAN/CSA-Z1000 Occupational Health And Safety Management
- CAN/CSA-Z195 Protective Footwear
- CAN/CSA-Z94.3 Hearing Protection Devices
- CAN/CSA-Z94.1 Industrial Protective Headwear
- CAN/CSA-Z11 Portable Ladders
- CSA M421-00 Use of Electricity in Mines

5.4 International Standards

- IEEE 1584-2002 Guide for Performing Arc-Flash Hazard Calculations
- NFPA 70E-2004 Standard for Electrical Safety in the Workplace

Appendix 1 – Energized Electrical Work Authorization

This form is a template in Livelink.



SUNCOR ENERGY

Energized Electrical Work Authorization Form

For common tasks, use procedures with appropriate approval level, ensuring all elements of this form are addressed.

Work Description		
1.1	Job/WO#	
1.2	Equipment tag/description	
1.3	Planned work date(s)	
1.4	Work Description	
1.5	Justification for energized work	
Risk Assessment		
Hazard Analysis		
2.1	Voltage(s)	
2.2	Are there exposed energized conductors or parts? ☐ Yes ☐ No	
	Description of exposed energized conductors	
2.3	Limited approach boundary	
2.4	Restricted approach boundary	
2.5	Working distance	
2.6	Incident energy	
2.7	Arc Flash Boundary	
2.8	PPE Category	
Controls/Mitigations		
2.9	De-energize & lockout	
2.10	Work zone barrier	
2.11	Incident energy reduction	
2.12	Procedure / switching order	
2.13	Arc Flash PPE	
2.14	Insulating PPE/tools	
2.15	Equipment condition assessment	
2.16	Emergency isolation point	
2.17	Other mitigations	
2.18	**Consequence**	
2.19	**Likelihood**	
2.20	**Risk Rank with Mitigations**	*See approvals section (below) and*

Approvals		**Name**	**Suncor ID#**	**Date**
3.1	Worker(s)			
3.2	Supervisor Front Line Leader			
3.3	Maintenance Manager			
	Operations Manager			
	Reliability Manager			

Application: The Supervisor/Managers must **ensure the proper application** of this form.

Signatures: Signatures in the approval section can also be done **electronically**

Retention: The Maintenance Managers must retain this form for 1 year.

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Appendix 1 – Energized Electrical Work Authorization *(Cont'd)*

SUNCOR ENERGY

Energized Electrical Work Authorization Form

GUIDELINE: Instructions for Completion

Use this form to manage electrical hazards including shock and arc flash associated with energized electrical work. The basic sequence is to:

1. Identify hazards.
2. Identify controls and mitigations that can be applied to the hazard.
3. Analyze risks.
4. Obtain necessary approvals to facilitate execution of the work.

Complete this form when indicated in section E 'Work Authorizations and/or Documents' section of the work permit.

Definition: 'Energized' means being connected to or being a source of voltage. Working on energized conductors involves intentionally coming into contact with or within the approach limits of energized electrical conductors. Energized work includes testing with applied voltages above 240V of isolated equipment / apparatus.

Section 1 – Work Description

Identify the job or work order number, a description of the equipment / system to be worked on, a description of the work, and an explanation of why energized work is being considered.

Section 2 – Risk Assessment – Hazard Analysis

2.1 List any expected voltages you might encounter, including stored or induced energy.

2.2 Use the check boxes to indicate whether there are any exposed energized conductors. If there are, describe them. You can augment the description with illustrations, drawings, photos, etc.

2.3-2.4 Take Limited and restricted approach boundaries directly from CSA Z462 (table 1A/B in 2015 edition). Limited approach boundary is defined as an approach limit within which a shock hazard exists, while the restricted approach boundary is similar, but with greater risk of shock due to proximity of workers / tools, the possibility of arc-overs (insulation failures) combined with inadvertent movement.

2.5 Working distance is the rough distance between a potential arc flash source and a worker's head and torso. CSA Z462 lists 'default' values as:

- 18" for LV (<750V_{AC}) MCCs
- 24" for LV switchgear
- 36" for most medium voltage apparatus including motor control and switchgear

2.6 Incident energy is a worst expected value considering that all devices (relays, breakers, etc.) function as expected. Enter the value from equipment labels. If the value is not there or where the detailed incident energy analysis hasn't been completed, use the alternate 'table method' from CSA Z462 to determine the arc flash PPE requirements. Leave this area blank if the systems meeting the following conditions:

- less than 125 kVA and less than or equal to 240 VAC as the combination of short circuit and voltage levels are too low to sustain arc flashes

2.7 Enter the arc flash boundary from the incident energy analysis. The arc flash boundary is a distance from a potential arcing fault where the incident energy is 1.2 cal/cm^2 (the threshold for second degree burns on bare skin).

2.8 Categorize the arc flash PPE category per CSA Z462 and using the working distance and the incident energy values as follows:

- Category 1: 1.2 - 4 cal/cm^2
- Category 2: 4 - 8 cal/cm^2
- Category 3: 8 – 25 cal/cm^2
- Category 4: 25 – 40 cal/cm^2

If appropriate PPE is used and the work risk assessment and approvals are obtained on this

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Appendix 1 – Energized Electrical Work Authorization *(Cont'd)*

SUNCOR ENERGY

Energized Electrical Work Authorization Form

authorization form, personnel can work above these incident energy levels .

Section 2 – Risk Assessment – Controls/Mitigations

At this point in the hazard/risk management process, consider unmitigated risks and if voltages are above 50V and currents above 10 mA (AC 'let-go' threshold), the worst credible consequence is generally an electrocution or a 'C5'. This process defers overall risk assessment until controls and/or mitigations are considered.

2.9 The first choice is always to de-energize and render the equipment 'electrically safe' as per RGP0005A. This may involve the tasks of de-energizing equipment and applying/removing temporary protective grounds (if required). If so, this is energized work entails risk that must be considered and assessed.

2.10 Work zone barriers are meant to protect people who don't have the appropriate PPE or electrical competency from approaching electrically hazardous areas, that is, keeping them on the safe side of the boundary. Consider shock and arc flash approach boundaries when placing boundaries. Boundaries can be barricades, ribbons, tags / signage, etc. as appropriate for the work. Take care to ensure that all workers within in the areas are aware of work, hazards, controls, mitigations and risks.

2.11 Where available, incident energy reductions are generally protective device setting changes that reduce arc fault current or duration.

2.12 Procedures or switching orders are administrative controls that provide a structured, sequenced task list. Consider all elements of risk management addressed in this form when creating this list. Approvals on these prepared and pre-approved documents can take the place of approvals on form.

2.13 Arc Flash PPE is the last-line-of-defense for arc flash hazards. This PPE should be adequate for the expected incident energy levels and should conform to RGS0005A. Enter the required PPE.

2.14 Insulating PPE / tools are similarly the last-line-of-defense for shock hazards and these must be adequate for the voltages and working conditions involved. Enter the required PPE/Tools

2.15 Assess whether the equipment is suitable to operate as designed and/or intended. This may include an assessment of the equipment installation and/or application, loading, maintenance history, cleanliness (possibility of insulation failure), whether all doors covers are properly installed, whether there is any evidence of impending failure (heat, moisture, noise, etc.). The assessed likelihood of an electrical safety event must consider whether any of these conditions aren't satisfactorily met.

2.16 Emergency isolation point is the device that would be used to de-energize the equipment being worked on in the event of an emergency. An electrical safety watch is required for 'higher risk' work as per the corporate Electrical Safety Risk Management standard. This person would lead the application of any emergency measures including emergency isolation.

2.17 List other controls and/or mitigations that minimize the likelihood of an event.

2.18 Consequence forms a part of the risk. If > 50V is used and available current exceeds 10mA, the consequence is C5. Many portable and handheld insulation testers do not meet this current threshold hence the worst credible consequence for these off-line tasks is much lower.

2.19 Assess the likelihood or probability that an event may occur if all the controls and/or mitigations listed are in place.

2.20 Enter the overall mitigated risk assessment for the work being considered. This rank determines the required approvals.

Section 3 - Approvals

As indicated in the corporate Electrical Safety Risk Management standard, workers must be competent for assigned tasks. The Manager/Supervisor must ensure the proper application of the EEWA forms.

3.1 Assign a lead worker as the work execution owner. All directly involved workers are required to sign

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Appendix 1 – Energized Electrical Work Authorization *(Cont'd)*

the form indicating that they understand all elements of the work authorization.

3.2 - 3.3 Enter the appropriate name, ID and date for the required approvals as per the assessed risk and the Suncor Risk Assessment standard.

Appendix 2 – Arc Flash and Shock Hazard Analysis Form

This form is a template in Livelink.

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Arc Flash and Shock Hazard Analysis Form

Equipment Type:			
Work Task:			
Location:		**Date:**	

1	Is the equipment operating at more than 50 volts or is a shock hazard present? If "no", the rest of this form is not applicable. Hazard/risk analysis is not required for this task. If "yes", perform a hazard/risk analysis.	Circle one: Yes / No
2	Determine the shock protection boundaries. Limited approach boundary: _____ Restricted approach boundary: _____	
3	Determine the available fault current and clearing time for this equipment: _____ kA _____ cycles The available fault current must be: _____ kA or less with _____ cycle clearing time for the table to be applicable. If either the fault current or the clearing time exceeds these numbers, calculate the incident energy and display it here: _____	
4	Determine the flash protection boundary Flash protection boundary: _____	
5	Select the hazard/risk category for the task Hazard/risk category: _____	
6	Are voltage-rated tools required?	Circle one: Yes / No
7	Are voltage-rated gloves required?	Yes / No
8	List PPE required for the selected hazard/risk category: Use the back of the form, if required. _____ _____ _____	

The following individuals have approved and signed this document.

UserName: Jim Chuey (jchuey)
Title: GM EH&S Upstream
Date: Wednesday, 26 October 2016, 08:51 AM Mountain Time
Meaning: Approver 1 Signed
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