ENERGY SAFETY CANADA

ELECTRICAL SAFETY

A Program Development Guideline

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Setting the standard in oil gas safety

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- Petroleum Services Association of Canada (PSAC)

ABOUT ENERGY SAFETY CANADA

Energy Safety Canada is the upstream oil and gas industry's advocate and leading resource for the continuous improvement of safety performance. Our mission is to help companies achieve their safety goals by providing practices, assessment, training, support, metrics and communication.

AVAILABILITY

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DISCLAIMER

This document is intended to be flexible in application and provide guidance to users rather than act as a prescriptive solution. Recognizing that one solution is not appropriate for all users and situations, it presents generally accepted guidelines that apply to industry situations, as well as recommended practices that may suit a company's particular needs. While we believe that the information contained herein is reliable under the conditions and subject to the limitations set out, Energy Safety Canada does not guarantee its accuracy. The use of this document or any information contained will be at the user's sole risk, regardless of any fault or negligence of Energy Safety Canada and the participating industry associations.

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PREFACE

PURPOSE

This guideline has been written specifically for the oil and gas industry and provides a framework to develop and address electrical safety within a Company's Occupational Health and Safety Management System (OHSMS). This guideline discusses electrical safety programs - as they apply to large and small employers.

This guideline for electrical safety programs deals with safe work practices and not safe installations. For guidance on safe installations practices, reference the Canadian Electrical Code and jurisdictional specific requirements.

HOW TO USE THIS GUIDELINE

This guideline can be used by any organization within or supporting the oil and gas industry whose workers may be exposed to electrical hazards. Companies may use this guideline to:

- Assist them in determining the need for an electrical safety program and in developing their electrical safety program.
- Perform an audit or gap analysis of existing systems.
- Apply the templates, processes, tools and additional resources provided in this guideline to improve their program.

This guideline can also be utilized by producers, service companies, transportation companies, drilling, seismic and exploration operations. Examples of these include, but are not limited to:

- Oil and gas exploration and production companies
- Electrical and instrumentation service providers
- Construction service providers
- Cathodic protection service providers
- Hydrocarbon transmission companies
- Oil & Gas service companies

LIMITATIONS

This guideline has been developed with reference to industry related publications. However, it is not exhaustive. The reader should defer to published standards and applicable legislation for guidance. This document is intended as a guideline, and not as a compliance standard. This guideline is not intended to be a protocol for the audit of an electrical safety program.

REGULATIONS

Each provincial and federal Occupational Health and Safety jurisdictional authority has a well-established occupational health and safety regulatory framework. The Occupational Health and Safety legislation in each jurisdiction defines the responsibilities for employers, supervisors and workers to work safety and follow safe work practices. It is the employer's legal obligation to ensure current regulatory requirements are adhered to. This includes the required qualifications and competencies of all supervisors and workers.

REVISION PROCESS

Industry Development Guidelines (IDGs) are developed by industry for industry. Energy Safety Canada (ESC) acts as an administrator and publisher.

Each IDG is reviewed on a three year cycle. Technical issues or changes may prompt a re-evaluation and review of this IDG in whole or in part. For details on the IDG creation and revision process, visit the ESC website at www.EnergySafetyCanada.com.

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1.0 Introduction

1.1 Due Diligence and Electrical Safety

Most people are unaware of how dangerous electricity can be. Electricity is invisible, and because we use it constantly, we often fail to recognize the potential risk of exposure to electrical hazards. In the oil and gas industry, incidents involving electric hazards occur and serious incidents, including fatalities can occur without attention to electrical safety practices.

The requirements for electrical safety are constantly changing. Guidance for strategies to manage electrical hazards can be found in regulations and national consensus standards like the Canadian Standards Association CSA Z462, Workplace Electrical Safety Standard.

An electrical safety program documents the necessary policies and practices to eliminate or reduce the risk of exposure to electrical hazards in the workplace. Whenever employees are interacting with energized (e.g., voltage is present) electrical equipment, employers shall ensure that electrical safety is a component of their Occupational Health and Safety Management System (OHSMS). Provincial and Federal occupational health and safety authorities and the Criminal Code of Canada require that employers provide safe work sites for their employees and contract workers.

All employers have an obligation to identify, assess and control the risk of worker exposure to electrical hazards in the workplace. Incorporating an electrical safety program as a component of the OHSMS provides the appropriate due diligence with respect to the effective management of electrical hazards.

Due diligence is a legal phrase referring to the duty to take reasonably practicable actions to protect the well-being of others. In terms of occupational health and safety, due diligence requires that everyone with responsibility for health and safety take every precaution in the circumstances to avoid a work related injury or illness.

When it comes to occupational health and safety, due diligence requires employers to:

- Establish an occupational health and safety management system.
- Ensure the system is adequate.
- Monitor and evaluate the system's effectiveness.

In the case of electrical safety, a hazard which has the potential for serious harm or death, the degree of risk is deemed to be high and therefore a higher degree of due diligence is required. At a minimum, an electrical safety program should:

- Identify electrical hazards.
- Assess the electrical hazards and associated risks related to a work task.

- Document the application of preventive and protective control measures to reduce risk of exposure to electrical hazards to as low as reasonably practicable (ALARP).
- Train workers to identify the electrical hazards and apply appropriate control measures to reduce risk of exposure.
- Monitor the effectiveness of the control measures by completing audits.

This guideline provides direction and resources to establish an electrical safety program in the oil and gas industry and is applicable to small and large organizations.

1.2 The Hazards of Electricity

The two primary hazards associated with electricity are the potential of exposure to electric shock and arc flash when energized electrical equipment is in an abnormal condition (See Glossary definition). Exposure to electric shock and arc flash can cause serious injury or death.

During an electric shock incident, a worker becomes part of an electric circuit by providing a path for the electrical current to flow. The severity of the injury is determined by; the amount of electric current that flows through the body, the path that the electrical current takes through the body and how long the current flows. Physical contact with an energized conductor or circuit part may not be necessary for electric shock to occur. Simply getting too close to high voltage electrical equipment (e.g., overhead power lines) can be enough to cause electricity to flow through the body.

An arc flash can occur when there is an abnormal condition in energized electrical equipment that causes an electrical current to pass through the air. This can occur either between ungrounded conductors or between grounded conductors and ungrounded conductors. Air temperatures can reach 20,000°C (35,000°F). These extreme temperatures can burn the skin directly and can also ignite polyester, polyester blends and natural fibre clothing. The toxic vapours that are released from the arc flash event can cause respiratory damage as well.

Along with extreme temperature, there may be an explosive expansion of the surrounding air and metallic components of electrical equipment. This blast effect, called arc blast, can cause high pressures, extreme sound concussion (e.g., up to 165 dB) and push shrapnel away from the arcing fault location. Materials and molten metals are propelled away from the arcing fault location at high speeds.

Arc blast high pressures can cause physical trauma; (e.g., break bones), knock workers off ladders, and possibly rupture eardrums if no hearing protection is worn.

1.3 Who is at Risk?

Electrical installation codes such as the Canadian Electrical Code establish safety standards for the installation of electrical equipment. These codes and standards do not establish safe work practices or provide procedures for electrical workers. An electrical safety program is recommended to establish policies, practices and procedures for the safe operation and maintenance of energized electrical equipment.

Any person who uses electrical energy, or works in proximity to electrical energy, may be at risk of an electrical injury. The initial step is to determine whether employees are at risk.

To help make this determination, answer the following questions:

- Do workers transport or operate equipment under or near energized overhead power lines or buried electrical cables?
- Do workers conduct work on or around energized electrical equipment and systems where there are exposed conductors or circuit parts?
- Do workers conduct energized electrical work (e.g., voltage testing, current measurements, inspections, isolations, etc.)?
- Do workers operate energized electrical equipment (e.g., motors, heaters, lighting, etc.)?
- Do workers complete de-energized electrical work?
- Are any workers qualified in a trade that may work with electrical equipment and systems, such as electricians, instrument technicians or linemen? Are there motor control centres or panel boards on your work site?
- Is exposure to electricity an identified hazard to which workers are potentially exposed, and which requires hazard control?
- Do any workers use portable cord-and-plug-connected electrical equipment and extension cords?

Note: These questions are only an example to provide guidance to the reader. Many more questions may be included in a risk assessment determination. If the answer is yes to any of the above questions, then an electrical safety program may be required.

The following are examples of workplace situations that could result in exposure to electrical hazards:

- A floor-hand is using an extension cord to connect a power washer. This worker needs to understand that damaged extension cords can expose workers to electric shock and that this equipment must be plugged into a receptacle protected by a ground fault circuit interrupter (GFCI).
- A plant operator becomes aware of a tripped circuit breaker. This worker needs to understand that a tripped circuit breaker is often the result of an electrical fault. Re-energizing that fault could cause electrical arcs at the faulted location. This could contribute to a fire hazard or the electrification of metallic parts that could result in personnel receiving an electric shock. A qualified electrical worker should investigate the cause of the tripped circuit breaker.

- An instrumentation technician is adding a new pressure transmitter to a control system. The instrumentation technician needs to know that the termination panel may have multiple sources of voltage and that multiple circuit breakers or fused disconnects may have to be opened in order to safely de-energize the panel.
- An electrician needs to add a new motor control centre starter bucket to an energized electrical bus. The electrician needs to analyse the electrical hazards in order to determine if this task must be done while the system is energized. If the task must be performed while the system is energized, then the electrician needs to understand the voltage and arc flash incident energy present in order to determine the correct procedure and personal protective equipment required.
- Non-electrical workers such as pipeline workers, drilling and completions workers, fallers/buckers, etc. working near or under overhead power lines (i.e. installing goal posts or dummy poles) are at risk of inadvertently getting too close to a power line.
- Unqualified workers, for example Rig managers working on motor control centres or electrical panels.
- Connecting and disconnecting equipment from power distribution equipment.
- A camp kitchen worker is operating an electric mixer in a wet area. This worker needs to understand that this equipment must be plugged into a GFCI receptacle.
- In short, almost any worker may be exposed to electrical hazards and there are numerous combinations of workplaces, workers and tasks that merit analysis in order to determine exposure to electrical hazards.

2.0 Develop an Electrical Safety Program

An electrical safety program outlines requirements, policies and practices to address hazards associated with working near electricity. It can be a stand-alone program or be integrated into an existing safety management system. It should be aligned with the requirements of the safety management system, be practical, sustainable and a measurable program to mitigate or reduce the risk of exposure to electrical hazards.

Determining the size and scope of an electrical safety program begins with a consideration of the nature of the business and the electrical hazards involved. An organization dealing with energized electrical work tasks should have an extensive electrical safety program. This may involve highly detailed and documented procedures, a program manual, and a defined training matrix which is integrated into the employer's existing safety management system. On the other end of the spectrum, a small operation that undertakes work with a low risk profile may need only a small task-specific program that requires only minor amendments to an existing safety management system.

Regardless of the size and scope, what matters is that an electrical safety program is designed and implemented to keep people safe. See Appendix 2 for a simple checklist that may prove helpful in planning or updating your electrical safety program.

An introductory paragraph should be considered. Each paragraph should explain one concept to the reader.

2.1 Safety Management Systems and Electricity

As mentioned, electrical safety should be part of an organization's health and safety management system. However, the development of an electrical safety program does not necessarily require a significant change to existing practices.

Developing an electrical safety program begins with an understanding of the current safety management system. All organizations should have a safety management system. Information on how to develop a safety management system can be found in the Energy Safety Canada guideline—Safety Management Systems. In addition, the Canada Standards Association CSA Z1000, Occupational Health and Safety Management Standards provide a model to develop and implement an occupational health and safety management system.

A safety culture in the workplace is demonstrated through behaviour, values, and action. It is a reflection of employee opinions about how much the organization values their personal safety. Being aware of the prevailing safety culture can help maximize program effectiveness.

Simple concise concepts that are easily remembered are excellent ways to influence behaviour. One example is Test-Before-Touch, an easy to remember protocol to ensure energized electrical equipment is safe to work on (see section 3.6 for more information).

2.1.1 Leadership

The success of any program requires commitment from all levels of management in an organization. Management should take a leadership role in preparing and implementing the program. Management should:

- Be involved and interested in activities.
- Show leadership in action and words.
- Communicate safety regularly.

An effective strategy is to integrate and communicate the cost benefit of an electrical safety program. The cost benefit can help to establish the financial justification for program development, implementation and maintenance. This may include using real data from the company's incident history to establish the true costs of an electrical injury (i.e., medical costs, insurance, replacement costs, lost time and fines).

2.2 Involve Employees

Successful safety management systems have a strategy to involve employees to get their commitment. One approach is to create an electrical safety steering committee at the worksite to oversee and guide the development and implementation of the program. This can foster employee commitment and involvement in the process. Other steps to take may include:

- Advise employees about the program both informally and also through company communication channels such as memos and newsletters.
- Hold meetings and provide regular updates.
- Stress the importance of getting employee input into program development and implementation.
- Interview affected workers in their workplace to better understand hazards and increase their investment in the process.
- Share the completed program with employees and actively involve them in the implementation.
- Encourage on going feedback.

2.3 Identify Applicable Standards Regulations

When creating an electrical safety program, employers must ensure they adhere to applicable regulations and legislation and utilize industry recognized and accepted standards. There are many standards that may apply to an electrical safety program. Worker safety in Canada is covered by provincial and federal regulations. Below is a partial list of the regulations and standards that should be consulted before developing an electrical safety program:

- Provincial Occupational Health and Safety (OH&S) Legislation—Most provincial OH&S legislation contains the general requirements for employers to identify hazards, which would include shock and arc flash, and the requirement to take steps to protect workers from these hazards. Depending on the province, there may be legislation that is applicable to an electrical safety program. For example, there may be requirements and limits for:
  - Working on or near energized electrical equipment
  - Safe limits of approach to energized conductors
  - Recommended personal protective equipment (PPE), special tools and equipment (e.g., use of non-conductive ladders)
  - Training requirements
  - Working alone legislation
  - Safe work procedure development
  - Other requirements

Note: Be sure to consult legislation for all provinces where the company may operate.

  - The Canadian Standards Association CSA Z462, *Workplace Electrical Safety* is an important standard to review.
  - Related standards that are specific for electrical PPE, tools and equipment are detailed in Appendix 1.

2.4 Identify Affected Workers

A key factor in determining the nature and extent of an electrical safety program is whether the company employs qualified electrical workers. If there are qualified electrical workers on site, then an electrical safety program should be larger, more extensive, more comprehensive and more detailed. If there are non-qualified workers only on site, then the electrical safety program may be less extensive.

There are generally two main categories of workers covered by an electrical safety program. These are:

- Qualified electrical workers with formal training in electrical work. This may include; electricians, instrumentation technicians, electrical technologist, electrical engineers, AC and refrigeration technicians, cathodic protection technicians, elevator mechanics, etc.

- Non-electrical workers typically would include roles such as operators for various types of services, equipment, or installations within the industry, mechanics/millwrights, welders, and general labourers.

The difference in qualifications as well as the type of hazards encountered dictates the type of training required. The frequency of electrical safety training should occur, at a minimum, when a new worker enters the company or when there is a change in the worker's role. The CSA Z462 standard recommends a three year frequency for electrical safety training.

2.5 Review of Existing Systems

The most effective safety management systems are those that are incorporated into existing systems and methodologies. These systems are more likely to have a long life and be maintained as they become part of the organization's existing audit systems and maintenance programs.

2.5.1 Safety Audit and/or Gap Analysis

Prior to making any decisions about electrical safety, it is essential to review current systems and do a safety audit and/or gap analysis to determine key areas for consideration. There are a variety of ways to undertake this analysis depending on the size and nature of the business, and the electrical hazards that workers are exposed to.

Employers may require outside expertise such as electrical engineering professionals, electrical trades persons and OH&S professionals to aid the development and implementation of an electrical safety program.

An audit/gap analysis should be undertaken and may be conducted by any of the following:

- Representatives from the Health and Safety Committee
- Any electrical engineering and/or electricians on staff
- Someone with knowledge of the unique characteristics of electricity
- Outside consultants
- A team of any of the above

An audit/gap analysis may include but is not limited to the following key questions:

- What are the electrical hazards?
- What needs to be done to mitigate or control them?
- What controls are currently in place?
- Are the controls adequate to ensure safety?
- What is needed in terms of training?
- What is needed in terms of electrical specific PPE, tools and equipment?

2.5.2 Site Assessment

The first step in a safety audit and/or gap analysis is a site assessment. Site assessments can provide very valuable information. Conducting a site assessment involves visiting and evaluating facilities or installations. It is recommended that a site visit be made to a series of representative facilities to provide the opportunity for employee consultation and to ensure that assumptions that are made are representative of the actual site conditions. In a mobile business, where facilities may change from week to week, some reasonable assumptions may need to be made in terms of electrical hazards.

The site assessment process is part of the data gathering exercise and should not be rushed. A checklist can also assist in this process. For a sample checklist see Appendix 3.

A site assessment may involve answering the following questions:

- What are the voltage sources and potential electrical hazards?
- What tasks may be required on or near energized electrical conductors or circuit parts?
- Are there single line diagrams available?
- Are there arc flash and shock warning labels available on electrical equipment?
- What are the lock out policies and procedures and isolation points?
- What safe work practices are already in place?
- Are electrically safe work procedures available and used?
- Is there adequate facility signage at all access points where there are electrical hazards?
- What are the existing emergency response requirements and has the appropriate emergency response training been provided for electrical incidents?
- What are the training needs?
- What are the possible installation deficiencies?
- Have any changes or modifications been made since installation?

A team inspection process may also be of value. Photographs can be taken of the findings for later reference and review. A site assessment should gather any documentation available on site for further review, and consider interviewing management, supervisors, electrical workers, and non-electrical workers with respect to energized electrical equipment and current work practices. These findings should be documented and a prioritized corrective action list developed.

2.5.3 Corrective Action Plan

Once a safety audit and/or gap analysis has been conducted, the next step is to develop a corrective action plan. The employer should establish a budget, prioritize the corrective actions that need to occur, identify the potential resources required and assign individuals to implement these corrective actions. Formulation of a corrective action plan requires careful consideration. It is important to allow adequate time and be realistic in establishing the plan.

Employers may require outside expertise (e.g., electrical engineering professionals, electrical trades persons and OH&S professionals) to support the corrective action plan.

It is vital that everyone involved in the plan be fully aware of the scope, possible requirements and actions, and is committed to the successful achievement of the plan. On-going management support is imperative

3.0 Elements of an Electrical Safety Program

This section contains a suggested list and description of the most common elements found in an electrical safety program. Consideration should be given to incorporating each element for a comprehensive electrical safety program. These elements are also consistent with OHSMS programs such as the Certificate of Recognition (COR) Safety Management System elements.

It is important to note that this suggested list of elements may not address all of an organization's electrical safety needs and not all organizations will need to address each element in this section. Each organization's electrical safety program should be tailored to meet their electrical safety needs. See Appendix 4 for a helpful checklist to use.

3.1 Policy Statement

A safety policy statement documents a company's guiding principles regarding safety. It should be made available in the workplace and communicated to all employees. A sample has been included in Appendix 5.

A policy statement may include:

- An affirmation of the company's intention to identify, assess and control hazards in the workplace.
- A statement regarding whether tasks can be performed on energized electrical conductors and circuit parts.
- The requirement for all equipment to be verified in an electrically safe work condition prior to any task being performed on the equipment.
- The minimum training requirements for qualified electrical workers and non-electrical workers.
- A statement specifying accountability for the electrical safety program.

3.2 Purpose and Scope

The purpose statement explains why the program was developed and will generally address safeguarding of workers with respect to the hazards of electric shock and arc flash with associated arc blast.

The scope explains where, when and to whom the program applies. The scope should clearly state if:

- The program is mandatory.
- The program applies to all workers, including contractors, vendors and service personnel.

- Procedures may be supplemented by other documents.
- Any boundary conditions or limits exist.

See Appendix 5 for a few examples.

3.3 Roles and Responsibilities

Various workers affected by the program must be defined by their roles and responsibilities. For example:

- Key decision makers
- Staff with roles in developing or administering the program
- Program auditors
- Program funders
- Managers
- Supervisors
- Qualified electrical workers
- Non-electrical workers

3.3.1 Qualified Electrical Workers

The electrical safety program should clearly identify the tasks that may only be performed by qualified electrical workers. Applicable provincial legislation and consensus standards such as CSA Z462, Workplace Electrical Safety should be consulted to determine these tasks. In addition, the electrical safety program should define what is meant by a qualified electrical worker. The CSA Z462 standard defines a qualified electrical worker. It is not enough that the worker is certified as an electrician, they must also be qualified and competent to perform the specific tasks that they are assigned and there may also be other requirements. The electrical safety program should clearly state what these requirements are. For example, an electrician must:

- Hold a Journeyman Electrician ticket in the electrical trade or other certification that is acceptable to the local jurisdiction, and;
- Be able to recognize the hazards involved in the work task and;
- Have the appropriate skills, knowledge, experience and sufficient expertise related to the construction and operation of the electrical equipment and installations involved in the work task and;
- Have received safety training on the hazards involved in the work task.

See Appendix 6 for electrical safety competencies expected of qualified electrical workers in the Canadian upstream oil and gas industry.

3.3.2 Non-Electrical Workers

The CSA Z462 standard defines a non-electrical worker as an unqualified person (worker) as; "a person who is not a qualified person." An unqualified person (worker) therefore should not be allowed to perform the work that the electrical safety program stipulates must be done by a qualified electrical worker. Non-electrical workers can injure themselves or others if they attempt to perform work they are not qualified or competent to perform. These workers may not understand the equipment or be able to recognize the hazards present.

The electrical safety program must be clear in setting limits on what a non-electrical worker can and cannot do.

3.4 Hazard Identification and Assessment

The electrical safety program should include the hazard analysis process for workers to identify and assess electrical hazards. Electrical hazards may be identified using accepted OH&S safety practices, such as job task hazard analysis, job safety analysis or field level hazard analysis. Employers are encouraged to consider worker participation in electrical hazard identification and ensure sufficient subject matter expertise in electrical hazard identification.

Once potential electrical hazards are identified, the hazards must be quantified with respect to shock and arc flash. Quantification of shock and arc flash hazards requires:

- The determination of system voltage and establishing limits of approach or shock approach boundaries;
- The determination of available incident energy or the level of arc rated clothing at an assumed working distance and what the arc flash boundary is.

Determination of system voltage and available incident energy can be complex and requires a thorough understanding of electrical systems and competency in electrical engineering principles.

Guidance is available to determine arc rated clothing requirements such as:

1. Engineering analysis to determine incident energy (See Glossary definition)
2. Use of tables provided in industry standards

When energized electrical work tasks are required, the quantification of the voltage and arc flash hazards allows for determination of safe approach boundaries to exposed, energized conductors or circuit parts.

Once electrical hazards have been identified and quantified and approach boundaries have been determined, then further job task hazard analysis is required. Assessment of electrical hazards requires an understanding of the position of the worker within the approach boundaries, the task being performed at that position and the likelihood and consequence of an electrical incident.

This assessment will facilitate the development of effective controls using a risk assessment process, including the classification of electrical hazards for the development of electrical safe work procedures. Section 3.6 of this guideline provides guidance on the development of safe work practices and procedures.

The development and implementation of controls for electrical hazards should follow the hierarchy of controls methodology. These are:

1. Elimination of the hazard.
2. Substitution.
3. Implementation of engineering controls.
4. Implementation of administrative controls through safe work practices, procedures and training including the use warning signs and barricading.
5. Personal protective equipment

Each control methodology is explained in more detail below.

3.4.1 Elimination

Elimination of electrical hazards means to de-energize all sources and potential sources of electricity that the worker may be exposed to. Elimination of electrical hazards is achieved by establishing an electrically safe work condition as outlined in CSA Z462, Workplace Electrical Safety (Refer to Section 3.6 of this guideline for more information).

An electrical safety program requires that procedures be developed to establish an electrically safe work condition. Where equipment design does not facilitate the establishing of an electrically safe work condition, de-energizing concurrent with a lock-out procedure may serve to eliminate the hazard.

3.4.2 Substitution

Where possible energized electrical equipment can be substituted with other electrical equipment or related components to mitigate potential risks.

3.4.3 Engineering Controls

Engineering controls seek to protect the worker from contact with energized electrical conductors and circuit parts, as well as offer a measure of protection should certain electrical faults occur.

The implementation of guarding and insulation is one method of engineering control. Barriers and fencing, sometimes with locked gates, serve to prohibit unauthorized persons from contacting exposed energized conductors and circuit parts. Installing and closing doors and covers on electrical equipment also guards against contact with energized conductors and circuit parts. Additionally, guards may be installed to cover exposed parts and finger safe components used.

It is possible, in some cases, to reduce the incident energy (energy from a potential arc flash event) by reducing the fault clearing time. This is achieved by adjusting settings in protective devices installed in electrical systems, installing arc flash relays and installing specialized protective relay schemes. Lastly, some engineering controls are imbedded in the design of electrical equipment and systems. For more information see Section 3.16.

3.4.4 Administrative Controls

Administrative controls seek to establish safe work practices, procedures and training specific to electrical tasks and electrical safety. Many electrical incidents are at least partially due to unsafe work practices; therefore consideration of safe work procedures is critical to the development and implementation of an electrical safety program. In order to develop safe work procedures, hazards must first be identified and then assessed. Guidance regarding the identification and assessment of electrical hazards and completing a risk assessment is provided in Section 2.6.1 of this guideline.

High risk electrical work tasks may require detailed, step-by-step procedures be used to reduce risk. Routine, or low risk electrical work tasks, may require less rigorous procedures. All procedures should be written specifically for the work tasks and environment. Procedures should be documented in a format that workers can understand and utilize, be up to date and available in the workplace. Written procedures must be available to the workers and training should be provided in the performance of these procedures.

The jurisdiction that has legislative authority may detail the obligations of employers and workers with respect to the development, implementation and continuous review of procedures.

Procedures specific to electrical work may include:

- Establishing an electrically safe work condition.
- Performing Test-Before-Touch protocols.
- Conducting energized electrical work e.g. voltage testing or current measurement.
- Completing an infrared thermographic survey.
- Operating disconnection devices (opening and closing circuit breakers or switches).

Critical task procedures may include:

- Inserting and removing motor starter buckets.
- Racking in and racking out of power circuit breakers.
- Applying temporary protective grounds.

Additional relevant procedures may include:

- Lock-out procedures.
- Obtaining a Safe Work Permit to work.
- Transportation of over-height vehicles and equipment under overhead power lines.
- Working in proximity to overhead power lines.
- Ground disturbance.

For an example of procedures see Appendix 7.

3.4.5 Personal Protective Equipment (PPE)

Electrical-specific PPE, tools and equipment offer some protection to workers in the event of an electrical incident. PPE should never be considered as a substitute for establishing an electrically safe work condition. Energized electrical work requires the use of electrical specific PPE, tools and equipment for the safe performance of energized electrical work procedures. Electrical specific PPE, tools and equipment include, but are not limited to:

- rubber insulating ("voltage-rated") gloves with leather protectors
- arc rated coveralls
- arc rated face shields with arc rated balaclavas or arc flash suit hood
- arc flash suits with arc flash suit hoods
- insulated hand tools
- insulating live-line tools (i.e., hot sticks)
- test equipment
- rubber insulating blankets
- Class E (nonconductive) hard hat

For more information refer to Appendix 1 for applicable standards.

3.5 Electrical System Information

Electrical drawings, signage, labelling and the use of barricading may be crucial to inform workers of electrical hazards and may play a critical role in safe work planning and executing procedures. The electrical safety program should outline the requirements for these items.

3.5.1 Electrical Drawings

For employers who own or operate large or complex electrical systems, the creation and maintenance of accurate electrical drawings is critical to worker safety.

Electrical workers and operations personnel can use accurate single line diagrams to:

- Develop switching and isolation procedures and related safe work plans for de-energizing electrical distribution equipment.
- Convey information on arc flash incident energy and approach boundaries when qualified electrical workers are exposed to electrical hazards.

3.5.2 Labels

Labels may be used on electrical equipment to provide information about the voltage of the equipment, the available arc flash incident energy and the applicable approach boundaries for shock and arc flash. Consult CSA Z462, Workplace Electrical Safety for more information on the labelling of equipment.

3.5.3 Signage

Signage at entrances to electrical rooms, buildings and other areas such as outdoor substations and transformer yards may be used to inform workers of restricted access to these areas and to warn of the voltage of the electrical equipment that the area contains.

3.6 Electrically Safe Work Condition

Electrical safety programs should include a policy to establish an electrically safe work condition. All energized electrical conductors and circuit parts should be considered to be energized unless an electrically safe work condition has been established. Additionally, electrical workers need to understand the difference between simple de-energization and the establishment of an electrically safe work condition.

A critical requirement of establishing an electrically safe work condition is confirming the absence of voltage before working on electrical conductors or circuit parts. This is achieved by completing a Test-Before-Touch procedure. An electrically safe work condition establishes a state in which an energized electrical conductor or circuit part:

- Is de-energized and isolated.
- Has been tested to ensure the absence of voltage.
- Is locked out in accordance with lockout programs and procedures.
- Has temporary protective grounds installed (if necessary) to guard against induced electricity or inadvertent re-energization. Establishing an electrically safe work condition may require the installation of temporary protective grounds where there is a chance that de-energized circuit parts or conductors become energized by induced voltages, stored electrical energy devices, accidental re-energization of the circuit

due to operation of disconnect devices or accidental contact with energized circuits. Some electrical equipment rated at less than 750 V may not be designed for the installation of temporary protective grounds, so additional consideration for the safeguarding of workers must be identified.

- Is physically disconnected from the locked out voltage source(s) (optional).

The electrical safety program should aim to minimize the amount of energized electrical work that qualified electrical workers are tasked with. Where it is not feasible to de-energize, procedures must be in place so that the qualified electrical worker can perform the work safely. CSA Z462, Workplace Electrical Safety defines how to establish an electrically safe work condition in clause 4.2.1.

3.7 Power Line Safety

Employers are required to identify, assess and control the hazards associated with work performed near power lines and electric power facilities. Power lines may be installed overhead or underground. Electric power facilities include transmission and distribution facilities like substations.

With respect to power lines, employers are required to control the hazards associated with working too close to a power line. In order to establish OH&S safe limits of approach to power lines, employers must consult the owner of the electrical utility system prior to any work within 7 m of an overhead power line. Additionally, employers must ensure that all underground power lines are located and marked prior to any activities that require the ground to be disturbed.

Workers must be trained in emergency response procedures should they find themselves near a downed overhead power line or an exposed power line, or if they are involved in a vehicle collision with an overhead power line.

Activities in the oil and gas industry that pose the greatest risk of contact with power lines are:

- Transportation or movement of high loads
- Excavation
- Hoisting and reaching
- Drilling and boring

Comprehensive treatment of power line safety is beyond the scope of this document. The reader is encouraged to consult existing industry guidance from local electrical utilities and additional training programs.

3.8 Job Planning Meetings

The electrical safety program should specify requirements for pre-job planning of energized electrical work. Pre-job planning should include, but is not limited to:

- Identification and evaluation of the hazards associated with the work task.
- Completion of a risk assessment related to the work task.
- A plan of the work task, including the development of procedures.
- Identification of required electrical-specific PPE, tools and equipment for the work.

The electrical safety program should also specify that a pre-job briefing is required prior to starting the job. The pre-job briefing should include all workers involved with the work and even other workers who may be in the area where the work is to take place. The pre-job briefing should cover, but is not limited to:

- Hazards and risk assessment associated with the job.
- Work procedures involved.
- Special precautions.
- Energy source controls (e.g., lockouts in place.)
- PPE, tools and equipment requirements.
- Information on the energized electrical work permit if required. (For an example of an energized electrical work permit See Appendix 8).

A hazard assessment is to be conducted utilizing atmospheric monitoring prior to working on energized equipment in a hazardous location (See Glossary definition).

For a pre-job briefing and planning checklist, consult CSA Z462, Workplace Electrical Safety, Annex I. The checklist is a useful tool to ensure that the pre-job planning is done correctly.

3.9 Operating Fixed Electrical Equipment

Where workers are required to operate circuit breakers, disconnect switches, push buttons, relays, etc., the electrical safety program should address electrical safety requirements for these operations.

Some considerations for the electrical safety program include:

- Qualifications and training requirements for workers who operate electrical equipment.
- Proper body positioning (i.e., stand to the side, consider whether the worker should face or turn face away from the electrical equipment depending on the PPE worn).
- Whether the worker should ensure that equipment is closed and all hardware is in place and fully tightened or latched.

- The required or recommended PPE should be clearly stated depending on the specific work task being performed.
- Once the equipment is operated, the worker should determine if anything seems to be abnormal (i.e., any abnormal noises, smells, visual clues, etc. that indicate a possible problem has occurred during operation of the equipment). If abnormal, contact a qualified electrical worker to investigate.
- Proper investigation of tripped protective devices by a qualified electrical worker prior to re-energization.

3.10 Portable Electric Equipment and Extension Cords

The electrical hazards associated with the use of portable electrical equipment and extension cords are often overlooked or poorly understood. When they are improperly assembled or maintained, they pose a shock and electrocution hazard.

An electrical safety program should include a section on the hazards associated with this type of equipment and specify procedures for its operation, inspection and maintenance.

Most regulatory agencies and electrical installation codes require that electrical equipment be maintained by qualified electricians. Portable equipment may be operated by a variety of non-electrical workers. Frequently, correct operation of this equipment requires the performance of detailed procedures. For example, many portable electric generators require the installation of a ground rod and the connection of a grounding conductor. Failure to follow procedures required by the manufacturer may expose workers to the hazards of electric shock. Additionally, the use of portable electric power tools in indoor or outdoor locations where water may be present requires the use of a Class A GFCI in order to safeguard the worker from shock. Inadequate or improper maintenance of electrical equipment may cause shock injuries and electrocution to the worker.

Extension cords are found in most workplaces and are often an essential tool. When they are improperly assembled and when incorrectly or inadequately maintained, extension cords pose a shock and electrocution hazard. Electrical installation codes, such as the Canadian Electrical Code, specify the requirements for extension cords. Qualified electricians are trained to assemble and maintain extension cords in accordance with these installation codes.

Frequently, extension cords are assembled at work sites by unqualified workers. The use of incorrect conductor sizes, incorrect conductor specification, incorrect attachment plugs and poor workmanship when making electrical connections creates a significant fire and shock hazard, as do damaged or severed extension cords.

3.11 Temporary Power Distribution Systems

During facility construction and maintenance turnarounds, temporary power distribution systems are often developed in order to provide power to portable electric equipment and other electrical loads (e.g., lighting). These temporary power distribution systems should be addressed in the electrical safety program in order to identify the potential hazards of shock and arc flash (e.g., 120/208 Vac, 480 Vac, 600 Vac and higher voltage temporary power distribution). Safe work procedures should address how to inspect cables and cords for damage, proper system protection to protect against shock, fire and arc flash and other installation methods to reduce the probability of shock or arc flash from occurring.

3.12 Electrical-Specific Personal Protective Equipment (PPE)

The electrical safety program should identify PPE that is specific to protect the qualified electrical worker from the hazards of electric shock and arc flash. Issues that may be addressed include, but are not limited to:

- How to select appropriate PPE for the hazards of electric shock and arc flash.
- Minimum levels of PPE for various tasks.
- When electrical-specific PPE should be worn.
- Requirements to properly care for and store of the PPE.
- Requirements for testing rubber insulating gloves every six months.
- Requirements for testing live-line tools every 24 months.

3.13 Equipment and Tools for Electrical Work

For any organization that requires work on energized electrical equipment, the electrical safety program should have rules pertaining to the test equipment (e.g., digital multi-meters) used to test electrical circuits. The electrical safety program should also specify the tools that may be used to work on or near energized conductors.

Electrical workers use portable test equipment (e.g. low and high voltage testers/detectors, multi-meters, meggers, etc.) for tasks such as troubleshooting, maintenance, Test-Before-Touch protocols and others. These meters must be appropriately rated for their intended use and be in good working condition. The electrical safety program should outline:

- Minimum standards for the test equipment that stipulate voltage ratings that must be met.
- The suggested standards for test equipment rated 1000 V and below include ANSI/ISA - 61010-1 (82.02.01) and IEC 61010.
- The suggested standard for test equipment intended for use on circuits rated above 1000 V is IEC 61243-1.
- Pre-use checks should be done to ensure the test equipment is ready for use, can be expected to perform reliably and do not introduce additional hazards (e.g., the test leads are plugged into the correct location, the batteries are in good condition, there are no cracks in the case of the meter, the probes and leads are in good shape, the meter is set to the correct setting for the intended use, etc.).

Qualified electrical workers may also use insulated hand tools (e.g., 1000 V rated screwdrivers, pliers, wrenches, sockets, etc.) to work on energized circuits. The electrical safety program should outline:

- Minimum standards such as international standards that must be met.
- Standard for insulated hand tools to be used on energized circuits rated below 1000 V (ASTM F1505).
- Pre-use checks should be done to ensure insulated hand tools are ready for use (e.g. check to ensure there are no nicks in the insulated portions of the tool, the tool is clean and it is mechanically and structurally sound, etc.).

The electrical safety program may need to address the specification and use of live line tools. Live Line tools shall meet the ASTM F711 standard and CANIULC-D60855 standard. Live line tools shall be tested by an approved testing facility at intervals not to exceed two years.

3.14 Training

The specific training requirements for each type of worker, or each defined role, should be developed and stated in the electrical safety program. The training requirements should consider the types of tasks performed and the possible hazards encountered.

The electrical safety program should provide direction regarding electrical safety training. Some questions to address may include, but are not limited to:

- Who will be trained?
- How they will be trained?
- Who will provide the training?
- How often the training is required?
- Training documentation to be retained?
- Specific competencies that must be demonstrated?

Written requirements and/or a training matrix should be developed for all workers who operate or maintain energized electrical equipment. It may be necessary to further split qualified electrical workers into those with full certification (e.g., journeyman electricians) and those who are still apprenticing. The electrical safety program should specify how often workers need to be re-trained.

CSA Z462 requires that workers be retrained at intervals not to exceed three years.

The electrical safety program will need to determine how training will be done (i.e., classroom, on-line computer-based training, self-study, on-the-job training, etc.) and who will deliver it.

Training should also be documented appropriately, including:

- Who was trained.
- When were they trained.
- Who provided the training.
- What the training entailed.
- Copies of tests or test results.

3.14.1 Demonstrating Competency

The electrical safety program may define critical task procedures that require documented competency validation prior to allowing a worker to perform these tasks. As part of this process, the worker's task competency could be assessed by another individual, who has already demonstrated and has been validated as competent in performing the task. This may include the worker's supervisor. See Appendix 6 for electrical safety competencies expected of qualified electrical workers in the Canadian upstream oil and gas industry.

3.15 Maintenance and Housekeeping

The electrical safety program should outline basic requirements for maintenance and housekeeping of electrical equipment and electrical rooms and buildings.

3.15.1 Maintenance

Electrical equipment that is kept clean, well maintained and tested on a regular basis (where applicable) is more likely to perform as expected and less likely to contribute to a shock or arc flash incident. An electrical equipment maintenance program should consider the day-to-day operation of the equipment as well as the interaction of workers with the equipment when maintenance and testing is required.

Circuit breakers that are expected to operate in a specific amount of time in order to limit the incident energy in the event of an arcing fault and an arc flash should be exercised and tested, if possible, at regular intervals to help ensure that they will operate as expected. These circuit breakers must be maintained at regular intervals to help ensure they will operate correctly.

Cleaning dust and other contaminants from bus bars and other non-insulated conductors or circuit parts can help ensure that arcing faults do not develop.

Visual inspections of electrical equipment should be done on a regular basis to spot potential problems such as excessive corrosion of electrical enclosures, overheating or damage to electrical components such as grounding systems, cable and conduit systems, etc. These inspections can be done without exposing workers to energized conductors.

For larger electrical distribution systems, infrared thermography and other methods can spot problem "hot" spots that may otherwise go undetected.

3.15.2 Housekeeping

The electrical safety program should contain requirements for good general housekeeping in the vicinity of energized electrical equipment. It is well established that workspaces that are kept neat and tidy have fewer incidents. Also, the Canadian Electrical Code requires electrical rooms and buildings to have certain access, egress routes and clearances around electrical equipment. Materials shall not be stored in electrical rooms or buildings with the exception of materials related to the maintenance and operation of the electrical equipment.

3.16 Safety by Design

Initial engineering design and future upgrades can have a tremendous effect on electrical safety over the lifetime of an electrical installation. Companies involved in the design of new electrical systems in any capacity, whether as owner, operator, engineer/designer, manufacturer, etc., should make safety-by-design part of new and retrofit designs. The requirement for safety-by-design should be included in the electrical safety program. This section of the electrical safety program should require that electrical safety be a design consideration during the initial design phase of new projects, as well as during upgrades of existing facilities or systems.

In all instances, it is recommended that electrical risk exposure be reduced to as low as reasonably practicable at the design phase.

Safety-by-design requirements may include:

- Reducing the need for workers to interact with energized equipment.
- Reducing the available arc flash incident energy where possible.
- Reducing the shock hazards where workers need to interact with energized equipment (e.g., separate the different voltage levels so that workers who are troubleshooting control voltages are not exposed to higher voltage power circuits, include finger safe designs, insulated bus and cable terminations, and guarding).
- Increasing the working distance from potential arcing fault source to the worker.
- Installing infra-red scanning windows.
- Incorporating finger-safe terminals to reduce the chance of accidental contact with energized circuits.
- Installing permanent voltage meters or other permanent voltage indicators as an initial indication of energized circuit parts.
- Installing neutral grounding resistors to reduce the chance of a single phase to ground fault escalating to a three-phase fault.

3.17 Emergency Response to Electrical Incidents and Fires

Electrical safety programs should include emergency response procedures specific to electrical incidents and electrical fires.

Depending on the nature of work of an organization, it may be appropriate to provide training and emergency response plans in the event that a worker is injured or incapacitated due to electric shock or arc flash. A key requirement in training and emergency response is to ensure that emergency responders for electrical incidents understand that the injured worker or the surrounding area may pose a shock hazard. Similar to H2S hazards, we do not want the emergency responder to become a second victim.

Workers exposed to shock hazards and those workers responsible for taking action in case of emergency shall be trained in methods of release of victims from contact with exposed energized electrical conductors or circuit parts.

Personnel who may be tasked with fighting an electrical fire must understand how to respond to this type of incident. Training and safe work procedures should be developed for these workers. Note that emergency response procedures related to electrical incidents should be included in the organization's overall emergency response plan as part of the overall health and safety management system.

Requirements for the electrical incident reporting and in the jurisdiction having authority will include both Occupational Health and Safety and organizational responsibility for the Canadian Electrical Code Part 1 compliance.

At least one person on a work site must have first aid and CPR training in order to respond to a shock incident.

4.0 Implementation

After all the work involved in developing an electrical safety program, implementation is where the program becomes a reality. The following five components are key to supporting a successful implementation process:

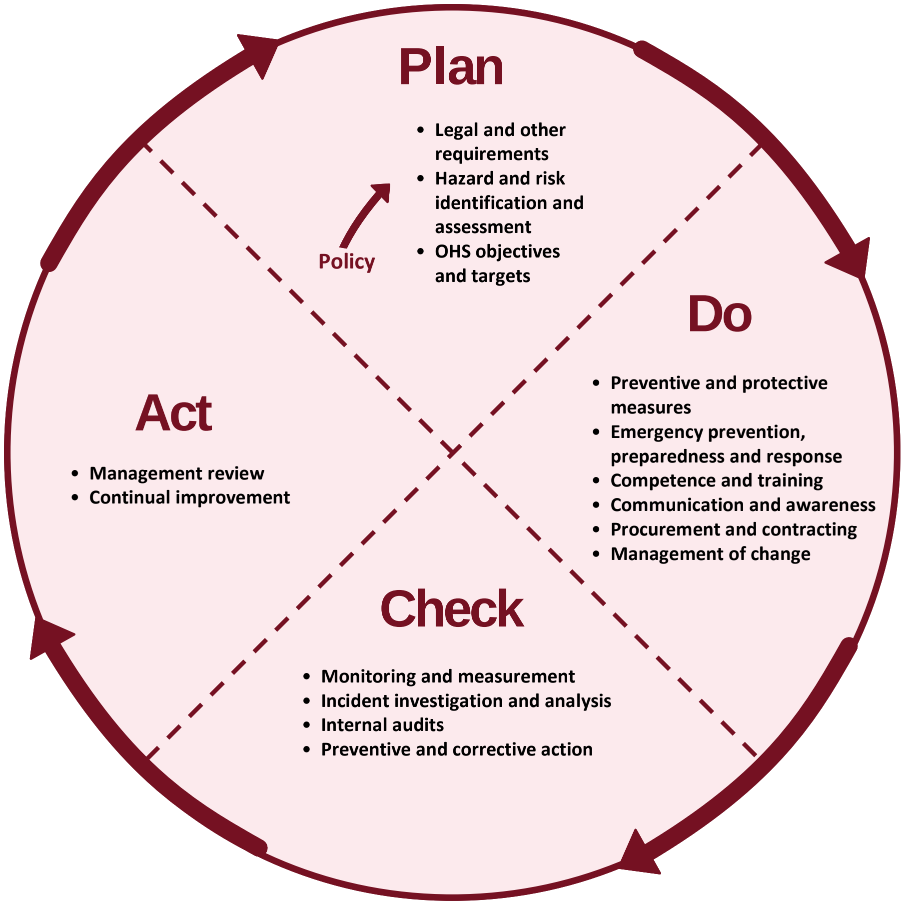
- People—Involve people with the required knowledge and skills.
- Resources—Allow sufficient time and resources, including time for staff to participate and engage in training activities.
- Budget—Ensure that budgets allow for the related costs of implementation and maintenance of the program.
- Structure—Establish a management structure with clear lines of communication. Identify an Electrical Safety Program Manager or “owner” of the program and hold regular strategy meetings.
- Systems—Use management and technology systems to track progress and build milestones into the plan that must be achieved within a specific timeframe. Have an internal electrical safety audit performed within 12 months of implementing the electrical safety program.
- Culture—Create an environment that connects employees to the program and develop creative consequences for achieving or not achieving targets.

4.1 A Systems Approach

Programs tend to be narrowly focused and generally have a start, middle and end. They are designed to ensure the prescribed requirement has been completed.

Systems, on the other hand, are integrated and have a defined structure with inputs, processes and outputs—all emphasizing feedback to ensure the processes are working properly. The systems approach is characterized by the cycle of **Plan, Do, Check, Act** as shown in the diagram below. It is designed to drive continuous improvement in safety and health performance.

Wherever possible it is recommended that employers integrate their electrical safety program into their overall OHSMS. This integration supports continual improvement activities. For example, company quality systems can be used to obtain feedback and encourage worker suggestions and input. The integration of systems ensures quality management principles are maintained and supports more robust outcomes.



4.2 Continual Program Audit

In order for electrical safety programs to remain current and responsive, any defects should be remedied using quality management processes. A system for undertaking regular internal electrical safety audits should be built into the electrical safety program. The objective of t a gap analysis process is to ensure the program is working as intended, identifies and controls electrical hazards and utilizes current knowledge and standards. A simple and responsive system is preferable to one that is complex and cumbersome. See Appendix 2 for a useful tool to complete a gap analysis. Note: This guideline is not intended to be a protocol for an audit of an electrical safety program. It is the responsibility of the individual companies to establish audit standards of this guideline for their own use.

Internal electrical safety audits should occur annually and also whenever there is a change in circumstances that may affect the program. These changes may include the introduction of new technologies or processes or new regulations or updated standards. It is essential to regularly review applicable legislation and standards. The program should also be reviewed when new risks associated with existing hazards or conditions are identified. Deficiencies may be identified through review of documentation, interviews, inspections, work task observations, or investigations into incidents.

Ensure that an audit or gap analysis report is generated that identifies the findings and that any system improvements or corrective actions are taken and documented. Ensure that workers are made aware of any changes. When changes are made, remember to ensure that parallel systems and tools are also altered to retain internal consistency between systems. For example, if you alter the labelling convention used, then ensure that the training, orientation systems and resources reflect consistent information.

Internal electrical safety audits have the dual role of both verifying program effectiveness and identifying weaknesses in the program's design and implementation. When the review process triggers revisions to the program, the objective of continuous improvement is furthered.

4.3 Summary

For a continuous improvement process to be successful, it is vital to ensure that all the steps of the **Plan, Do, Check and Act** process are addressed. This ensures the program stays current and effective.

There must be a process of providing feedback to the program owners and the employer as to whether the program is providing the electrical safety performance expected. Without an evaluation process, there is no way of being certain that the resources were expended prudently.

By implementing an electrical safety program a sustainable and measurable system is established to ensure that the electrical hazards of arc flash and shock are eliminated or reduced to as low as reasonably practicable.

Appendix 1: Reference and Resources

References and resources should be consulted in the development of an electrical safety program. These references may include, but are not limited to, the latest editions of the following:

American National Standards Institute (ANSI)

ANSI/ISA -61010-1 (82.02.01), Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

Canadian Standards Association (CSA)

- C22.1, Canadian Electrical Code Part 1
- CSA Z462, Workplace Electrical Safety
- CSA M421, Use of Electricity and Mines
- CSA Z460, Control of Hazardous Energy – Lockout and Other Methods
- CSA Z463, Guideline for Electrical Equipment Maintenance
- CSA Z1000, Occupational Health and Safety Management
- CSA Z1002, Occupational Health and Safety – Hazard Identification and Elimination and Risk Assessment and Control

International Electrotechnical Commission (IEC)

- IEC 61010-2-010, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory use.
- IEC 61243-1, Voltage Detectors, 3.3-33 kV

National Fire Protection Association (NFPA)

- NFPA-70E, Standard for Electrical Safety in the Workplace
- Occupational Health &Safety Regulations Alberta Occupational Health & Safety Act, Regulation, and Code
- British Columbia Occupational Health & Safety Act, Regulation, and Code
- Saskatchewan Employment Act, Regulation and Code
- Canada Labour Code, Part II
- CAN/ULC -D60855, Live Working—Insulating Foam-Filled Tubes and Solid Rods for Live Working

Institute of Electrical and Electronics Engineers

- IEEE1584, Guide to Performing Arc-Flash Hazard Calculations

Table 1: Applicable Standards for Electrical-Specific PPE and Electrical Equipment

Subject	**Number and Title**
Apparel	ASTM F 1506, Standard Performance Specification for Textile Material for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards
Eye and Face Protection	CSA-Z94.3, Eye and Face Protectors ANSI/ISEA Z87.1, Occupational and Educational Personal Eye and Face Protective Devices
Face Protective Products	ASTM F 2178, Standard Test Method for Determining the Arc Rating and Standard Specification for Face Protective Products
Footwear	CSA-Z195, Protective footwear ASTM F 1117, Standard Specification for Dielectric Footwear
Gloves	ASTM D 120, Standard Specification for Rubber Insulating Gloves
Head Protection	CSA-Z94.1, Industrial Protective Headwear ANSI/ISEA Z89.1, Industrial Head Protection
Insulated Hand Tools	ASTM F 1505, Standard Specification for Insulated and Insulating Hand Tools
Leather Protectors	ASTM F 696, Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens
Live-Line Tools (“Hot Sticks”)	ASTM F 711, Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live-Line Tools
Raingear	ASTM F 1891, Standard Specification for Arc and Flame Resistant Rainwear
Rubber Insulating Gloves and Sleeves	ASTM F 496, Standard Specification for In-Service Care of Insulating Gloves and Sleeves
Sleeves	ASTM D 1051, Standard Specification for Rubber Insulating Sleeves
Temporary Protective Grounds	ASTM F 855, Standard Specification for Temporary Protective Grounds to be Used on De-Energized Electric Power Lines and Equipment

Appendix 2: Electrical Safety Program Development Checklist

This checklist can be used to assist with development or to review an existing electrical safety program or documentation. Note: This checklist is not intended to be a protocol for an audit of an electrical safety program. It is the responsibility of the individual companies to establish audit standards for their own use.

Questions:	Yes	No
Do you have an established Occupational Health and Safety Management System (OHSMS)?		
Do you have a documented electrical safety program?		
Do you have documented policies, and practices that are consistent with this guideline included within your OHSMS or a specific electrical safety program?		
If you do have a documented electrical safety program is it consistent with your organization's needs and culture?		
Did you use the CSA Z462 *Workplace Electrical Safety* standard as a resource for the electrical safety program?		
Have you reviewed your jurisdiction specific OH&S Regulations and any specific electrical safety requirements?		
Do you have management commitment to the electrical safety program?		
Is the organization's written electrical safety program available to all workers?		
Do you have someone assigned to be responsible for the implementation and on-going maintenance of the electrical safety program?		
Do staff and senior management understand that the electrical safety program is an on-going endeavour and the program is slated to be updated at least every three years?		
Do you have an established Hazard Identification, and Risk Assessment process? • Are the electrical hazards of arc flash and shock identified? • Does this form identify arc flash and shock?		
Have you completed an engineering incident energy analysis and applied arc flash and shock warning labels to electrical equipment?		
Can your workers properly interpret detailed arc flash and shock labels that may be applied to power distribution equipment?		
Do your worker's identify the shock hazard and document the voltage and limited, restricted and prohibited approach boundaries? • Do your qualified electrical workers identify when an arcing fault and arc flash hazard potential exists related to energized electrical work? • Have your workers identified the arc flash boundary, and arc rated clothing required for the task?		
Do your qualified electrical workers know that arc rated clothing is identified by an Arc Thermal Performance Value (ATPV)?		
Do you define Roles & Responsibilities related to controlling and performing energized electrical work?		
Do you define and control the work tasks that qualified electrical workers can perform (i.e., low voltage versus high voltage work tasks)?		
Are worker qualifications and competencies validated?		
Do you have in place and use an "Energized Electrical Work Permit" or equivalent?		
Do you have an established lockout program and it addresses the isolation of		

Questions:	Yes	No
electrical equipment?		
Do you establish an electrically safe work condition related to energized electrical equipment before working on it?		
Do you have an established overhead power line encroachment policy?		
Do you have overhead power line safety related policies and training for your workers?		
Have you procured and made available to qualified electrical workers arc rated clothing for qualified electrical workers?		
Have you procured and made available rubber insulating gloves with leather protectors for qualified electrical workers?		
Do you have insulated and insulating hand tools for qualified electrical workers?		
Are the electrical-specific tools and PPE properly stored and regularly inspected?		
Are you doing regular maintenance on the equipment?		
Do workers have access to manuals, single line drawings, procedures or other documentation to do the work?		
Is the installation compliant with the required codes and standards? (i.e., bonding/grounding, fuse sizing, breaker setting, spacing, identification of equipment, etc.)		
Do you have appropriately certified and rated test equipment (e.g., Category III, 600 V digital multi-meters for low voltage testing) available for your workers?		
Are the employees trained in the care, use and maintenance of arc flash and shock PPE, tools and equipment?		
Are the employees trained in company procedures for working on energized electrical equipment?		
Do you establish an electrical work zone using the arc flash and shock boundaries to establish the distance?		
Has your program for identification, assessment and control of hazards been regularly reviewed?		
Do you use spot audits and field check to ensure the electrical safety program is implemented correctly?		
Do you have portable in line ground fault circuit interrupters (GFCIs) available for all workers to use?		
Have all workers been advised that all electrical incidents shall be reported as per company policies, procedures or formal reporting requirements for both shock and arc flash?		
Do you have a documented policy that advises all workers to report an electrical incident (e.g., shock, arcing fault or arc flash)?		
Do you have documented procedures for energized electrical work?		
Do all employees know how to activate the emergency response system?		
Have you provided emergency response training for affected workers and specifically release of shock victims?		
Do affected workers have CPR and first aid training?		
Has the appropriate electrical safety training been provided to other workers who may be exposed to electrical hazards?		

Appendix 3: Site Assessment Checklist

This electrical work practices checklist can be used to provide an evaluation of your company's electrical work processes. Any item that is marked with a "No" response should be addressed immediately. This checklist may include, but is not limited to the following inspection questions:

Inspection Questions:	Yes	No
Are employees who are at risk of electric shock trained in and are familiar with safety-related work practices?		
Are qualified electrical workers (those who are permitted to work on exposed energized conductors or circuit parts) given the following training: • The skills and techniques necessary to distinguish between exposed energized conductors and circuit parts from other parts of electric equipment? • The skills and techniques necessary to determine the nominal voltage of exposed energized conductors and circuit parts? • The shock approach boundaries and arc flash boundary corresponding to the work tasks to which the qualified electrical worker will be exposed?		
Is the degree of training provided determined by the risk to the worker?		
Are all energized conductors or circuit parts de-energized before an employee works on them (e.g., repair or alteration), unless de-energizing increases risk or is not possible because of equipment design or operational limitations?		
If energized conductors or circuit parts are not de-energized, are other practices used to protect persons who may be exposed to electrical hazards?		
Do these work practices protect the body against direct contact with energized conductors or circuit parts and against indirect contact through a conductive object?		
If an employee has contact with parts of fixed electrical equipment or circuits that have been de-energized, have the circuits energizing the parts been locked out?		
Is a written copy of electrical safety procedures (including lockout) available for inspection?		
Are safe procedures determined before circuits or equipment are de-energized?		
Are the circuits and equipment to be worked on disconnected from all energy sources?		
Has stored, hazardous electric energy been released?		
Is stored nonelectrical energy in devices that could reenergize electric circuit parts blocked or relieved enough to prevent circuit parts from being accidentally energized by the device?		
Is a lockout protocol used to de-energize circuits and equipment?		
Does each tag have a statement prohibiting unauthorized operation of the disconnecting means and removal of the tag?		
When a tag is used without a lock, is at least one additional safety measure used that provides a level of safety equivalent to that obtained from a lock?		
Is a lock placed without a tag only under all the following conditions: • Only one circuit or piece of equipment is de-energized? • The lockout period does not extend beyond the work day? • Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure?		

Inspection Questions:	Yes	No
Are the requirements below met before any circuit or equipment can be considered de-energized: • A non-electrical worker or qualified electrical worker verifies that the equipment cannot be restarted? • A qualified electrical worker verifies that the electrical conductors or circuit parts of equipment to which employees will be exposed are de-energized. The qualified electrical worker must also determine whether voltage exists as a result of inadvertently induced voltage or unrelated voltage feedback?		
Are all of the following requirements met (in the order given) before circuits or equipment are re-energized, even temporarily: 1. A qualified electrical worker verifies that all tools, electrical jumpers, shorts, temporary protective grounds, and other such devices have been removed so that the circuits and equipment can be safely energized? 2. Persons exposed to the hazards associated with re-energizing the circuit or equipment are warned to stay clear of circuits and equipment? 3. Each lock and tag is removed by the person who applied it or under his or her direct supervision? 4. All persons are clear of the circuits and equipment?		
Are only qualified persons permitted to work on electric conductors, circuit parts or equipment that have not been de-energized?		
Are employees prevented from handling conductive materials and equipment that are in contact with the person's body that may contact exposed energized conductors or circuit parts?		
If employees must handle long-dimensional conductive objects (such as ducts and pipes) in areas with exposed energized parts, have work practices been instituted (such as the use of insulation, guarding, and material handling techniques) that will minimize the hazard?		
Do portable ladders have non conducting side rails when they could contact exposed, energized parts?		
Is the use of conductive articles of jewelry, clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive threads, or metal head gear) prohibited for qualified electrical workers?		
Are employees prohibited from performing housekeeping duties where exposed energized electrical conductors and circuit parts present an electrical contact hazard due to housekeeping duties that must be performed near such parts?		
If employees do conduct housekeeping duties near energized electrical conductors or circuits, are adequate safeguards (such as insulating equipment or barriers) used?		

Appendix 4: Site Assessment Checklist

✓	Program Element	✓	Program Element
	Corporate & management safety statement and policy		Job hazard/risk evaluation and briefing procedures
	Electrical safety hazards roles and responsibilities		Establishing an electrically safe work condition, lock out policies and forms
	Electrical safety training requirements for electrical work		Safe work practices demonstration
	Safety brief/toolbox topics		Lock out audits
	Outside personnel/contractor requirements		Electrical-specific Personal Protective Equipment (PPE), tools and equipment requirements
	Requirements for electrical work, de-energization		Requirements related to portable power equipment, extension cords and Ground Fault Circuit Interrupters (GFCIs)
	Multi-employer responsibility		Insulated hand tool requirements
	Energized electrical work policy		Electrical equipment maintenance practices to minimize risks and hazards
	Work task electrical hazard analysis and risk assessment		Electrical power distribution system design practices to minimize risks and hazards
	General electrical safety requirements		Incident review and safety program update policies
	Field level hazard analysis/job hazard analysis		Emergency response to electrical incidents
	Work permits and job briefing requirements		Other applicable corporate safety policies
	Electrical safety audit		Appendices
	Validation of work competency		Action item summary and tracking documents
	Definitions and references		Electrical safety program update tracking

Appendix 5: Policy, Purpose and Scope

Sample 1

Policy Statement:

It is the policy of XYZ Company that all workers be trained and aware of all electrical safety requirements as stated in this document.

Purpose Statement:

The purpose of this policy is to establish safe work practices that are intended to prevent or reduce risk of exposure to the electrical hazards of arc flash and electric shock. These safe work practices will prevent or reduce injuries resulting from either indirect or direct electrical contacts when work is justified to be performed on energized electrical conductors or circuit parts.

Scope:

Establishing safe work practices for electrical safety is the responsibility of all employees.

Sample 2

Policy Statement:

(Company name) recognizes workplace electrical safety to be a key component of its overall occupational health and safety management system and related policies and practices.

Purpose Statement:

The purpose of this document is to specify the requirements and guiding principles of our electrical safety policies in order to mitigate or reduce the risk of exposure of personnel to electrical hazards.

Scope:

All employees involved in the planning, supervision and execution of operating, maintenance and construction tasks performed on electrical equipment or systems are required to understand and comply with this program.

Appendix 6: Sample Electrical Safety Competencies for Qualified Electrical Workers

Qualified electrical workers in the oil and gas industry should be able to demonstrate the following electrical safety competencies:

- Identify current standards, specifications and legislation for electrical safety.
- Understand the effects of electric shock and arc flash.
- Identify energized electrical work.
- Identity electrical hazards in every work task.
- Assess the hazards of shock and arc flash in every work task by determining the nominal electrical equipment voltage, incident energy at the assumed working distance, the arc flash boundary, and the limited, restricted and prohibited approach boundaries.
- Understand industry best practices and regulatory requirements for de-energizing electrical equipment prior to performing work.
- Demonstrate the Test-Before-Touch procedure.
- Explain how to use electrical test equipment for Test-Before-Touch procedures.
- Explain individual and group lock-out procedures.
- Explain how an electrically safe work condition is achieved.
- Understand how to select, perform pre-use checks, and maintain electrical-specific PPE, tools and equipment.
- Demonstrate how to safety operate low-voltage (e.g., <750 Vac) breakers, switches and disconnects.
- Understand safe limits of approach to energized, exposed conductors or circuit parts.
- Explain emergency response and first aid for electrical incidents.

Appendix 7: Safe Work Procedures

Sample of Safe Work Procedures

The following is a content example of an electrical work hazard assessment and safe work procedures document.

Work Task: Opening and Closing Circuit Breakers or Disconnect Switches

Scope of Work: Isolation of electrical equipment under normal operating conditions

Employee performing task: operators, electricians

Tools and PPE required: as per hazard assessment

Procedure:

1. Identify the electrical load to be isolated. Identify the circuit breaker or disconnect switch.

Action recommended: Consult the single line diagram, check equipment tag on the single line and on the front door of the electrical equipment. Check the lighting panel schedule to identify the circuit breaker.

2. Turn off the electrical load with the control system or on/off switch.

Action recommended: Check the equipment to ensure that it is not running.

3. Stand to the hinged side of the electrical equipment or to the left of the lighting panel.

Action recommended: Stand as close as possible to the equipment or wall in front of you.

4. Grab the handle of the circuit breaker or disconnect switch.
5. Look away from the electrical equipment.
6. Open or close the circuit breaker or disconnect switch by moving the handle up or down, left or right in a continuous motion.

Action recommended: There is low probability of an arc flash. If anything is abnormal, stop and leave the area. Contact an electrician.

7. Apply lock and tag. This completes the work task.

Sample of Electrical Safety Principles

Electrical safety program principles include, but are limited to, the following:

- Inspect and evaluate the electrical equipment
- Maintain the electrical equipment's insulation and enclosure integrity
- Plan every job and document first-time procedures
- De-energize, if possible
- Anticipate unexpected events
- Identify and minimize the hazard
- Protect the worker from shock, burn, blast, and other hazards due to the working environment
- Use the right tool for the job
- Assess people's abilities
- Audit the principles specified

Appendix 8: Energized Electrical Work Permit

This is a sample of an energized electrical work permit.

1. Work Location: ______________________ __________________
2. Work Order Number _________________________________
3. Reason equipment could not be de-energized:

☐ Introduces increased hazard ☐ Introduces additional hazards
☐ Infeasible due to equipment design ☐ Infeasible due to operational limitations

4. Description of the work to be done: ____

____

5. Check the following considerations when they apply:

- ☐ Work is within the restricted approach boundary and there is a work plan
- ☐ Work is within the prohibited approach boundary, it is very hazardous and there is a work plan
- ☐ Request to shut down equipment was made
- ☐ Conducted a shock hazard analysis
- ☐ Shock approach boundaries have been determined
- ☐ Engineering incident energy analysis has been completed and the results are known
- ☐ Arc flash boundary has been determined
- ☐ Personal protective equipment including tools needed for the job have been determined and are available
- ☐ Unqualified persons are restricted from the work area
- ☐ Safe work practices that need to be employed have been considered
- ☐ Job can be done safely

_________________________________ _____________
(Signature, Qualified Electrical Worker) (Date)

_________________________________ _____________
(Signature, Immediate Supervisor) (Date)

Appendix 9: Glossary

For additional term definitions please consult CSA Z462, Workplace Electrical Safety and the Canadian Electrical Code, Part 1.

Abnormal condition	With respect to energized electrical equipment, abnormal condition means that the equipment is not acceptable, is not installed and maintained to the minimum requirements of electrical installation codes in-force in the applicable jurisdiction, not installed to manufacturers recommendations (e.g., doors are open and/or covers are removed and there are exposed, energized electrical conductors or circuit parts), has not been properly maintained following manufacturer's instructions and applicable industry codes and standards, and has visible evidence of impending failure (e.g., evidence of arcing, overheating, loose parts or connections, visible damage, contamination or deterioration.
Arc flash	A projection of energy when a phase-to-ground, or phase-to-phase, fault occurs. The jump of energy creates a super pressure wave similar to a strike of lightning.
Arc Rating	The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to break-open or at the onset of a second-degree skin burn. Arc rating is normally expressed in cal/cm^2.
De-energized	Free from an electrical connection to a source of potential difference and from electrical charge, i.e., not having a potential different from that of earth.
Disconnecting means	A device, or group of devices, or other means by that the conductors of a circuit can be disconnected from their source of supply.
Exposed	When referring to electrically energized circuit parts, "exposed" means that the circuit part or conductor could be touched or approached to a distance that is unsafe. Parts that are not suitably or appropriately guarded, insulated or isolated are considered "exposed".
Ground	A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.
Grounded	Connected to earth or to some conducting body that serves in place of the earth.
Ground Fault Circuit Interrupter	A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the over-current protective device of the supply circuit.

Guarded	CSA defines this as: Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms, to remove the likelihood of approach to a point of danger or contact by persons or objects.
Hazardous Location	Process or plant areas and related buildings, enclosures, or parts thereof in which: (a) an explosive gas atmosphere is present, or may be present, in the air in quantities that require special precautions for the construction, installation and use of electrical equipment (b) combustible dusts are present, or may be present, in the form of clouds or layers in quantities to require special precautions for the construction, installation and operation of electrical equipment. (c) combustible fibres or flyings are manufactured, handled, or stored in a manner that will require special precautions for the construction, installation and operation of electrical equipment.
Incident Energy	The amount of thermal energy, impressed on a surface a certain distance from the source, generated during an electrical arc flash event. Note: Incident energy is typically expressed in calories per square centimeter (cal/cm2).
Isolated (from power source)	Securely and physically separated or blocked with non-conductive material sufficient to ensure that equipment cannot be energized by identified power sources.
Lock-Out	Placement of a lockout device on an energy–isolating device in accordance with an established procedure.
Non-Electrical Worker	One who may operate energized electrical equipment, portable plug and cord connected equipment or work within proximity to overhead power lines, but may lack knowledge to identify and avoid electrical hazards. May have received electrical safety awareness training
Qualified Electrical Worker	One who has demonstrated skills and knowledge related to the construction, operation and maintenance of electrical equipment and installations and has received safety training to identify and avoid the hazards involved.
Shock	A dangerous condition associated with the possible release of energy by contact with or approach to energized electrical conductors or circuit parts. Electrical current flows through the human body.
Single Line Diagram	An engineered drawing depicting the schematic representation of the main electrical energy sources and loads, voltage transformations, switching and disconnecting devices, and protection devices associated

	with electrical power distribution at the facility.
Voltage, nominal	CSA defines this as: A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240, 480Y/277, 600, etc.). The actual voltage that a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

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