Electrical Safety

A PROGRAM DEVELOPMENT GUIDELINE

EDITION #1

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SETTING THE STANDARD IN OIL AND GAS SAFETY

ENERGY SAFETY CANADA

About Energy Safety Canada

Energy Safety Canada is the national safety association for Canada's energy industry. Our mission is to mobilize industry to drive safe work performance through education, resources, and engagement.

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.

Preface

PURPOSE

This guideline has been written specifically for the energy 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 energy 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 an existing program.
- Apply the templates, processes, tools and additional resources provided in this guideline to improve their program.

This guideline can be utilized by energy 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
- Energy 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.

Preface

REGULATIONS

Each provincial, territorial 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 safely 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 EnergySafetyCanada.com

LIFE SAVING RULES

Many companies have health and safety rules designed to save lives. However, these rules are not consistent from company to company. Standardization is part of ESC's strategy to improve safety outcomes and reduce inefficiencies.

The Safety Standards Council, a key component of ESC's governance, has executive representatives from companies of varying sizes across industry sectors. The Safety Standards Council agreed to accept 10 standard Life Saving Rules.

The applicable Life Saving Rule will be identified with the corresponding icon through the document.

Additional information about Life Saving Rules is available at EnergySafetyCanada.com

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Introduction

1.1 DUE DILIGENCE AND ELECTRICAL SAFETY

Most people are unaware of the risks related to our use of electricity. Electricity is invisible and, because it is ever present in our lives, people often fail to recognize the potential risk of exposure to electrical hazards. In the oil and gas industry, incidents involving electric hazards, including fatalities, can occur without attention to electrical safety policies and 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's standard, *Workplace electrical safety* (CSA Z462). See Appendix 1: References and Resources.

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 electrical equipment (e.g., voltage is present), employers shall ensure that electrical safety is a component of their OHSMS. Provincial, territorial 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 for 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. It requires that everyone with responsibility for health and safety take every precaution in the circumstances to avoid a work-related injury or illness.

Due diligence requires that employers:

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

An electrical safety program documents the necessary policies and practices to eliminate or reduce the risk of exposure to electrical hazards in the workplace.

In the case of electrical safety, a hazard which has the potential for serious injury or damage to health, the degree of risk is deemed to be high without the application of appropriate risk control methods. Therefore, a higher degree of due diligence is required. At a minimum, an electrical safety program should:

- Identify electrical hazards related to discrete work tasks.
- Assess the electrical hazards and associated risks related to a work task.
- Document the application of preventive and protective risk control methods to reduce risk of exposure to electrical hazards to as low as reasonably practicable.
- Train workers to identify electrical hazards and apply appropriate risk control methods to reduce risk of exposure.
- Monitor the effectiveness of the risk control methods by completing audits.

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 damage to health that can lead to 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 at the point of the arcing fault can reach 20,000˚C (35,000˚F). The resulting incident energy that is released 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.

Air temperatures at the point of the arcing fault can reach 20,000˚C (35,000˚F). The resulting incident energy that is released can burn the skin directly and can also ignite polyester, polyester blends and natural fibre clothing.

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 potentially 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 should be developed 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 exposed energized conductors or circuit parts of may be at risk of an electrical injury. The initial step is to determine whether employees are at risk by answering 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, cathodic protection technicians, elevator mechanic, overhead door or crane mechanic or power line technician? 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 examples 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 examples 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 analyze the electrical hazards to determine if this work task must be done while the system is energized. If the work 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 (e.g. 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.

As this list demonstrates, almost any worker may be exposed to electrical hazards and there are numerous combinations of workplaces, workers and tasks that merit analysis to determine exposure to electrical hazards.

2.0 Develop an Electrical Safety Program

An electrical safety program outlines the requirements, policies and practices to address hazards associated with working on energized electrical equipment. It can be a standalone 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 work 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 checklist to help in planning or updating an electrical safety program.

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. Energy Safety Canada's Introduction to Health and Safety Management Systems: A Program Development Guideline and the Canada Standards Association's Occupational Health and Safety Management Systems – Requirements With Guidance for Use (CSA Z45001). Standards provide a model to develop and implement an occupational health and safety management system.

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 and should:

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

An effective strategy is to communicate the cost benefit of an electrical safety program, which helps to establish the financial justification for program development, implementation and maintenance.

An effective strategy is to communicate the cost benefit of an electrical safety program, which helps 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 (e.g., medical costs, insurance, replacement costs, lost time and fines).

2.2 INVOLVE EMPLOYEES

Successful safety management systems involve the employees. One approach is to create an electrical safety steering committee at the work site to oversee and guide the development and implementation of the program. This can foster employee commitment and buy-in. Other strategies include:

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

2.3 IDENTIFY APPLICABLE STANDARDS REGULATIONS

The most effective safety management systems are incorporated into the organization's existing audit systems and maintenance programs. Therefore, it is essential to review current systems using the strategies outlined below. Before making decisions about electrical safety, it is important to perform a safety audit and/or gap analysis to determine key areas for consideration.

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, territorial and federal regulations. Below is a partial list of the regulations and standards that should be consulted before developing an electrical safety program:

- Provincial or Territorial Occupational Health and Safety (OH&S) Legislation. Most provincial or territorial OH&S legislation contains the general requirements for employers to identify hazards, which include shock and arc flash, and the requirement to eliminate exposure or take steps to protect workers from these hazards by implementing appropriate risk control methods. Depending on the province or territory, 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: Consult legislation for all provinces where the company operates.

- The Canadian Standards Association's *Workplace electrical safety* (CSA Z462) is an important standard to review.
- Related standards specific to 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 more comprehensive and detailed. If there are only non-qualified workers on site, then the electrical safety program may be less extensive as comprehensive electrical work would not be taking place.

There are two main categories of workers whose work tasks should be addressed by an electrical safety program:

- Qualified electrical workers with formal training in electrical work. This may include electricians, instrumentation technicians, electrical technologist, electrical engineers, air conditioning and refrigeration technicians, cathodic protection technicians, elevator mechanics, etc.
- Non-electrical workers. This could include roles such as operators for various types of services, equipment or installations; mechanics/millwrights and welders; and labourers.

The difference in qualifications and the type of hazards encountered will dictate 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 EMPLOYEES

The most effective safety management systems are incorporated into the organization's existing audit systems and maintenance programs. Therefore, it is essential to review current systems using the strategies outlined below. Before making decisions about electrical safety, it is important to perform a safety audit and/or gap analysis to determine key areas for consideration.

2.5.1 SAFETY AUDIT AND/OR GAP ANALYSIS

There are a variety of ways to undertake this analysis depending on the size and nature of the business and the electrical hazards 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 may be conducted by:

- Representatives from the Health and Safety Committee
- Any electrical engineering and/or electricians on staff
- Workers 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 measures are needed to mitigate or control them?
- What risk controls are currently in place?
- Are the risk controls adequate to ensure safety?
- What training is needed?
- What electrical-specific PPE, tools and equipment are needed?

2.5.2 SITE ASSESSMENT

The first step in a safety audit and/or gap analysis is a site assessment, which can provide 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 equipment labels available on electrical equipment?
- What are the lockout 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?

An inspection process involving a diverse group may also be of value. Photographs can be a helpful reference for later review. A site assessment should include copies of any documentation for further review. Documentation may include policies, procedures, forms and logbooks. Also, 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, identify the potential resources required and assign individuals to implement these corrective actions. Formulation of such a plan requires careful consideration and it is important to be realistic and allow adequate time.

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 be fully aware of the scope, possible requirements and actions, and 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 list and description of the most common elements found in an electrical safety program. Consideration should be given to incorporating each element to ensure a comprehensive electrical safety program. These elements are also consistent with OHSMS programs such as the Certificate of Recognition (COR) Safety Management System.

Note: This list of suggested elements may not address all the electrical safety needs of an organization, and not all organizations will need to address every element. Each organization's electrical safety program should be tailored to meet their electrical safety needs. See Appendix 4 for a helpful checklist.

3.1 SAFETY POLICY STATEMENT

A safety policy statement documents a company's guiding principles regarding safety. It should be made available and communicated to all employees. See Appendix 5 for a sample statement.

A safety 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.
- A requirement for all equipment to be verified in an electrically safe work condition prior to any task being performed on the equipment.
- 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 addresses safeguarding workers against 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 whether:

- The program is mandatory.
- The program applies to all workers, including contractors, vendors and service personnel.
- Procedures are supplemented by other documents.
- Any boundary conditions or limits exist.

See Appendix 5 for examples.

3.3 ROLES AND RESPONSIBILITIES

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
- Qualified operation workers
- Other task qualified 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, territorial, or federal legislation and consensus standards such as CSA Z462 *Workplace electrical safety* should be consulted to determine these work tasks.

In addition, the program should define what is meant by a qualified electrical worker (such as the definition in the CSA Z462 standard). It is not enough that the worker is certified as an electrician or other trade that can complete limited scope energized electrical work. The individual must also be qualified and competent to perform the specific tasks assigned. The electrical safety program should also clearly state if there are additional requirements. For example, an electrician must:

> *It is not enough that the worker is certified as an electrician or other trade that can complete limited scope energized electrical work. The individual must also be qualified and competent to perform the specific tasks assigned.*

- Hold a Journeyman Electrician ticket in the electrical trade or other certification that is acceptable to the local jurisdiction.
- Be able to recognize the hazards involved in the work task.
- 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.
- 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

Electrical safety programs should stipulate which tasks must be performed by a qualified electrical worker. Non-electrical workers should not be allowed to perform those tasks as they may not understand the equipment or be able to recognize the hazards present and can injure themselves or others. 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 RISK 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 shock and arc flash hazards must be quantified by:

- Intended outcomes/goals.
- How success is measured.
- Connections to existing processes and programs.
- Data and records that must be maintained.
- How frequently the program will be evaluated.
- Responsibilities and accountabilities.

These determinations can be complex and require a thorough understanding of electrical systems and competency in electrical engineering principles.

The following provide guidance to determine arc rated clothing requirements:

- Engineering analysis to determine incident energy (See Glossary definition).
- Use of the arc flash PPE category tables provided in the CSA Z462 standard.

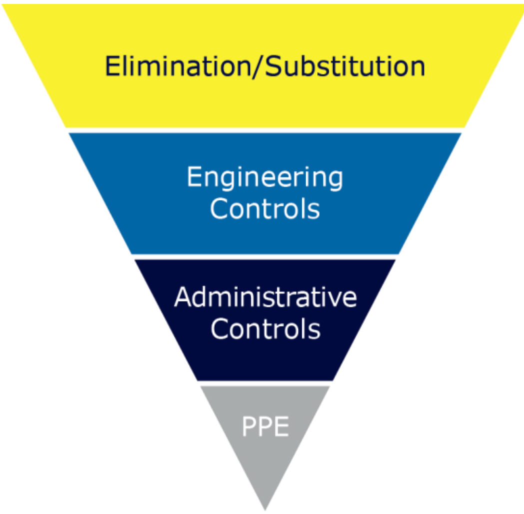
When energized electrical tasks are required, quantifying the shock and arc flash hazards help to determine safe approach boundaries.

Assessment of electrical hazards also requires an understanding of the:

- Position of the worker within the approach boundaries.
- Work task being performed at that position.
- Potential injury or damage to health.
- Likelihood of occurrence and severity of an electrical incident.

Assessing and understanding these hazards will help in the development of effective risk control methods, which should follow the hierarchy of controls (see Figure 1). Section 3.6 provides guidance on the development of safe work practices and procedures.

Figure 1: Hierarchy of Risk Controls



Each level of risk control is explained below.

3.4.1 ELIMINATION

Elimination of electrical hazards means all sources and potential sources of electricity that the worker may be exposed to are de-energized. Elimination of electrical hazards is achieved by establishing an electrically safe work condition as outlined in CSA Z462 *Workplace electrical safety* Standard (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.

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.

Examples of engineering controls may include:

- Guards and insulation.
- Barriers and fencing, sometimes with locked gates, to prohibit unauthorized persons from contacting exposed energized conductors and circuit parts.
- Doors and covers on electrical equipment.
- Use of finger-safe components.

In some cases, it is possible to reduce the incident energy (i.e., energy from a potential arc flash event) by reducing the fault clearing time. This is achieved by adjusting settings in an electrical system's protective devices, 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 work 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. 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 3.4 of this guideline.

High risk electrical work tasks may require detailed, step-by-step procedures 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 up-to-date and in a format that workers can understand and access. Written procedures must be available to workers and training should be provided.

The jurisdiction with 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 work 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:

- Lockout procedures.
- Obtaining a safe work permit.
- 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 but should never be considered a substitute for establishing safe work conditions. Electrical specific PPE, tools, and equipment may include:

- Rubber insulated (“voltage-rated”) gloves with leather protectors.
- Arc rated coveralls.
- Arc rated face shields with arc rated balaclavas.
- Arc flash suits with arc flash hoods.
- Insulated hand tools.
- Insulating live-line tools (hot sticks).
- Test instruments.
- Rubber insulated blankets.
- Class E (nonconductive) hard hat.

Refer to Appendix 1 for applicable standards.

3.5 ELECTRICAL SYSTEM INFORMATION

Electrical drawings, signage, labelling and the use of barricading are crucial to informing workers of electrical hazards, 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 EQUIPMENT LABELS

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

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 warn workers of restricted access to and the voltage of the electrical equipment in that area.

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 energized unless such a condition 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 this is to confirm 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 with an approved test instrument 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. The CSA Z462 *Workplace electrical safety* Standard defines how to establish an electrically safe work condition in clause 4.2.

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. 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.

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.

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 with 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 SAFETY PLANNING MEETINGS

The electrical safety program should specify requirements for pre-job safety planning of energized electrical work. Pre-job safety 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 those involved with the work as well as others 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 using atmospheric monitoring prior to working on energized equipment in a hazardous location (see Glossary definition).

For a pre-job briefing and planning checklist, consult the CSA Z462 *Workplace electrical safety* Standard, Annex I. The checklist is a useful tool to ensure pre-job planning is performed 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 (e.g., 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 defined depending on the specific work task being performed.
- Once the equipment is operated, the worker should determine if anything appears to be abnormal (e.g., abnormal noises, smells, visual clues) indicating a potential problem with the 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 CORD-AND-PLUG-CONNECTED ELECTRIC EQUIPMENT AND EXTENSION CORDS

The electrical hazards associated with the use of portable cord-and-plug-connected 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 electrical equipment be maintained by qualified electricians. Portable cord-and-plug-connected electrical equipment may be operated by a variety of non-electrical workers. Frequently, correct operation of this equipment requires the completion 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 where water may be present requires the use of a Class A GFCI 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/or 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.

Electrical installation codes, such as the Canadian Electrical Code, specify the requirements for extension cords.

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 to provide power to portable cord-and-plug connected electric equipment and other electrical loads (e.g., lighting). These temporary power distribution systems should be addressed in the electrical safety program 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 specifically for protecting 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 work tasks.
- When electrical specific PPE should be worn.
- Requirements to properly care (e.g., laundering) for and store the PPE.
- Requirements for testing rubber insulating gloves every six months.
- Requirements for testing live-line tools every 24 months.

3.13 TEST INSTRUMENTS 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 instruments (e.g., digital multi-metres) 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 instruments (e.g., low and high voltage testers/detectors, multi-metres, meggers) for tasks such as troubleshooting, maintenance, test-before-touch (testing for absence of voltage) protocols and others. These test instruments 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 instrument stipulating voltage ratings that must be met.
- The suggested standards for test instruments rated 1000 V and below includes ANSI/ISA -61010-1 (82.02.01) and IEC 61010.
- The suggested standard for test instruments intended for use on circuits rated above 1000 V is IEC 61243-1.
- Pre-use checks should be performed to ensure the test instrument is ready for use, can be expected to perform reliably and does 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 well maintained, the meter is set to the correct setting for the intended use).

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 to ensure insulated hand tools are ready for use (e.g., no nicks in the insulated portions of the tool, the tool is clean, and it is mechanically and structurally sound).

The electrical safety program may need to address the specification and use of live line tools (hot sticks). 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 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 be:

- Who will be trained?
- How they will be trained?
- Who will provide the training?
- How often the training is required?
- What training documentation will 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 categorize 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 should describe how training will be provided (e.g., classroom, online computer-based training, blended, self-study, on-the-job training) 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 may be assessed by another individual who 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 energy industry.

The electrical safety program may define critical task procedures that require documented competency validation prior to allowing a worker to perform these tasks.

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.

When possible, circuit breakers expected to operate within a specific time to limit the incident energy in the event of an arcing fault and an arc flash should be regularly exercised and tested to ensure they operate properly.

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 performed 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 completed without exposing workers to energized conductors.

For larger electrical distribution systems, infrared thermography, ultrasonic inspection and other methods can identify problem “hot” spots that may otherwise go undetected.

3.15.2 HOUSEKEEPING

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

It is well established that there are fewer incidents in workspaces that are kept neat and tidy.

3.16 SAFETY BY DESIGN

The initial engineering design and subsequent upgrades have a significant impact on safety over the lifetime of an electrical installation. Companies involved in the design of new electrical systems—as owner, operator, engineer/designer, manufacturer, etc.—should make safety-by-design part of new and retrofit designs. This requirement should state that electrical safety be a consideration during the initial design phase and during upgrades of existing facilities or systems.

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

Electrical risk exposure should be reduced to as low as is 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 infrared scanning windows or ultrasonic ports.
- 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 if a worker is injured or incapacitated due to electric shock or arc flash. A key requirement in training and emergency response is ensuring emergency responders at electrical incidents understand that the injured worker or the surrounding area may pose a shock hazard. 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 such emergencies shall be trained in methods for releasing 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 emergency response plan as part of the overall health and safety management system.

Requirements for reporting of electrical incidents vary depending on the jurisdiction and the regulatory body responsible for Canadian Electrical Code Part 1 compliance.

4.0 Implementation

The following five components are key to supporting successful implementation of an electrical safety program:

- **People** — Involve people with the required knowledge and skills.
- **Resources** — Allow sufficient time and resources, including time for staff to participate in training activities.
- **Budget** — Ensure the budget allows for the costs of implementing and maintaining 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 to be achieved within specific timeframes. Perform an internal electrical safety audit 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 PROGRAM VS. SYSTEM 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 (see Figure 2). 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.

Figure 2: Plan, Do, Check, Act Cycle

4.2 CONTINUAL PROGRAM AUDIT

To keep electrical safety programs up-to-date and responsive, any defects should be remedied using quality management processes. A system for regular internal electrical safety audits (i.e., a gap analysis) should be built into the program. This identifies and controls electrical hazards, and ensures the program is recognizing and managing hazards as intended and includes current knowledge and standards. See Appendix 2 for a helpful gap analysis tool.

Note: This guideline is not intended as 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 whenever there are changes that may affect the program, for example the introduction of new technologies or processes, new regulations, or updated standards. Applicable legislation and standards must be reviewed regularly, and 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 and/or incident investigations.

A report with the findings from the audit or gap analysis should be generated, and any system improvements or corrective actions should be implemented and documented. Ensure workers are aware of any changes and, when changes are made, ensure that parallel systems and tools are also altered to retain internal consistency between systems. For example, if the labelling convention changes, be sure that the training, orientation systems and resources also reflect that change.

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

It is critical to have a documented method for providing feedback on the effectiveness of the program to the program owner(s)/employer. Having a clear evaluation process is essential to the effectiveness, relevance and continuous improvement of the electrical safety program.

Appendix 1: References 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 Z45001 Occupational Health and Safety Management Systems – Requirements with Guidance for Use
- 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
- IEEE 1584.1 IEEE Guide for the Specification of Scope and Deliverable Requirements for an Arc-Fas Hazard Calculation Study in Accordance with IEEE Std 1584

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 CAN/CGSB 155.20 Workwear for Protection Against Hydrocarbon Flash Fire and Optionally Steam and Hot Fluids NFPA 2112 Standard on Flame Clothing for Protection of Industrial Personnel Against Short-duration exposures from fire NFPA 2113 Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire
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 the development or review of 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 ongoing maintenance of the electrical safety program?	☐	☐
Do staff and senior management understand that the electrical safety program is an ongoing 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 equipment labels to electrical equipment or provided results tables?	☐	☐
Can your workers properly interpret detailed arc flash and shock equipment labels or results tables that may be applied to power distribution equipment?	☐	☐

QUESTIONS	YES	NO
Do your workers 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 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 stored properly and regularly inspected?	☐	☐
Are you doing regular maintenance on the electrical equipment?	☐	☐

QUESTIONS	YES	NO
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 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: Electrical Work Practices 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:

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?	☐	☐

QUESTIONS	YES	NO
Has stored, hazardous electric energy been released?	☐	☐
Is stored non-electrical 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 workday? • Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure?	☐	☐
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?	☐	☐

QUESTIONS	YES	NO
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 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 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.
- Read and interpret single line diagrams and schematics.
- Understand the potential injury or damage to health of electric shock and arc flash and the likelihood of occurrence of exposure.
- Understand when an energized electrical work permit would be required or NOT required.
- Identify energized electrical work tasks.
- Identity electrical hazards in every energized electrical work task.
- Understand the concept of risk assessment as it applies to energized electrical work.
- Be able to identify the hierarchy or risk control methods that can be applied to reduce risk.
- Determine additional protective measures related to 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 (or the arc flash PPE category), the arc flash boundary, and the limited, restricted and prohibited approach boundaries for shock.
- 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 instruments for test-before-touch procedures.
- Explain individual and group lockout 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 (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 include methods of emergency release of a shock victim.

Appendix 7: Safe Work Procedures

SAMPLE OF SAFE WORK PROCEDURES

The following is an 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 equipment condition

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.
2. 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.
3. Turn off the electrical load with the control system or on/off switch.
4. Action recommended: Check the equipment to ensure it is not running.
5. 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.
6. Grab the handle of the circuit breaker or disconnect switch.
7. Look away from the electrical equipment.
8. 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.
9. Apply lock and tag. This completes the work task.

SAMPLE OF ELECTRICAL SAFETY PRINCIPLES

Electrical safety program principles include, but are not limited to, the following:

- Inspect and evaluate the electrical equipment
- Maintain the electrical equipment's insulation and enclosure integrity
- Plan every job, document a job safety plan 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 no 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 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, 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 source of possible injury or damage to health associated with the release of energy cause by an electric arc caused by an abnormal condition on energized electrical equipment. Under normal operating conditions on electrical equipment an arc flash is not likely to occur.
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 as the Arc Thermal Performance Value (ATPV) or arc flash PPE.
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	A device, or group of devices, or other means by that the conductors of a circuit can be disconnected from their source of supply.
Energized	Electrically connected to or is a source of voltage.
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".
Fault Current, Available	The largest amount of electrical current capable of being delivered at a point on the power distribution system during a short-circuit condition.
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.
Hazard	A source of possible injury or damage to health.
Hazardous	Involving exposure to at least on hazard.
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/cm^2).
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.
Lockout	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

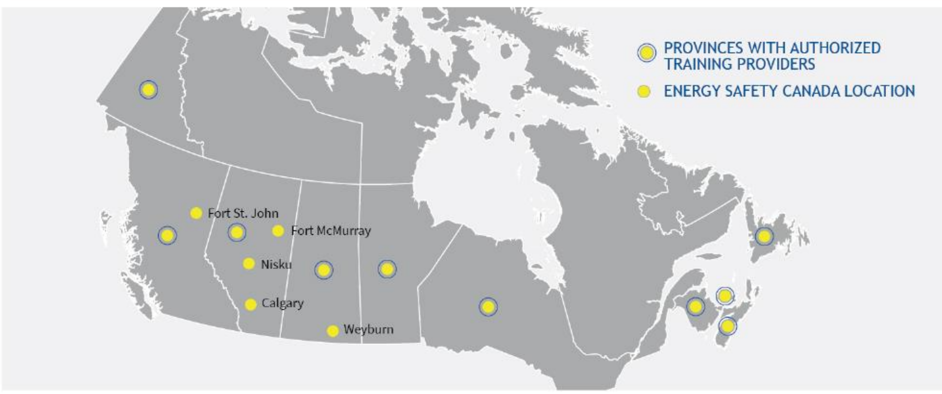
Qualified Electrical Worker	One who has demonstrated skills and knowledge related to the construction, operation and maintenance of electrical equipment and installations and has received safety training to identify and avoid the hazards involved.
Risk Assessment	A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard. An overall process that identifies hazards, estimate the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if risk control methods are required in order to reduce risk.
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.

SAFETY DOESN'T CLOCK IN AND IT DOESN'T PUNCH OUT. IT'S 24/7.

ENERGY SAFETY CANADA'S SERVICES:

- Virtual training
- Safety services
- Company consultations
- Data reports
- Certificate of Recognition

LOCATED WHERE YOU ARE:



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