OE Corporate Required Standard
Electrical Safe Work Practice

Endorsed by the OEGB on April 1, 2010

Purpose

The purpose of this Standard is to define requirements for safe work around electrical equipment and facilities. In particular, the purpose of this Standard is to address shock and arc-flash hazards and to protect personnel from these hazards.

Objectives

This Standard establishes minimum requirements for performing work safely on or near electrical equipment and sets the minimum requirements for such work. Local electrical code and safety code regulations may require additional or more conservative practices than defined herein.

Scope

This Standard applies to all Chevron Corporation (Company) and contractor personnel performing and/or monitoring construction, operational or maintenance activities at any global facility or property and/or any joint-venture operation, where joint-venture agreements allow its use.

This Standard complements *OE Expectation, Element 3.2* by defining a written Safe Work Practice for work around electrical equipment and facilities.

Requirements

Operating Companies or facilities shall have a management system to adopt and maintain a documented Electrical Safe Work Practice that defines all of the following:

- **A:** The roles, responsibilities, and training requirements for supervisors who oversee individuals who perform electrical work or are exposed to electrical energy or equipment.
- **B:** Standard instructions, required personal protective equipment, and work procedures.
- **C:** The requirements for work permits.
- **D:** Required records to be retained.

The interactive form field ("blue text") text boxes within this document may be used to incorporate local electrical code and safety code regulations, which may require additional or more conservative practices than defined in the Standard.

Key Terms and Definitions

Authorized Electrical Person: An individual who is competent in isolation of hazardous energy and is capable of recognizing electrical hazards. The person is given the training, authority and responsibility to perform specific assignments in an electrical area before being assigned to any electrical work. Examples of personnel who might be authorized electrical persons for specific assignments are electricians, mechanics, supervisors, operators, engineers, custodians, painters, etc. An authorized electrical person is not necessarily competent to perform the duties of a qualified electrical person.

Electrical Standby Person: An electrically qualified or authorized person whose responsibilities are to observe the actions of a person performing a task, ensure his or her safety, assist if in danger, and to exercise stop work authority.

Electrical Work: Any task that involves working on or near (that is, within 3.2 meters [10 feet], in most cases) any electrical system or equipment that is operating at a voltage of 50 volts or more and that has exposed energized electrical conductors or circuit parts. This includes work on nonelectrical equipment that is within 3.2 meters (10 feet) of equipment or lines operating at 50 volts or more and that have exposed energized electrical conductors or circuit parts.

Energized Electrical Work Permit: A special permit process applied any time work is to be performed on or near electrical equipment that is in an energized state. May be a subset of the General Work Permit system but includes additional safety requirements and approvals.

Qualified Electrical Person: One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

Safe Work Practices: An integrated set of policies, procedures, permits, and other systems that are designed to manage risks associated with non-routine activities. Safe Work Practices fill the void between Operating Procedures (focused on producing and delivering a product) and Maintenance Procedures (focused on inspecting, maintaining, or repairing equipment within the process), and address the exchange of equipment custody and information between the affected work groups.

OE CORPORATE REQUIRED STANDARD

ELECTRICAL SAFE WORK PRACTICE

Rev	Date	Description	Author	Sponsor
–	2007	Initial release of SWP 5159	PSHA	PSHA
A	10/09	General revision of SWP 5159	PSHA	PSHA
–	04/10	Re-release as OE Required Corporate Standard —ESWP. No content changes.	PSHA	PSHA

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1.0 PURPOSE, OBJECTIVES, AND SCOPE

1.1 Purpose

The purpose of the standard is to address shock and arc-flash hazards and to protect personnel from these hazards.

Note *Each strategic business unit (SBU) or business unit (BU) or location may have additional or more stringent regulatory requirements.*

1.2 Objective

This standard establishes minimum requirements for performing work safely on or near electrical equipment. Local electrical code and safety code regulations may require additional or more conservative practices than defined in this standard.

Comment: This standard defines minimum requirements for electrical safe work practices. If the SBU or BU document exceeds all of the requirements of this standard, it can be used instead.

1.3 Scope

This standard applies to all Chevron Corporation (Company) and contractor personnel performing and/or monitoring construction, operational or maintenance activities at any global facility or property and/or any joint-venture operation, where joint-venture agreements allow its use.

This standard applies to work on or near electrical equipment operating at voltage levels 50 volts dc or ac (rms) and above. This standard applies to electrical work conducted on ground level equipment, on elevated poles, below grade enclosures and inside confined spaces.

This standard does not address working on low voltage/low current instrumentation systems (for example, 4–20 mA signals). This class of equipment operates at less than 50 volts dc or ac (rms), and is not required to be placed in an electrically safe work condition, and is exempt from this standard.

Comment: Equipment operating at voltages less than 50 volts does not normally present a shock hazard and are excluded. Energized electrical conductors and circuit parts that operate at less than 50 volts to ground are not required to be de-energized, but the capacity of the source and any overcurrent protection between the energy source and the worker should be considered. A battery bank rated 48 volts dc without overcurrent protection (e.g., a fuse) is an example of a high-energy source that could result in a chemical explosion if the terminals were short circuited. See Annex A.

2.0 TERMS AND DEFINITIONS

2.1 Definitions

The following terms and definitions apply to this SWP Electrical Standard.

Comment: The definitions given are consistent with, and in most cases identical to, the definitions of NFPA 70E-2009, Standard for Electrical Safety in the Workplace.

Approved Written Work Procedure—A written procedure developed by competent personnel using risk management considerations that have been approved, as appropriate, and maintained in a retrievable filing system in electronic or hard-copy format. The procedure lists task-oriented steps that have a starting and ending point and details how work is to be completed using the

SWPs and guidelines or other materials (where appropriate). The procedure also identifies activities, roles, responsibilities, training, personal protective equipment (PPE), and authorities assigned to all the parties involved.

Arc Flash Hazard—A dangerous condition associated with the possible release of energy caused by an electric arc.

Note 1: *An arc flash hazard may exist when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard.*

For example, opening and closing a switching device that is applied within its published voltage, continuous-current, and short-circuit ratings is considered a normal operating condition. An activity such as insertion or removal of a starter or a circuit breaker from its cubicle is not a normal operating condition.

Note 2: *See Table 130.7(C)(9) of NFPA 70E-2009 for examples of activities that could pose an arc flash hazard.*

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

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

Authorized Electrical Person—An individual who is competent in isolation of hazardous energy and is capable of recognizing electrical hazards. The person is given the training, authority and responsibility to perform specific assignments in an electrical area before being assigned to any electrical work. Examples of personnel who might be authorized electrical persons for specific assignments are electricians, mechanics, supervisors, operators, engineers, custodians, painters, etc. An authorized electrical person is not necessarily competent to perform the duties of a qualified electrical person.

Barricade—A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning about and to limit access to a hazardous area.

Barrier—A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts or to prevent unauthorized access to a work area.

Classified Hazardous Area—Any area classified as a hazardous zone area (Zone 0, 1 or 2 or Class I, Division 1 or 2) in accordance with API RP 505/API RP 500 or other equivalent local standards.

Close Proximity—The state or quality of being close enough to reach, fall into, or otherwise accidentally touch an object (see also Restricted Approach Boundary).

De-energized—The state or quality of being free from any electrical connection to a source of potential difference and discharged of any stored electrical energy; not having a potential different from that of the earth.

Earthed or Earthing—See Grounded or Grounding.

Electrically Safe Work Condition—A state in which an electrical conductor or circuit part has been:

- Disconnected from energized parts;
- Locked/ tagged in accordance with established standards;
- Tested to ensure the absence of voltage; and
- Grounded, if determined necessary (See Section 4.9).

Electrical Standby Person—An electrically qualified or authorized person whose responsibilities are to observe the actions of a person performing a task, ensure his or her safety, assist if in danger, and to exercise stop work authority.

Electrical Work—Any task that involves working on or near (that is, within 3.2 meters [10 feet], in most cases) any electrical system or equipment that is operating at a voltage of 50 volts or more and that has exposed energized electrical conductors or circuit parts. This includes work on non-electrical equipment that is within 3.2 meters (10 feet) of equipment or lines operating at 50 volts or more and that have exposed energized electrical conductors or circuit parts.

Energized Electrical Work Permit—A special permit process applied any time work is to be performed on or near electrical equipment that is in an energized state. May be a subset of the General Work Permit system but includes additional safety requirements and approvals. See Annex B for the Energized Electrical Work Permit Form, which includes the minimum requirements for this permit.

Exposed (as applied to energized electrical conductors or circuit parts)—Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated.

General Work—All non-routine work or periodic work for which approved written operating procedures do not exist and which does not involve a source of ignition and/or entry into a confined space. General work might also be referred to as cold work or safe work.

Grounded or Grounding—The act of providing an intentional connection to earth through an electrically conductive connection of sufficiently low impedance and with sufficient current carrying capacity as to prevent voltage build-up that might result in undue hazard to persons or to connected equipment. This also is referred to as "earthing."

High Voltage—Voltage that is equal to or greater than 1000 volts AC or 1500 volts DC between conductors or that is equal to or greater than 600 volts AC or 900 volts DC between conductors and the earth.

High-Risk Work—Job tasks involving the following SWPs: confined space entry, electrical work, hot work, isolation of hazardous energy, work at heights and additional SWPs identified by the SBU/BU.

Job Safety Analysis (JSA)—A detailed, written hazard assessment which breaks down a job task into the sequence of steps required to perform the task, identifies the hazards specific to each step, evaluates their risk and details mitigation measures to eliminate or manage the risk.

Limited Approach Boundary (to electrical hazards)—An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Note *Unqualified personnel may not approach any exposed energized conductor closer than the limited approach boundary.*

Low Voltage—Voltage that is less than 1000 volts AC or 1500 volts DC between conductors or less than 600 volts AC or 900 volts DC between conductors and earth.

Non-Routine Task—Any operation or maintenance activity performed within an operating area that is outside of the operator's or maintenance worker's normal work duties where no approved written work procedure exists. For example, any task involving hot work or line-breaking by operational, maintenance, or contractor personnel.

Permit Approver—A competent individual who has been trained, tested and authorized by the Company to review and, where applicable, sign and approve the relevant permits. Refer to the following applicable document for contractor self-permitting requirements.

Global Downstream - Contractor HES Management Process -or-
Insert appropriate OPCO link here.

Permit Issuer—A competent and trained individual who has been authorized by the Company to complete, review and issue the various types of work permits and work forms for their assigned area. BUs can determine if the Permit Issuer may also serve as the Permit Approver or whether an additional level of approval is required.

Person in Charge—A competent individual who is responsible for an assigned area and the safe execution of work in that area. The designated person may vary, depending on the work specified.

Prohibited Approach Boundary (to electrical hazards)—An approach limit within which work is considered the same as making contact with an exposed energized electrical conductor or circuit part.

Qualified Electrical Person—One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

Note *Most work on electrical systems and parts must be done by a qualified electrical person.*

Comment: If no formal qualification program exists, facilities should develop an internal program to qualify and document their "qualified electrical person(s).

Restricted Approach Boundary (to electrical hazards)—An approach limit within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to an exposed energized electrical conductor or circuit part.

Safe Work Zone—The space required to safeguard personnel. An area temporarily marked off by rope, tape, or other barricading devices into which entry is prohibited for all personnel except those authorized by the Person in Charge.

Shock Hazard—A dangerous condition associated with the possible release of energy caused by contact with or approach to energized electrical conductors or circuit parts.

Troubleshooting (temporary re-energizing)—The steps necessary to remove lockout / tagout protections in order to temporarily re-energize to facilitate diagnosis of problems or to test electrical repairs. Usually does notresult in the final completion of work or handover of equipment to operations.

Working On (energized electrical conductors or circuit parts)—Coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment a person is wearing. There are two categories of "working on:" *Diagnostic (testing)* is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment; *repair* is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

2.2 Acronyms

ATPV—Arc Thermal Performance Value (Annex E, Table E-2)

BU—Business unit

CB—Circuit Breaker

ESWP—Electrical Safe Work Practice

FR—Flame Resistant

FRP—Fiberglass-Reinforced Plastic

GFCI—Ground-Fault Circuit-Interrupter

HRC—Hazard/Risk Category

JSA—Job Safety Analysis

MCC—Motor Control Center

OPCO—Operating Company

OPP—Overhead Powerline Policy (Annex L, from NFPA 70E)

PPE—Personal Protective Equipment

RCD—Residual Current Device

SBU—Strategic Business Unit

SWP—Safe Work Practice

VF—Ventricular Fibrillation

VT—Voltage Transformer

3.0 ROLES, RESPONSIBILITIES AND TRAINING REQUIREMENTS

All individuals performing electrical work shall have clearly defined roles, and shall meet the training and competency requirements of this standard prior to starting work. SBUs/BUs or country regulations may specify additional training and competency requirements. When selecting personnel for electrical work, consideration should be given to their level of experience and their past performance.

A single individual may fulfill more than one role as long as that person meets all of the competency requirements and is able to perform multiple responsibilities fully. For example, a Permit Issuer may also serve as an Electrical Standby Person. SBUs/BUs may determine the appropriateness of personnel fulfilling dual roles.

Insert any additional SBU/BU language here.

The following roles and responsibilities are specific to electrical work:

- Authorized Electrical Person
- Electrical Standby Person
- Qualified Electrical Person

These roles are further defined in the following applicable document:

Global Downstream - SWP Training Requirements Tool -or-
Insert appropriate OPCO link here.

Since electrical work requires a work permit, the following roles are also applicable:

- Permit Approver
- Permit Issuer
- Permit Requester or Permit Holder

Refer to the following applicable document for instructions:

Global Downstream - SWP General Work Permit Standard -or-
Insert appropriate OPCO link here.

When electrical work is performed in a confined space such as a cable entry area, an underground vault or other below grade work, the following roles are also applicable:

- Authorized Entrant
- Entry Supervisor
- Entry Watch
- Qualified Gas Tester
- Rescue Personnel

Refer to the following applicable document for instructions.

Global Downstream - SWP Confined Space Entry Standard -or-
Insert appropriate OPCO link here.

There may be additional SWPs and roles needed for performing electrical work, such as gas detection, hot work or isolation of hazardous energy. Refer to the Roles, Responsibilities and Training Requirements section of the applicable SWP standard (see Sections 6.0 (References) and 7.0 (Other Guidance Documents) of this document) for additional relevant roles.

Insert any additional SBU/BU language here.

3.1 Initial Training

Personnel shall meet the competency requirements prior to starting work. Refer to the following applicable document:

Global Downstream - SWP Training Requirements Tool -or-
Insert appropriate OPCO link here.

BUs in geographies that do not have a licensing system for electrical workers shall define the appropriate competencies and verification methods for a Qualified Electrical Person in addition to those listed in the following applicable document.

Global Downstream - SWP Training Requirements Tool -or-
Insert appropriate OPCO link here.

Comment: Proper training is imperative and must be completed as required by the local BU. In-class, hands-on training for the Chevron ESWP Standard is available through third-party companies.

Contractors must also verify that any electrical workers they provide who will be working on energized electrical systems have met the same training requirements.

3.2 Refresher Training

Refresher training shall be provided as follows:

- Whenever an individual demonstrates insufficient knowledge of this Electical SWP Standard;
- At least every three years.

4.0 STANDARD INSTRUCTIONS

The optimal practice at all Chevron-owned and operated facilities is to place electrical systems and electrical equipment of 50 volts or more into an electrically safe work condition before performing work within the limited approach boundary.

When work must be performed on or near electrical systems or equipment of 50 volts or more with exposed energized electrical conductors or circuit parts that have not been placed in an electrically safe work condition, the work to be performed is considered energized electrical work and shall be conducted in accordance with this SWP and the following applicable document:

Global Downstream - SWP Assessing Hazards and Managing High-Risk Work Procedure -or-
Insert appropriate OPCO link here.

The following applicable document shall be used to ensure safe isolation and de-energization of electrical equipment prior to the start of work.

Global Downstream - SWP Isolation of Hazardous Energy Standard -or-
Insert appropriate OPCO link here.

Also, because electrical work often involves potential sources of ignition, the following applicable document shall be used any time work is conducted inside a classified hazardous area.

Global Downstream - SWP Hot Work Standard -or-
Insert appropriate OPCO link here.

Electrical work inside confined spaces may also be required to comply with the following applicable document:

Global Downstream - SWP Confined Space Entry Standard -or-
Insert appropriate OPCO link here.

Comment: The first choice is to work on de-energized equipment. Treat the circuit as energized until placed into an electrically safe work condition. This section outlines other SWP documents that may apply to electrical work, in addition to an energized electrical work permit (see Section 4.2.2).

4.1 Assessing and Managing Hazards

All high risk work shall be permitted and managed in accordance with the following applicable document:

Global Downstream - SWP Assessing Hazards and Managing High-Risk Work Procedure -or-
Insert appropriate OPCO link here.

A shock and arc flash hazard analysis shall be performed by a qualified electrical person before a person approaches any exposed energized electrical conductor or circuit part that has not been placed in an electrically safe work condition. Refer to Annex D and Annex E, Section E.2, for information on the shock approach boundaries and the arc-flash protection boundary. This requirement includes the tasks required to place equipment into an electrically safe work condition and to re-energize the equipment to return it to service. It shall be permitted to define standard boundaries for a given voltage class in a particular facility where an arc flash hazard analysis has been performed previously. The arc flash hazard analysis shall identify all of the following:

- The voltage to which a worker may be exposed;
- The associated arc flash protection boundary, and
- The personal protective equipment to be worn by workers within that boundary.

Refer to Annex F (Sample Calculation of Arc Flash Protection Boundary) and Annex G (Recommended Personal Protective Equipment) for more information.

Exception No. 1: An arc flash hazard analysis shall not be required where all of the following conditions exist:

1. The circuit is rated 120 volts, nominal, to ground or less.
2. The circuit is supplied by one transformer.
3. The transformer supplying the circuit is rated less than 125 kVA.

Exception No. 2: Annex E shall be permitted to be used in lieu of a detailed incident energy analysis.

Note *Arc flash hazards are more severe in enclosed spaces and require a greater arc flash boundary. The special hazards of arc flash in a confined space should be considered before authorizing the work. In general, cables connected to a solidly-grounded power system represent a greater arc flash hazard than cables connected to a resistance-grounded system.*

Electrical equipment that exposes a worker to incident energy levels greater than 167.4 J/cm^2 (40 cal/cm^2), calculated at the distance required for working on the energized electrical conductors or circuit parts, shall only be worked on with the circuit placed in an electrically safe work condition.

In addition, the applicable document in the table below requires that a qualified person:

- Conduct a hazard assessment using appropriate subject matter experts;
- Physically inspect/walk the job site prior to signing the permit;
- Write a job safety analysis (JSA) or an approved, written work procedure;
- Create a written work plan;

- Conduct a pre-job briefing with personnel—or when changes in personnel occur—before performing work;
- Ensure that a field review of work in progress occurs at least once during a work shift (or once during a 24 hour time period), and
- All individuals have the authority and responsibility to stop the work if an unsafe condition occurs or if there is uncertainty about the scope of work or work plan.

Global Downstream - SWP Assessing Hazards and Managing High-Risk Work Procedure -or-
Insert appropriate OPCO link here.

Insert any additional SBU/BU language here.

Comment: There are two principle risks to which a worker is exposed when working on or near electrical equipment. The first is the shock or electrocution hazard and the second is the arc-flash burn and blast hazard. Analysis of both hazards is necessary, however, a simplified approach is allowed through the use of Annex E.

The arc-flash blast hazard has not yet been addressed directly by consensus standards due to the extreme variability of the hazard. The PPE recommendations of this standard cannot completely protect a person against the arc-flash blast hazard.

This section outlines what is required to assess and manage these hazards. If the incident energy of the arc-flash exposure exceeds 167.4 J/cm^2 (40 cal/cm^2), work must be done in a de-energized state, or other means must be used—such as remote circuit breaker racking (insertion or removal) or increasing the working distance. Job briefings are essential, and the hazard assessment must be revisited if there is a change in the job or whenever "job creep" occurs.

4.2 Documentation

Comment: Documentation by a General Work Permit, as specifically required by the BU, must be defined in the "blue text" area. See Annex A for a flow chart and Annex B for a sample form for an Energized Electrical Work Permit. Energized work is to be discouraged, and in most cases the equipment can be de-energized to do work—which *is why the signatures are required for approval. For emergencies, there should be a written delegation of authority on file for approval of energized work.*

4.2.1 General Work Permit

In most cases, electrical work requires permit authorization. There are exceptions to this as listed in Section 4.3.6 (Jobs That Do Not Require an Electrical Permit). Refer to the following applicable document for instructions:

Global Downstream - SWP General Work Permit Standard -or-
Insert appropriate OPCO link here.

4.2.2 Energized Electrical Work Permit

Any work performed on energized equipment inside the restricted approach boundary is considered high risk and shall be managed. An Energized Electrical Work Permit is required in addition to the General Work Permit. See Annex A (Energized Electrical Work Permit Flow Chart) to determine if an Energized Electrical Work Permit is necessary.

4.2.3 Additional Work Forms

Other high-risk factors may be associated with electrical work such as confined space entry, working at height, and isolation of hazardous energy. Determine if additional work permits or documentation are needed based on the risk assessment. Refer to the relevant Global Downstream or Global Upstream SWP standards for more information.

4.2.4 Contractor Self-Permitting

Self-work permitting by select contractors may be a viable option if the contractors meet all of the requirements in the following applicable document:

Global Downstream - SWP General Work Permit Standard -or-
Insert appropriate OPCO link here.

Each SBU/BU shall determine if contractor self-permitting is acceptable. Refer to the following requirements for more information, as applicable:

Global Downstream - Contractor HES Management Process -or-
Insert appropriate OPCO link here.

4.3 Basic Rules

The following rules are applicable in all Chevron-owned and operated facilities.

4.3.1 Flow Chart

All isolation activities shall address the basic steps outlined in Annex A (Energized Electrical Work Permit Flow Chart).

4.3.2 Presume Electrical Equipment is Energized

Electrical equipment, power lines, cables and other devices shall be considered energized until they are put in an electrically safe work condition. An "electrically safe work condition" means that an object is disconnected from energized parts, tested, locked and tagged out, and grounded, unless not required per Section 4.9.

4.3.3 Limited Approach Boundary (Ten-Foot Rule)

Unqualified personnel shall maintain a minimum safe distance outside the limited approach boundary of 3.2 meters (10 feet) from exposed energized electrical conductor or circuit parts. The safe distance restriction also applies to mobile overhead equipment such as cranes, mobile scaffolds and fork trucks. Voltages above 72.5 kV require additional clearances. See Annex D, Table D-1.

As permitted by specific local Business Unit practices, the limited approach boundary distance may be reduced to 1.1 m (3 ft. 6 in.) if the exposed energized electrical conductor or circuit part is fixed (not movable) and the nominal system phase-to-phase voltage is 750 volts or less.

Insert any additional SBU/BU language here.

Comment: General rules are given in this section for work on electrical equipment. A uniform rule (10 ft) is easier for employees to remember and enforce for all voltage levels. However, there may be situations for systems rated 750 volts (phase-to-phase) and below where the distance of ten feet (3.2 m) may prove disruptive, such as when low-voltage distribution panelboards are located in building hallways. The ESWP Standard permits a BU, by written local exception, to reduce this distance to the value listed in Table D-1 (1.1 m [3 ft 6 in.]) if the exposed energized electrical conductor or circuit part is in a fixed position.

4.3.4 Voltage Testing Requirements

Voltage testing procedures shall include all of the following minimum requirements:

- Ensure that the voltage detector (or voltmeter) is of the correct rating and type for the voltage magnitude to be measured;
- Verify that the testing device is approved for checking voltage;

Note *An example of an "approved" device for low-voltage use is one that conforms to ANSI/ISA 61010-1.*

- Verify that the testing device is working properly immediately before and after use;

Note *A valid method of voltage verification includes the measurement of a known "live" voltage source (such as a receptacle outlet) with the voltmeter. For higher voltages, verification of the voltmeter against the known output of a low-capacity, high voltage test source is recommended.*

- Define the work area (what equipment will be tested and what are the area boundaries);
- Test every exposed conductor or circuit part within the identified area of work;

Note *Test for voltage both "phase-to-ground" and "phase-to-phase."*

- Retest for absence of voltage anytime the circuit conditions change or the work site is left unattended, and
- Identify approved alternate voltage testing methods when there are no accessible exposed points from which to take readings (such as the use of non-contacting voltage detectors at taped motor-lead connections).

Comment: This is a description of the "Test Before Touch" practice and procedure that is an essential habit for an electrician. Non-contacting voltage detectors should only be used as an indication, and the use of a contacting voltmeter or a proper grounding technique is required prior to touching an exposed part with a bare hand.

4.3.5 Locking and Tagging Out Equipment

Locking and tagging out equipment shall be performed in accordance with the following applicable document:

Global Downstream - SWP Isolation of Hazardous Energy Standard -or-
Insert appropriate OPCO link here.

4.3.6 Jobs That Do Not Require an Electrical Permit

The following work tasks may be performed by a qualified electrical person without an electrical permit. Since this type of work occurs inside the limited approach boundary and a shock hazard may exist until proven otherwise, two workers shall be present (see 4.3.7.2, below). Any work tasks other than those listed shall be permitted and managed in accordance with the following applicable document:

Global Downstream - SWP Assessing Hazards and Managing High-Risk Work Procedure -or-
Insert appropriate OPCO link here.

A qualified electrical person shall be permitted to perform the following jobs:

- Use an approved voltage detector to measure voltage on equipment not placed in an electrically safe working condition;
- Attach grounds on equipment previously placed in an electrically safe working condition;
- Check electrical phase synchronization (phasing) using low-voltage instrumentation (at the secondary of instrument voltage transformers prior to closing a switch or circuit breaker;
- Use approved live-line tools to perform switching operations.

When maintenance troubleshooting and diagnostic testing such as the following must be performed on energized equipment, the qualified electrical person is required to take special precautions:

- Take voltage readings;
- Perform voltage phasing (See Annex K for the preferred procedure using instrument voltage transformers);
- Perform preventive maintenance observations and meter checks;
- Perform predictive maintenance observations and infrared thermography;
- Reset device overloads.

Note *Special precautions are job specific and should be covered by a JSA before work begins. Some locations may have documented special precautions for various jobs.*

Even with special precautions in place, if the worker is in close proximity to energized equipment or exposed energized electrical conductors or circuit parts, appropriate personal protective equipment (PPE) shall be worn (see Section 4.5). In addition to the facility basic PPE, protective equipment for electrical workers may include:

- An arc-rated face shield (used with a flame-resistant head-sock hood, or balaclava) or an arc flash suit hood;
- Insulating gloves with outer protective leather gloves;
- Flame-resistant clothing or arc flash suit;
- Undergarments made from fabric that does not melt (no polyester or synthetic fabrics which can melt against the skin).

Comment: Note that an Electrical Standby Person is required if the energized state of the circuit or part cannot be assured. It is strongly recommended that "phasing" be completed utilizing the low-voltage side of instrument voltage transformers, if available (see Annex K). Appropriate use of personal protective equipment is required.

4.3.7 Working On or Near Electrical Systems

Comment: Rules for work in close proximity to exposed energized electrical conductors or circuit parts are described in this section, based on the distance and the worker's qualification.

Exposure to voltage 50 volts and above is considered a shock and electrocution hazard, which is one reason working on electrical components is considered a high-risk activity. If a worker is within the "limited approach *boundary," this means that there is an exposed energized part in the immediate vicinity of the work to be done, a shock hazard exists (i.e., 50 volts and above), and that an Electrical Standby Person is required. The Electrical Standby Person, as defined in Section 2.0, is "An electrically qualified or authorized person whose responsibilities are to observe the actions of a person performing a task, ensure his or her safety, assist if in danger, and to exercise stop work authority." An Authorized Electrical Person does not need to be as trained or experienced as a qualified electrical person. He or she may be, for example, an operator or an engineer who has had the training to shut off the power and administer help, if required.*

Additionally, a section is included that describes special procedures associated for work on or near insulated cables. Insulated cables are not "exposed energized electrical conductors or circuit parts," but require certain safe work practices to be followed.

4.3.7.1 Remove Conductive Apparel

When working in close proximity to exposed energized electrical conductors or circuit parts, workers shall remove all jewelry and other conductive apparel.

4.3.7.2 Work Inside Limited Approach Boundary

Two workers shall be present for work inside the limited approach boundary where a shock hazard exists. One of the two shall be a qualified electrical person and the second may be either a qualified or authorized electrical person; the second person shall act as an Electrical Standby Person. This person's responsibility is to know where to immediately shut off the source of voltage and to provide assistance, if needed, in case of an incident.

Exception: The presence of two workers shall not be required if one of the following conditions is satisfied:

- All voltage sources to the equipment of 50 volts or more have been de-energized (including possible back-feeds) prior to starting work, or
- The equipment has a built-in grounding device where the device is fully visible to be able to confirm that grounding has been accomplished.

Additionally, prior to working on a previously energized conductor or circuit part, the qualified electrical worker shall test for voltage (see Section 4.3.4) while using insulating rubber gloves rated for the equipment's nominal voltage (see Section 4.5, Table 1).

Note *The intent of this exception is to define a process and the conditions under which a single qualified electrical worker can prove that there is no shock hazard present before working on de-energized electrical conductors or circuit parts.*

4.3.7.3 Safe Work Zone Barriers

A safe working zone, as defined by the limited approach boundary, shall be visibly barricaded using tape or ropes with red "Dangerous - Do Not Enter" warning labels. More substantial barricades are required where mechanical work or extensive pedestrian or vehicle traffic is expected in the work area. This is intended to prevent accidental contact with exposed energized electrical conductors or circuit parts.

4.3.7.4 Work Inside Restricted Approach Boundary

Only qualified electrical personnel are allowed to work at or inside the restricted approach boundary. Any work inside the restricted approach boundary is considered high risk and shall be conducted under an approved Energized Electrical Work Permit, except as allowed in Section 4.3.6. This includes work not directly performed on the energized electrical equipment, such as pulling new wires into an energized electrical junction box or mounting new equipment inside an enclosure with energized electrical conductors or circuit parts). Qualified electrical persons working at or within the restricted approach boundary shall wear protective equipment appropriate for working on exposed energized electrical conductors or circuit parts and rated for the voltage and energy exposure level involved (see Section 4.5).

Barricades and insulation devices shall be deployed to minimize the potential for unprotected body parts to cross the restricted approach boundary. This restriction shall be enforced to help prevent inadvertent electrical shock. Safe distances vary with the voltage levels of the equipment or systems. The minimum safe distances for various voltage levels are as follows:

Voltage	Restricted Approach Boundary
300 volts up to 750 volts	30 cm (1 foot)
>750 volts up to 46 kV	0.84 m (2 feet, 9 inches) or essentially arm length
> 46kV	The minimum distances increase. See Annex D, Table D-1.

4.3.7.5 Tool and Equipment Insulation

Tools and equipment used for electrical work shall be insulated and rated for the voltages at which they can be safely used.

4.3.7.6 Working On or Near Insulated Cables

Most insulated power cables of voltage ratings above 5 kV have an electrostatic shield, i.e., a thin copper tape wound spirally around the outside of the conductor's insulation and below the outer jacket of the cable. This type of cable does not present a shock hazard if the cable's outer jacket were touched. Many circuits rated 5 kV and below use “unshielded” insulated cable, where a shock hazard may exist if the cable were touched with a bare hand. Following are procedures for working on or near energized insulated cables.

The first and preferred choice is to de-energize the cable in the vicinity of where the work will be done, or if the cable is to be disturbed or moved. Where de-energizing the cable is not possible, a General Work Permit and a written work plan shall be required for the following work:

- Cables should be identified by tags, ducts, and/or records. As a final verification that the cable to be repaired or removed has been de-energized, the use of a remotely-operated, hydraulic piercing (spiking) tool is recommended (see Annex G). Insulating rubber gloves and safety glasses shall be used when performing the piercing operation.

- Cables that are energized shall only be touched or moved by workers using insulating rubber gloves rated for the power system voltage. Old or fragile cables shall not be moved while energized. See Section 4.1 for information and cautions regarding arc-flash hazards.
- When cables are pulled into manholes or vaults, a physical barrier shall be used to prevent contact between existing energized cables, the new cables, cable pulling equipment, and personnel.

4.4 De-energizing and Re-energizing Lines and Equipment

Comment: Generalized procedures for de-energizing and re-energizing lines and equipment are given, and BU-specific procedures for isolation of hazardous energy can be added.

4.4.1 Procedures for De-energizing

Procedures for de-energizing lines and equipment shall include the following steps:

1. Ensure correct identification of lines/equipment etc where work is to be performed
2. Identify all possible sources of electrical supply to the equipment or line;
3. Interrupt the load current, then open the disconnecting device(s) for each identified source;
4. If possible, visually verify that the blades of disconnecting devices are fully open or that draw-out type circuit breakers are fully removed from cubicles;
5. Verify that the application of lockout/tagout devices is done in accordance with the following document:

Global Downstream - SWP Isolation of Hazardous Energy Standard -or-
Insert appropriate OPCO link here.

6. Use an adequately rated voltage tester on each phase conductor or circuit part toverify de-energization has occurred. Verify that the voltage detector is operating properly before first use and after each test;

   Note *Conduct voltage tests phase-to-ground and phase-to-phase.*

7. Perform grounding as required in Section 4.9, and

   Note *Ground the phase conductors or circuit parts before touching equipment or lines wherever stored electrical energy or induced voltages are possible. This shall be done in addition to locking and tagging out the device.*

8. Establish a safe work zone.

   Note *It is unnecessary to lock and tag out or ground equipment with a cord that is unplugged, when the plug and cord are under the exclusive control of the person working on the equipment.*

4.4.2 Procedures for Re-energizing

Procedures for re-energizing equipment or lines shall include all of the following steps:

1. Remove all protective grounds;

Note *Grounds left on equipment present a short circuit hazard when the equipment is re-energized. A positive method of control shall be used to ensure ground removal before re-energizing equipment (tags, leaving doors or covers open, leaving the ground cables clearly visible, use of magnetic ground signs, utilization of the same crew that conducted the lockout/tagout to remove the grounds, keeping records/lists/schematics showing points of grounding, peer review, check-offs, etc.).*

2. Ensure all covers and panels have been replaced;
3. Clear all workers from lines and equipment;
4. Remove all tags and locks;
5. Re-engage or insert (rack) interrupting devices such as circuit breakers or fuses; and
6. Re-energize the equipment or lines as directed by the facility owner and manufacturer recommended procedures.

4.5 Personal Protective Equipment

Comment: Flame-resistant clothing, hard hats, safety glasses, and other personal protective equipment are required for electrical work. Annex G details some available items. The class of insulating rubber gloves should be chosen based on the system voltage on which work will be done.

Personal protective equipment for workers performing electrical work shall include the following:

- Clothing shall be constructed of arc-rated flame-resistant materials (ASTM F 1506), have electrically non-conductive properties, and have long sleeves and long pant legs;
- Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (underwear) next to the skin;

  Exception: An incidental amount of elastic used on nonmelting fabric underwear or socks shall be permitted.
- Hard hats shall meet the International Safety Equipment Association (ISEA) Z89.1 Class E or equivalent standard;

  Note *An example of an available, but not an equivalent, standard is the European standard DIN EN 397, Industrial Safety Helmets. The EN electrical test voltage is 1200 volts ac versus the ISEA "Class E" test voltage of 20,000 volts ac.*
- Hard hats should be kept clean and shall not be altered in any manner with the exception of an SBU authorized logo or stickers with hard-hat-manufacturer approved adhesives;
- Safety glasses shall be approved and have non-conductive side shields;
- The appropriate class of rated insulating rubber gloves shall be selected in accordance with Table 1.
- Rubber insulating sleeves shall be worn whenever it is possible that a worker's arms will violate the restricted approach boundary;
- Leather work gloves shall be worn for arc flash protection when insulating rubber gloves are not required;
- Since electrical faults can result in hazardous noise levels, hearing protection is required, and
- Additional PPE that is appropriate for the voltage levels and the degree of hazard exposure shall be worn, in accordance with Annex G (Recommended Personal Protective Equipment) and Annex E (Flame Resistant Clothing Requirements).

Table 1: Insulating Rubber Glove Class Designations and Corresponding AC Use and Test Voltages

Class	Maximum Use Voltage (AC)	Test Voltage (AC)
00	500 Volts	2,500 Volts
0	1,000 Volts	5,000 Volts
1	7,500 Volts	10,000 Volts
2	17,000 Volts	20,000 Volts
3	26,500 Volts	30,000 Volts
4	36,000 Volts	40,000 Volts

Note:

Visually inspect and air test rubber gloves before each use and after any event that could have resulted in damage to the glove. Air testing involves trapping air in the glove and then squeezing the glove and checking for pinhole leaks. (See Annex I) Gloves shall also be dielectrically tested every 6 months in accordance with ASTM F 496 or equivalent.

4.6 Power System Switching Procedures

Facilities that perform switching of power systems shall follow the procedures listed below.

Comment: Switching procedures must be written and include appropriate permits (Annex B) and job briefings (Annex C). Repetitive or routine operations may be "standard," but must have proper review and approval.

4.6.1 Preparation

4.6.1.1 Written Switching Procedure

A written switching procedure is required before any switching is performed on a high voltage power system (this does not include switching of individual motors). The switching procedure shall be:

- Written by a qualified electrical person;
- Reviewed by at least one other qualified electrical person;
- Signed and dated by both people before it is used;

Routine switching may employ a standard switching procedure. Such standard procedures shall be properly approved, on file for ready access and execution by a qualified electrical person.

See Annex B for a sample Energized Electrical Work Permit form.

4.6.1.2 Job Briefing for Switching Procedures

Hold a job briefing before starting any switching. The person in charge of the switching procedure and all employees involved in the switching shall attend.

At a minimum, the following items shall be reviewed:

- Reason switching is being performed;
- One line drawing and/or power system status board to assure that all involved understand what will occur;
- Each step of the switching procedure;
- The job assignments for all involved (who will do what);

- Safety issues and required PPE;
- If required:
  - Electrical clearance requirements and/or lockout/tagout issues;
  - Location of safety grounds—to be installed or removed and by whom;
  - Other issues (such as operational limitations).

See Annex C for a sample Job Briefing and Planning checklist.

4.6.1.3 Job Briefings Prior to Work

The Person in Charge shall conduct a job briefing before starting work. This applies to new installations and modifications to existing facilities.

Conduct at least one job briefing before the start of each shift. Hold additional job briefings if changes occur during the course of the work that could affect personnel safety.

The job briefing shall include the following:

- Hazards associated with the job;
- Work procedures involved;
- Special precautions;
- Energy source controls;
- Personal protective equipment requirements;
- Work zones.

During the job briefing, each person involved should ask the following questions prior to starting the task:

- What is the worst thing that could happen?
- Do I thoroughly understand the job?
- Do I thoroughly understand my role and everyone else's role in the job?
- Am I aware of all the hazards I may encounter?
- Am I knowledgeable about all safety rules and required personal protective equipment applicable to this job?
- Do I have safeguards in place to protect me from unexpected events?

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

A more extensive discussion is needed:

- If the work is complicated or particularly hazardous, or
- If the employee (qualified or unqualified) cannot be expected to recognize and avoid the hazards involved.

As work progresses during the day after the initial job briefing, a person working alone should plan and review the work as if a briefing were held before each task.

Refer to Annex C (Job Briefing and Planning Checklist).

4.6.2 During Switching

Follow the written switching procedure in the order in which the steps are written, check off each switching step when completed, and record the time of completion.

The following switching procedures are recommended:

- The person receiving a switching command should repeat the command and have it confirmed by the person issuing the order before executing the command.
- Use a unique channel when switching commands are given by radio. Cross talk on the radio during switching could cause a switching error.
- Document the status of the power system switching when complete. Use of a status board or pin board is one method to accomplish this.
- Document information on power system abnormalities in order to inform off-shift personnel who may be involved in responding to power system problems. Record this information in a log book and post near a power system status board or pin board.
- Post any issues involving open electrical clearances, parts of the power system under lockout/tagout, the location of any safety grounds, and other power system safety issues near the power system status board or pin board.

A second person should stand clear and be a safety observer for the person doing the switching. The safety observer should ensure that each step the switch operator is about to perform is correct.

4.7 Tools

Tools used for live line work shall be stored in a clean, dry location and shall be cleaned and inspected for defects before each use. Live line tools shall be tested annually, or as required by local codes or regulations.

If the tool has contaminants that could affect its insulating qualities or if its mechanical integrity is questionable, remove the tool from service and have it repaired.

The repaired tool shall be tested using the testing program procedures described below.

Testing Procedure

Remove each live-line tool from service at least annually and give it the following examination and tests:

- Thoroughly examine the tool for defects.
- If mechanical defects or contaminants that could affect the insulating qualities of the tool are found, the tool may be repaired and refinished or permanently removed from service.
- If no defects are detected and no contaminants found, clean and wax the tool using only a wax approved for live-line tools.
- Use a test method that tests the entire working length of the tool.
- Tools made of fiberglass-reinforced plastic should be tested with wet conditions applied over the entire working length of the tool.
- The design test for new tools made of fiberglass-reinforced plastic (FRP) consists of applying 100,000 volts ac per foot (30 cm) of length for 5 minutes. (Refer to IEEE Std. 978 for in-service testing.)
- Other high voltage tests such as IEEE Std. 978 are acceptable if the business unit can demonstrate that these are equivalent.

4.7.1 Ground-Fault Circuit-Interrupters or Residual Current Devices

Use ground-fault circuit-interrupters (called "GFCIs," or outside North America, referred to as residual current devices or "RCDs") on all cord-connected electric power tools and other cord-connected devices used outdoors, in damp environments, or on concrete slabs that originate at grade level. Inspect all portable electrical equipment and tool for defects or damage prior to each use, and do not use if defective or damaged. GFCIs shall be tested for proper operation in accordance with the manufacturers' recommendations prior to each use.

Comment: The term GFCI is unique to North American devices tested to UL 943; the term RCD is used internationally. Sensitivity ranges from 6 mA for the GFCI to 30 mA for the typical RCD. A sensitivity of 6 mA was selected by the North American codes and standards when the devices were introduced in the 1970's to permit people to be able to "let go" if they grasped a live conductor.

Experimentation has demonstrated that greater than 99.5% of the population can voluntarily let go for a current flow through the body of 6 mA. As the current flow increases through the body, the person is more likely to become frozen to (cannot let go of) the live conductor, respiratory paralysis can occur at approximately 18 mA of current flow, and the probability of heart ventricular fibrillation (VF) increases for a current flow exceeding 30 mA (from a very low probability of VF at 30 mA current flow, to greater than 50% probability of VF for long-term [in the order of seconds] exposure to a 80 mA current flow hand-to-foot). A good reference describing the above is IEC TS 60479-1. The threshold of VF is the rationale for why 30 mA was selected as the "international" standard for sensitivity of RCDs, although the international standards (i.e., IEC standards and national adoptions of the IEC standards) also define and permit 6 mA and 10 mA pickup sensitivity levels for selection and use.

If a search is made for the availability of portable residual current devices (PRCDs), per the international IEC Standard 61540, most are of 30 mA sensitivity. Some are available for 6 mA and 10 mA sensitivity. The use of a lower sensitivity RCD is recommended, but secure commercial availability should be verified. International standards permit the use of 30 mA RCDs for personnel protection and this sensitivity will prevent most electrocutions.

One aspect that the user needs to be aware of: The inherent capacitance between the phase "hot" conductor and the equipment grounding conductor within the extension cord itself, will be in the order of 5 mA per km length of cable at a voltage of 230 volts to ground. This is sensed by the GFCI or RCD and appears as a continuous leakage current to ground or earth. Construction applications may be limited to approximately 1 km total length of extension cords connected to a single GFCI or RCD that has a 6 mA pickup, in order to avoid false trips. To avoid nuisance trips, it is recommended that the total connected extension cord length not exceed approximately 500 meters at 230 volts for application with a single 6 mA GFCI or RCD device on a branch circuit. The allowable length doubles at 120 volts to about 1000 meters.

4.7.2 Portable and Vehicle Mounted Generators

Portable and vehicle-mounted generators that are used to provide power to cord-connected tools and equipment shall meet the following requirements:

1. The generator frame has a connection to ground (earth);
2. Only the receptacles (sockets) mounted on the generator or vehicle are used to provide power to cord connected tools or equipment;
3. Non-current carrying metal parts of the equipment and the equipment grounding conductor of the receptacles are bonded to the generator frame;
4. For vehicle mounted generators, the frame of the generator is bonded to the frame of the vehicle; and
5. Any neutral conductor is bonded to the generator frame.

Comment: This standard goes beyond the US National Electrical Code (NEC) requirements due to shock hazard that can be created during a situation when the "hot" side of a generator's output becomes accidently grounded (e.g., through a damaged extension cord or tool). This would then create a situation where the generator frame may be at a potential above ground that would be a shock hazard.

The use of a locally-driven ground rod electrode is the last choice if there is no existing buried ground ring or other grounding electrode for a connection from the generator frame to ground. For descriptions of example grounding electrodes, refer to the NEC, Article 250.52. The important point is to equalize any "touch" voltages in the immediate vicinity of the generator so that a shock hazard is not created for the generator's operator.

4.7.3 Ladders

Ladders used for electrical work shall have vertical components (the rung side supports) made of non-conductive materials. See Section 7.0 for representative ANSI standards.

4.8 Below Grade and Underground Electrical Facilities

Some below-grade electrical vaults are considered to be confined spaces and may require the application of the following, as applicable, for safe entry:

Global Downstream - SWP Confined Space Entry Standard -or-
Insert appropriate OPCO link here.

When accessing below-grade vaults, a rescue plan shall be in place before work begins. Qualified electrical personnel shall wear a body harness attached to an extraction tripod for use in the event a rescue is necessary.

Ladders shall be used to access below-grade electrical vaults more than 4 feet (122 cm) deep. Use tool baskets and ropes to transport tools and equipment into and out of the below grade vault (do not manually carry the tools while climbing the ladder).

Comment: Many cable basements beneath switchgear are also considered confined spaces, so be sure that the applicable confined space SWP is applied. Proper extraction means and personnel harnesses are essential.

4.9 Grounding

Grounding is required to prevent backfeeds on the following equipment:

- All switchgear buses;
- All feeders from sub-stations;
- All bare conductor circuits, and
- All motor circuits over 690 volts, nominal.

Grounding cables shall be sized in accordance with Annex H (Protective Ground Cable, Ferrule, and Assembly Ratings). Grounding cables shall not be required if the equipment is equipped with integral grounding switches that can be verified visually.

Insert any additional SBU/BU language here.

Comment: Application of safety grounding clusters with hot sticks requires hands-on personnel training and preferably the specification of "grounding balls" (e.g., those manufactured by A. B. Chance Company) on the load-side terminals of high-voltage circuit breakers to facilitate the connection of safety grounds. The larger size protective grounds may be difficult for personnel to physically handle, so multiple sets of cables sized 4/0 AWG (or the nearest metric size, 95 mm^2) or smaller may be required for systems with high short circuit capacity.

4.9.1 Grounding Previously Energized Parts

Grounding recently de-energized parts shall include the following steps in sequence:

1. Connect one end of the grounding device or assembly to an effective ground;.
2. Test the de-energized part for voltage;

   Note *See Sections 4.3.4 and 4.4.1 (item 5), which describe the use of a voltage tester.*

3. If the voltage test indicates the part(s) are not free from voltage, do not attach the ground to the part. Determine the source to ensure the voltage does not prohibit safe completion of grounding.

4. If part(s) are free from voltage, complete the grounding by securely attaching the grounding device to the part using live line tools.

4.9.2 Removing Grounds

Grounds may be temporarily removed by a qualified electrical person for testing. During the testing, consider the previously grounded lines and equipment to be energized. The following steps shall be followed in sequence for removing grounds:

1. Remove the grounding devices from the de-energized parts using live line tools, and
2. Remove the connection to the ground.

4.10 Mobile Equipment

This section includes requirements for "bucket trucks" working on overhead electrical equipment and for non-electrical mobile equipment including cranes, cement pumpers, aerial man-lifts, etc. Where mobile equipment is to be specifically used for working on energized electrical conductors or circuit parts, the booms and buckets shall be insulated, and shall be tested at least annually in accordance with ANSI/SIA A92.2.

Note *See Annex L (Example Industrial Procedures and Policies for Working Near Electrical Lines and Equipment).*

Comment: Mobile equipment has perhaps the highest risk of contact with power lines, so attention is drawn to Annex L. The use of orange cones placed on the ground is encouraged to define the work zones and to keep a safe distance from overhead lines. Barricades are placed around a vehicle's ground rod to avoid shock and electrocution from high voltage gradients at the grounding electrode ("step potential") if an overhead line contact is made and a fault to ground or earth is initiated. Make use of "Look Up and Live" flags, as describe in Annex L, to avoid inadvertent contact with overhead lines.

4.10.1 Trained and Qualified Personnel Only

Mobile equipment used for electrical work shall be operated qualified personnel trained in the use of this equipment.

4.10.2 Distance from Energized Components

Mobile equipment used for overhead work shall not be initially positioned within 3.2 meters (10 feet) of energized electrical conductors or circuit parts, or parts that can become energized.

4.10.3 Barricade and Ground

The qualified electrical person shall establish a barricade around any mobile equipment that is to be operated within the 3.2 meters (10 feet) safety distance. The mobile equipment shall be grounded. On distribution circuits, the best ground available (in ranked order) is:

1. The common neutral or ground grid system;
2. A tower or other grounded structure; or
3. A ground rod driven to a depth consistent with the local soil conditions.

Exception: The mobile equipment shall not be required to be grounded when the electrical conductors or circuit parts associated with the overhead lines (including any possible backfeeds) have been grounded from any possible direction as viewed from the mobile equipment.

4.10.4 Attaching Ground Sequence

When attaching grounds, perform the following steps in the order listed:

1. Attach the ground lead to the best available ground;
2. Attach the ground lead to the vehicle;
3. Install barricades at a 3.2 meters (10 feet) radius around the ground rod.

4.10.5 Removing Ground Sequence

When removing grounds, perform the following steps in the order listed:

1. Verify that the crane, derrick boom, or similar parts of the equipment have been removed from the vicinity of the potentially energized conductors or equipment;
2. Detach the ground lead from the vehicle;
3. Detach the ground lead from the ground.

4.10.6 Standby Person

Assign a standby person to monitor the location of the mobile equipment whenever:

1. The equipment could potentially come into contact with energized electrical conductors or circuit parts, or
2. When it is difficult for the equipment operator to accurately determine the distance between the equipment and the electrical components.

4.10.7 Distance from Electrical Lines

Mobile equipment, such as cranes that are in transit with the boom lowered, shall maintain a minimum safe clearance from uninsulated electrical lines of 1.22 meters (4 feet) from systems of 50 kV or less. Add 100 mm (4 inches) to the safe distance for every 10 kV over 50 kV. If insulated barriers, rated for the voltages involved, are installed and are not part of an attachment to the vehicle, the clearance shall be permitted to be reduced to the design working dimensions of the insulating barrier.

5.0 RECORDS

5.1 Required Records

The following records will be kept for conformance with this standard:

- Annual inspection and testing of electrical tools and PPE;
- List of qualified electrical persons, dates of qualification and the basis for their qualification;
- Copies of all permits and associated documentation (JSAs, hazard assessments, etc.) with authorizations and any other associated documents;
- Training records of relevant roles such as Permit Issuer, Permit Approver, etc.

Insert any additional SBU/BU language here.

The BU will maintain an up-to-date list of all contractor personnel authorized to be a Permit Issuer or Permit Approver for self-permitting. Refer to the following applicable documents:

For general work permitting instructions:

Global Downstream - SWP General Work Permit Standard -or-
Insert appropriate OPCO link here.

For the General Qualification Guideline for Contractor Self-Permitting and the Tracking Sheet for Self-Permitting Contractors:

Global Downstream - Contractor HES Management Process -or-
Insert appropriate OPCO link here.

5.2 Retention Requirements

All documents will be retained in accordance with the Chevron's retention schedule (see http://infoprot.chevron.com/programs/retentionSchedule/retentionSchedule.aspx) or as required by more stringent local regulations. At a minimum, records will be kept for the periods specified below:

- Copies of all permits, forms and associated documentation (including JSA forms and electrical permits) will be kept for one year or audit-to-audit, whichever is the lesser, as specified in the following applicable document:

Global Downstream - SWP General Work Permit Standard -or-
Insert appropriate OPCO link here.

- Training records and qualifications to perform electrical work will be kept for personnel until five years beyond termination of employment;
- Copies of the letter of authorization of the Permit Issuer and Approver will be kept on file for three years, as proof of role competency;

- In cases where contractor self-permitting is allowed, the Company Representative or the Person in Charge will keep the list of contractors authorized to self permit on site for one year;
- Records for electrical tools and PPE will be kept for as long as the equipment or PPE is available in the facility.

6.0 REFERENCES

Following is a complete list of the documents referenced in this standard:

Global Downstream Standards

Contractor HES Management Process

SWP Assessing Hazards and Managing High-Risk Work Procedure

SWP Confined Space Entry Standard

SWP General Work Permit Standard

SWP Hot Work Standard

SWP Isolation of Hazardous Energy Standard

SWP Training Requirements Tool

Comment: Users with access to the Chevron intranet can access these documents through the following web site:

http://dominous1.chevron.com/ds/prometheus.nsf/DiscByCategory1?OpenView&Start=1&Count=10000&Collapse=9.2#9.2

For other global organizations (e.g., Global Upstream and Global Chemicals), refer to the appropriate standardization home page.

American Petroleum Institute (API)

API RP 500	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2
API RP 505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, and Zone 2

American Society of Testing and Materials (ASTM)

ASTM F 479	Standard Specification for In-Service Care of Insulating Blankets
ASTM F 496	Standard Specification for In-Service Care of Insulating Gloves and Sleeves
ASTM F 855-04	Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment
ASTM F 1505	Standard Specification for Insulated and Insulating Hand Tools
ASTM F 1506	Standard Performance Specification for Flame Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards
ASTM F 1959	Standard Test Method for Determining the Arc Thermal Performance Value of materials for clothing

Deutsches Institut für Normung (DIN)

DIN EN 397	Industrial Safety Helmets

Institute of Electrical and Electronics Engineers (IEEE)

IEEE Std 978	IEEE Guide for In-Service Maintenance and Electrical Testing of Live-Line Tools
IEEE Std 1584-2002	IEEE Guide for Performing Arc-Flash Hazard Calculations

R.L. Doughty, T.E. Neal, and H.L. Floyd, "Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 Volt Power Distribution Systems." *IEEE Transactions on Industry Applications*, vol 36, no 1, pp 257-269, Jan/Feb 2000.

Instrumentation, Systems, and Automation Society (ISA)

ISA 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

International Electrotechnical Commission (IEC)

IEC TS 60479-1	Effects of current on human beings and livestock. Part 1: General aspects
IEC 61540	Electrical accessories - Portable residual current devices without integral overcurrent protection for household and similar use (PRCDs)
IEC 62271-200	High-voltage switchgear and controlgear. Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

International Safety Equipment Association (ISEA)

ISEA Z89.1	American National Standard for Industrial Head Protection

National Fire Protection Association (NFPA)

NFPA 70E-2009	Standard for Electrical Safety in the Workplace
NFPA 70 (NEC)	National Electrical Code. Article 250.52, Grounding Electrodes

Scaffold Industry Association (SIA)

SIA A92.2	American National Standard Vehicle-Mounted Elevating and Rotating Aerial Devices

Underwriters Laboratories, Inc. (UL)

UL 943	Ground-Fault Circuit-Interrupters

7.0 OTHER GUIDANCE DOCUMENTS

Global Downstream Standards

SWP Gas Detection Standard

SWP Work at Height Standard

Comment: Users with access to the Chevron intranet can access these documents through the following web site:

http://dominous1.chevron.com/ds/prometheus.nsf/DiscByCategory1?OpenView&Start=1&Count=10000&Collapse=9.2#9.2

American Ladder Institute (ALI)

ALI A14.1	Safety Requirements for Portable Wood Ladders
ALI A14.3	Safety Requirements for Fixed Ladders
ALI A14.4	Safety Requirements for Job-Made Ladders
ALI A14.5	Safety Requirement for Portable Reinforced Plastic Ladders

American Society of Testing and Materials (ASTM)

F 2249	Standard Specification for In-Service Test methods for Temporary Grounding Jumper Assemblies used on De-Energized Electric Power Lines and Equipment

CFR (Code of Federal Regulations) of the United States

29 CFR Part 1910	Occupational Safety and Health Standards Subpart I, 1910.137 (Electrical Protective Devices) Subpart R, 1910.269 (Electric Power Generation Transmission, and Distribution) Subpart S 1910.301 – 399 (Electrical)
29 CFR Part 1926	Safety and Health Regulations for Construction Subpart K 1926.400 – 449 Electrical)

International Electrotechnical Commission (IEC)

IEC 60903	Live working - Gloves of insulating material
IEC 60984	Sleeves of insulating material for live working
IEC 61112	Live working - Electrical insulating blankets

Institute of Electrical and Electronics Engineers (IEEE)

IEEE Std 1048	IEEE Guide for Protective Grounding of Power Lines

National Fire Protection Association (NFPA)

NFPA 70B	Recommended Practice for Electrical Equipment Maintenance

Comment: Users with access to the Chevron intranet can access the above-listed documents through the following web site:

http://itc.chevron.com/servicessolutions/infomgmt/global_library/documents/ihs4/

If you do not have access to the Chevron intranet, contact your local library resource for information on license and access requirements.

8.0 REVISION HISTORY

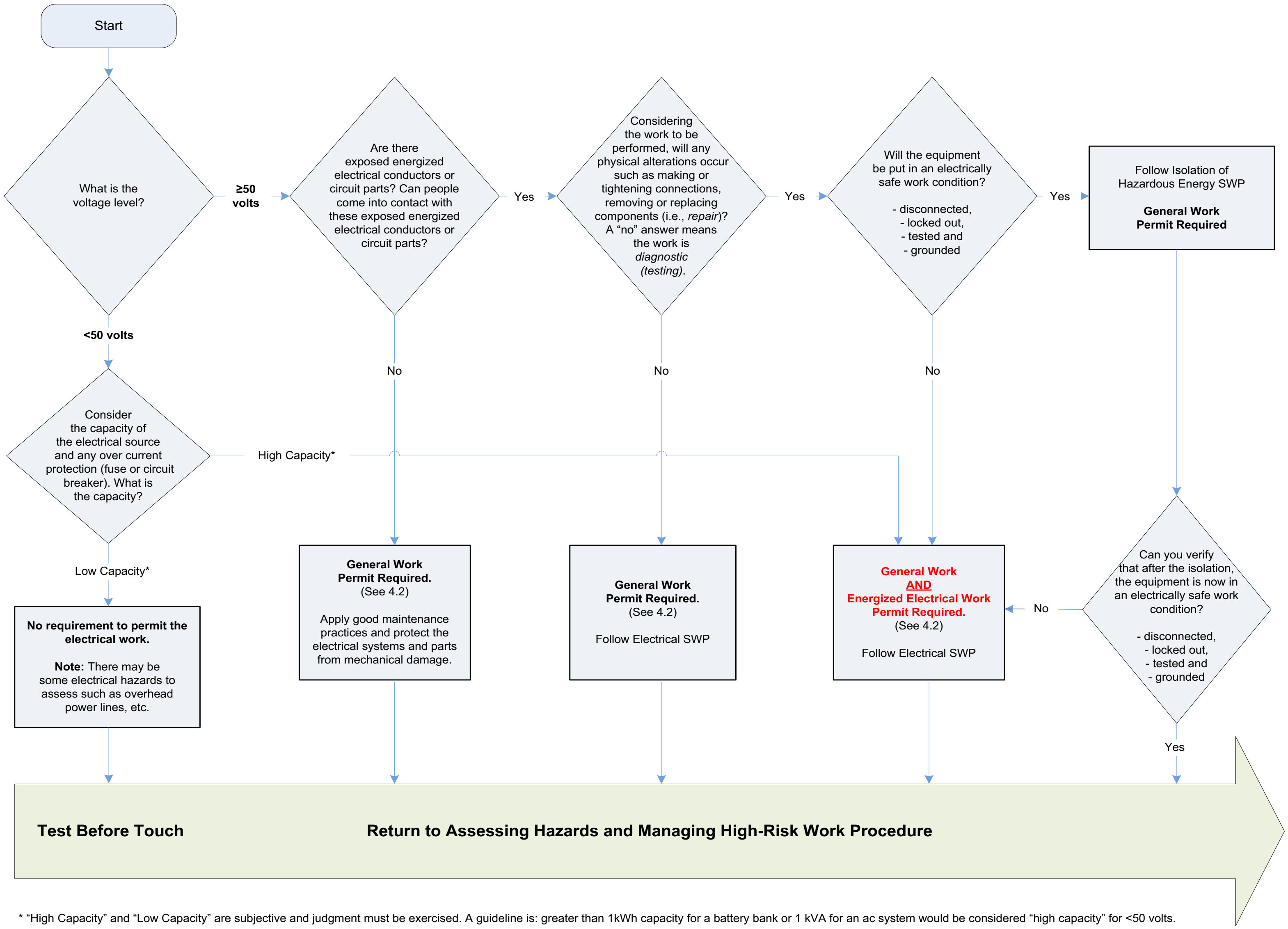
Table 2: Revision History

Description	OE Corporate Standard Electrical Safe Work Practice
Revision Date	October 2009, Revision A
Next Revision Due	Upon approval of next edition of NFPA 70E beyond 2009
Control Number	Insert document control number

Table 3: Amendment Details

Amendment Date	Detail
March 12, 2010	Errata change, page 49: Table E-4, Note 4, “455 m” corrected to “455 mm”
November 1, 2010	Errata change, page 59: Last column heading changed from “"Continuous Current Rating, kA RMS 60 Hz" to “"Continuous Current Rating, Amperes RMS 60 Hz"

ANNEX A ENERGIZED ELECTRICAL WORK PERMIT FLOW CHART



* "High Capacity" and "Low Capacity" are subjective and judgment must be exercised. A guideline is: greater than 1kWh capacity for a battery bank or 1 kVA for an ac system would be considered "high capacity" for <50 volts.

ANNEX B ENERGIZED ELECTRICAL WORK PERMIT FORM

ENERGIZED ELECTRICAL WORK PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER:

Job/Work Order Number____________

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

____

(2) Description of work to be done: ______________________________

____

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

____

____

______________________ ______________________

Requester/Title Date

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

Check when complete

(1) Detailed job description procedure to be used in performing the above detailed work:______________________ ☐

____

____

(2) Description of the Safe Work Practices to be employed:______________________ ☐

____

(3) Results of the shock Hazard Analysis:______________________ ☐

____

(4) Determination of Shock Protection Boundaries: ______________________ ☐

____

(5) Results of the Arc Flash Hazard Analysis:______________________ ☐

____

(6) Determination of the Arc Flash Protection Boundary:______________________ ☐

____

(7) Necessary personal protective equipment to safely perform the assigned task: ______________________ ☐

____

(8) Means employed to restrict the access of unqualified persons from the work area: ______________________ ☐

____

(9) Evidence of completion of a Job Briefing including discussion of any job-related hazards: ______________________ ☐

____

(10)Do you agree the above described work can be done safely? ☐ Yes ☐ No (If *no*, return to requester)

______________________ ______________________

Electrically Qualified Person Date

______________________ ______________________

Electrically Qualified Person Date

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

______________________ ______________________

Manufacturing Manager Maintenance/Engineering Manager

______________________ ______________________

Safety Manager Electrically Knowledgeable Person

______________________ ______________________

General Manager Date

ANNEX C

JOB BRIEFING AND PLANNING CHECKLIST

JOB BRIEFING AND PLANNING CHECKLIST

Identify

- ☐ The hazards
- ☐ The voltage levels involved
- ☐ Skills required
- ☐ Any “foreign” (secondary source) voltage sources
- ☐ Any unusual work conditions
- ☐ Number of people needed to do the job
- ☐ The shock protection boundaries
- ☐ The available incident energy
- ☐ Potential for arc flash (conduct an arc flash-hazard analysis)
- ☐ Arc flash protection boundary

Ask

- ☐ Can the equipment be de-energized
- ☐ Are backfeeds of the circuits to be worked on possible
- ☐ Is a “standby person” required?

Check

- ☐ Job plans
- ☐ Single-line diagrams and vendor prints
- ☐ Status board
- ☐ Information on plant and vendor resources is up to date
- ☐ Safety procedures
- ☐ Vendor information
- ☐ Individuals are familiar with the facility

Know

- ☐ What the job is
- ☐ Who else needs to know—Communicate!
- ☐ Who is in charge

Think

- ☐ About the unexpected event… What if?
- ☐ Lock—Tag—Test—Try
- ☐ Test for voltage—FIRST
- ☐ Use the right tools and equipment, including PPE
- ☐ Install and remove grounds
- ☐ Install barriers and barricades
- ☐ What else…?

Prepare for an Emergency

- ☐ Is the standby person CPR trained?
- ☐ Is the required emergency equipment available? Where is it?
- ☐ Where is the nearest telephone?
- ☐ Where is the fire alarm?
- ☐ Is confined space rescue available?
- ☐ What is the exact work location?
- ☐ How is the equipment shut off in an emergency?
- ☐ Are the emergency telephone numbers known?
- ☐ Where is the fire extinguisher?
- ☐ Are radio communications available?

ANNEX D APPROACH BOUNDARIES

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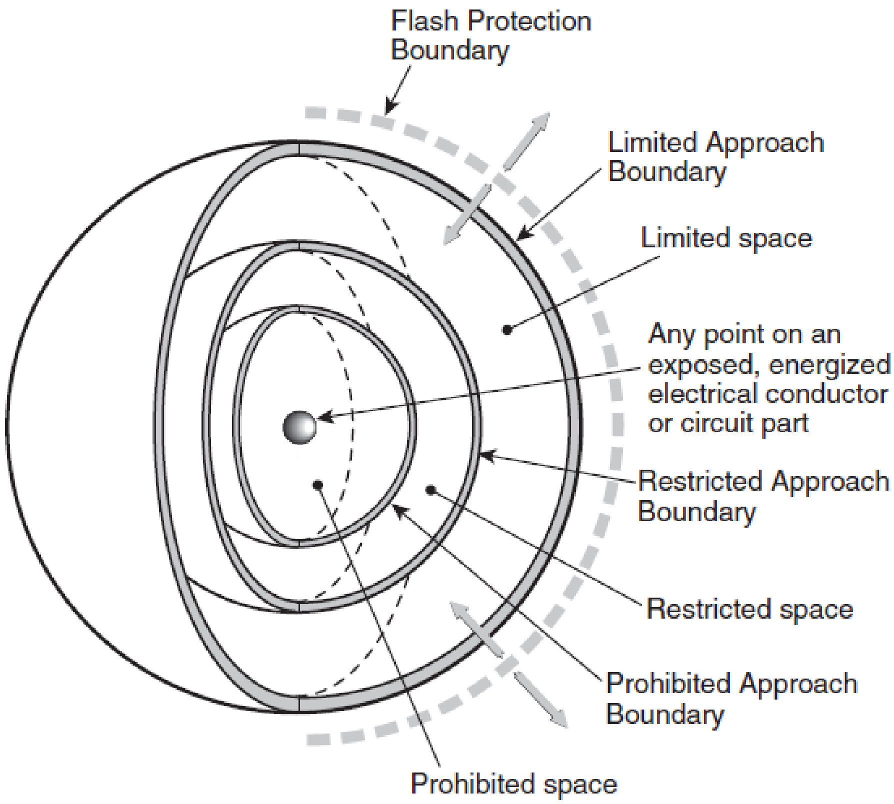

Table D-1 Approach Boundaries

Table D-1 is adapted from NFPA 70E-2009, Table 130.2 (C). Reprinted with permission from NFPA 70E-2009, *Electrical Safety in the Workplace*, copyright © 2008, National Fire Protection Association. This is not the complete and official position of the NFPA on the referenced subject, which is represented only by the Standard in its entirety.

Table D-1: Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection

Approach Boundaries				
Nominal System Voltage Range, Phase to Phase[2]	**Limited Approach Boundary[1]**		**Restricted Approach Boundary[1]; Includes Inadvertent Movement Adder**	**Prohibited Approach Boundary[1]**
	Exposed Moveable Conductor[3]	**Exposed Fixed Circuit Part**		
Less than 50	Not specified	Not specified	Not specified	Not specified
50 – 300	3.05 m (10 ft. 0 in.)	1.07 m (3 ft.6 in.)	Avoid contact	Avoid contact
301 – 750	3.05 m (10 ft. 0 in.)	1.07 m (3 ft.6 in.)	304.8 mm (1 ft. 0 in.)	25.4 mm (0 ft. 1 in.)
751 V – 15 kV	3.05 m (10 ft. 0 in.)	1.53 m (5 ft.0 in.)	660.4 mm (2 ft. 2 in.)	177.8 mm (0 ft. 7 in.)
15.1 – 36 kV	3.05 m (10 ft. 0 in.)	1.83 m (6 ft.0 in.)	787.4 mm (2 ft. 7 in.)	254 mm (0 ft. 10 in.)
36.1 – 46 kV	3.05 m (10 ft. 0 in.)	2.44 m (8 ft.0 in.)	838.2 mm (2 ft. 9 in.)	431.8 mm (1 ft. 5 in.)
46.1 – 72.5 kV	3.05 m (10 ft. 0 in.)	2.44 m (8 ft.0 in.)	1.0 m (3 ft. 3 in.)	660 mm (2 ft. 2 in.)
72.6 – 121 kV	3.25 m (10 ft. 8 in.)	2.44 m (8 ft.0 in.)	1.02 m (3 ft. 4 in.)	838 mm (2 ft. 9 in.)
138 – 145 kV	3.36 m (11 ft. 0 in.)	3.05 m (10 ft.0 in.)	1.15 m (3 ft. 10 in.)	1.02 m (3 ft. 4 in.)
161 – 169 kV	3.56 m (11 ft. 8 in.)	3.56 m (11 ft.8 in.)	1.29 m (4 ft. 3 in.)	1.14 m (3 ft. 9 in.)
230 – 242 kV	3.97 m (13 ft. 0 in.)	3.97 m (13 ft.0 in.)	1.71 m (5 ft. 8 in.)	1.57 m (5 ft. 2 in.)
345 – 362 kV	4.68 m (15 ft. 4 in.)	4.68 m (15 ft.4 in.)	2.77 m (9 ft. 2 in.)	2.79 m (8 ft. 8 in.)
500 – 550 kV	5.8 m (19 ft. 0 in.)	5.8 m (19 ft.0 in.)	3.61 m (11 ft. 10 in.)	3.54 m (11 ft. 4 in.)
765 – 800 kV	7.24 m (23 ft. 9 in.)	7.24 m (23 ft. 9 in.)	4.84 m (15 ft. 11 in.)	4.7 m (15 ft. 5 in.)

Table notes 1 – 3 refer to the original NFPA 70E-2009 document:

1. See definition in Article 100 and text in 130.2(D)(2) and Annex C for elaboration
2. For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
3. A condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

Table notes 4 – 7 are Chevron Specific Notes:

4. Affected persons, persons who are not an authorized electrical person or a qualified electrical person shall not cross the limited approach boundary. (See Section 4.3.7.)
5. Authorized electrical persons, specifically task trained, may work inside the limited approach boundary. However, in no case should an authorized electrical person be allowed to work as close to exposed energized electrical conductors or circuit parts as the restricted approach boundary allowed for a qualified electrical person. (See Section 4.3.7.)
6. Qualified electrical persons may work up to the restricted approach boundary. For a qualified electrical person to cross the restricted approach boundary he/she should follow the rules outlined in Section 4.3.7.
7. Qualified electrical persons who cross the prohibited approach boundary should follow local Business-Unit defined work procedures required to make contact with exposed energized electrical conductors or circuit parts. To cross the prohibited approach boundary is considered the same as making contact with exposed energized electrical conductors or circuit parts.

ANNEX E

FLAME RESISTANT CLOTHING REQUIREMENTS

E.1 Initiate an Arc Flash Hazard Analysis

Do an arc-flash hazard analysis before a person approaches any exposed electrical conductor or circuit part that has not been placed in an electrically safe work condition.

E.2 Determine the Arc Flash Protection Boundary

The arc flash protection boundary determined during the arc flash hazard analysis is utilized to initiate the need for personal protective equipment.

Refer to Section 130 of NFPA 70E-2009 for formulas and other information needed to establish the arc flash protection boundary. This section in NFPA 70E also contains information and recommendations that address personal protective equipment required for personnel to cross inside the arc flash protection boundary.

See the following table for default distances for the arc flash protection boundary for normal systems. This information is not from NFPA 70E, but usually represents a conservative approach if information is not available. Do not use the table for high-capacity systems (e.g., low voltage systems supplied by transformers 1500 kVA and larger, or high-voltage systems with greater than 1000 MVA short circuit capacity). The arc flash protection boundary may alternatively be calculated using information and formulas outlined in NFPA 70E-2009. The arc flash protection boundary is the distance at which the incident energy level equals 1.2 cal/cm^2.

Note *The distances given below may not be sufficient for faults at the line side of main circuit breakers that are transformer fed.*

Arc Location Relative to Equipment	System Voltage (volts)	Arc Flash Protection Boundary
Arc in Air	200 to 1000	1.22 m (4 ft)
Arc in Enclosure	200 to 1000	3.05 m (10 ft)
Arc in Enclosure	1000 and above	6.10 m (20 ft)

E.3 Calculate Arc Flash Exposure

Existing knowledge about arc flash exposure at voltage levels above 600 volts is limited. Methods of calculating the exposure, other than the equations given in NFPA 70E-2009, exist and may be used. Commercial and shareware programs are available for calculating these values. It is important to investigate the limitations of any programs to be used.

Experience suggests that the calculation of arc flash exposure above 600 volts is conservative and becomes more conservative as the voltage increases. It should be noted that all present methods of calculating incident energy and arc flash exposure at higher voltage levels have limitations.

Equations for calculating the incident energy produced by a three phase arc on systems rated 600 volts and below for an “Arc in Open Air” (E_{ma}) and an “Arc in a Cubic Box” (E_{mb} —arc flashes emanating from within switchgear, motor control centers, or other electrical equipment enclosures) may be calculated by using the formulas derived in the IEEE paper by R.L. Doughty, T.E. Neal, and H. L. Floyd, “Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 Volt Power Distribution Systems.”

Note *See Annex F for Sample Calculation of Arc Flash Protection Boundary Dc, Arc in Open Air* E_{ma}*, and Arc in Cubic Box* E_{mb} *using the Doughty, et al, equations.*

E.4 Determine PPE Requirements

Flame Resistant (FR) Clothing and Personal Protective Equipment (PPE) is used by the employee based upon the incident energy exposure associated with the specific task. As an alternative, the PPE requirements outlined in NFPA 70E-2009, 130.7 (C)(9)) may be used.

The above table may be accessed by downloading the NFPA 70E standard from the link given in Section 6.0.

Add the following Chevron notes to NFPA 70E-2009, Table 130.7(C)(9):

To "General Notes" add Note (g):

(g) (Chevron-specific note) For the items "Perform infrared thermography or other noncontact inspection outside the restricted approach boundary" above, the intent is that the worker shall never encroach within the restricted approach boundary while doing inspections to avoid a shock hazard.

To "Specific Notes" add Note 5:

5. (Chevron-specific note, as applied to the section on "Arc-Resistant Switchgear Type 1 or 2 (for clearing times of <0.5 sec with a prospective fault current not to exceed the arc resistant rating of the equipment)") Properly applied switchgear specified to IEC 62271-200, Annex A, internal arc containment (IAC), can also have work tasks conducted in accordance with this section of the table.

For additional information refer to Tables E-1 (NFPA 70E, Table 130.7 (C)(10)), E-2 (NFPA 70E, Table 130.7 (C)(11)), and E-3 (NFPA 70E, Table H.1).

The notes following each of the tables, outlining details and limitations, shall be adhered to.

Tables 130.7(C)(10) (shown in Table E-1), 130.7(C)(11) (shown in Table E-2) and H.1 (shown in Table E-3) were reproduced with permission from NFPA 70E®, *Electrical Safety in the Workplace*, Copyright © 2008, National Fire Protection Association. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety.

Table E-1: Protective Clothing and Personal Protective Equipment (PPE) (1 of 2)

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 0	
Protective Clothing, Nonmelting (according to ASTM F1506-00) or Untreated Natural Fiber	Shirt (long sleeve) Pants (long)
FR Protective Equipment	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 1	
FR Clothing, Minimum Arc Rating of 4 (Note 1)	Arc-rated long-sleeve shirt (Note 3) Arc-rated pants (Note 3) Arc-rated coverall (Note 4) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)
Hazard/Risk Category 2	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 2*	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated face shield or arc flash suit hood (Note 10) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes

Table E-1: Protective Clothing and Personal Protective Equipment (PPE) (2 of 2)

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 3	
FR Clothing, Minimum Arc Rating of 25 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 8) Arc-rated pants (AR) (Note 8) Arc-rated coverall (AR) (Note 8) Arc-rated arc flash suit jacket (AR) (Note 8) Arc-rated arc flash suit pants (AR) (Note 8) Arc-rated arc flash suit hood (AR) (Note 8) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes
Hazard/Risk Category 4	
FR Clothing, Minimum Arc Rating of 40 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9) Arc-rated coverall (AR) (Note 9) Arc-rated arc flash suit jacket (AR) (Note 9) Arc-rated arc flash suit pants (AR) (Note 9) Arc-rated arc flash suit hood (AR) (Note 9) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes

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

Notes:

1. See Table 130.7(c)(11). Arc rating for a garment or system of garments is expressed in cal/cm^2
2. If rubber insulating gloves with leather protectors are required by Table 130.7(c)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
3. The FR shirt and pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 4.
4. Alternate is to use FR coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
5. FR shirt and FR pants used for Hazard/Risk Category 2 shall have minimum arc rating of 8.
6. Alternate is to use FR coveralls (minimum arc rating of 8) instead of FR shirt and FR pants.
7. A face shield with a minimum arc rating of 4 for Hazard/Risk Category 1 or a minimum arc rating of 8 for Hazard/Risk Category 2, with wrap-around guarding to protect not only the face, but also the forehead, ears and neck (or, alternatively, an arc-rated arc flash suit hood), is required.
8. An alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk Category 3.
9. The total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.
10. Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas.

Table E-2: Protective Clothing Characteristics

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

Note:

Arc Rating is defined in Article 100 and can be either ATPV or E_{BT}. ATPV is defined in ASTM F 1959, "Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing," as the incident energy on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn based on the Stoll curve, cal/cm^2. E_{BT} is defined in ASTM F 1959 as the incident energy on a material or material system that results in a 50% probability of breakopen. Arc rating is reported as either ATPV or E_{BT}, whichever is the lower value.

Table E-3: Simplified Two-Category, Flame-Resistant Clothing System

The following quote and table are extracted from NFPA 70E-2009, Table H-1:

"The use of Table H-1 [numbered as Table E-3, below] is suggested as a simplified approach to provide minimum personal protective equipment for electrical workers within facilities with large and diverse electrical systems. The clothing listed in Table F-1 fulfills the minimum FR clothing requirements of Tables 130.7(C)(9) and 130.7(C)(10). The clothing systems listed in this table should be used with the other PPE appropriate for the Hazard/ Risk Category. See Table 130.7(C)(10). The notes at the bottom of Table 130.7(C)(9) must apply as shown in that table."

Clothing[a]	Applicable Tasks
Everyday Work Clothing: FR long-sleeve shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8).	All Hazard/Risk Category 1, 2, and 2* tasks listed in Table 130.7(C)(9)[b].
Arc Flash Suit: A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	All Hazard/Risk Category 3 and 4 tasks listed in Table 130.7(C)(9)[b].

a. Note other PPE required for the specific tasks listed in Tables 130.7(C)(9) and 130.7(C)(10), which includes arc-rated face shields or arc flash suit hoods, FR hardhat liners, safety glasses or safety goggles, hard hat, hearing protection, leather gloves, voltage-rated gloves, and voltage-rated tools. Arc rating for a garment is expressed in cal/cm^2.

b. The assumed short-circuit current capacities and fault clearing times for various tasks are listed in the text and notes to Table 130.7(C)(9). For tasks not listed, or for power systems with greater than the assumed short-circuit capacity or with longer than the assumed fault clearing times, an arc flash hazard analysis is required in accordance with 130.3.

Tables E-4 and E-5, Guidelines for the Use of Hazard/Risk Category (HRC) 2 and HRC 4 Personal Protective Equipment

The following is extracted from NFPA 70E-2009, Annex Section D.9:

"The following tables can be used to determine the suitability of Hazard/Risk Category (HRC) 2 and HRC 4 personal protective equipment on systems rated up to 15 kV, line-to-line. See NFPA 70E, Tables D.9.1 and D.9.2 [Tables E-4 and E-5, below] for recommended limitations of system three-phase short circuit currents for the listed fault-clearing times. The limitations listed below are based on IEEE Std 1584-2002 calculation methods."

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Table E-4: (Table D.9.1 of NFPA 70E) Low-Voltage Systems—Maximum Three-Phase Bolted-Fault Current Limits (in kiloamperes), at Various System Voltages and Fault-Clearing Times of Circuit Breakers, for the Recommended Use of Hazard / Risk Category (HRC) 2 and HRC 4 Personal Protective Equipment in an "Arc in a Box" Situation (see Notes below). (1 of 2)

System Voltage (volts, phase-to-phase)	Upstream Protection Fault-Clearing Time (seconds)	Maximum Three-Phase Bolted-Fault Current for use of HRC 2 PPE (8 cal/cm^2)	Maximum Three-Phase Bolted-Fault Current for use of HRC 4 PPE (40 cal/cm^2)
690	0.05	39kA	180 kA
	0.10	20 kA	93 kA
	0.20	10 kA	48 kA
	0.33	NR	29 kA
	0.50	NR	20 kA
600	0.05	48 kA	200 kA*
	0.10	24 kA	122 kA
	0.20	12 kA	60 kA
	0.33	NR	36 kA
	0.50	NR	24 kA
480	0.05	68 kA	200 kA*
	0.10	32 kA	183 kA
	0.20	15 kA	86 kA
	0.33	8 kA	50 kA
	0.50	NR	32 kA
400	0.05	87 kA	200 kA*
	0.10	39 kA	200 kA*
	0.20	18 kA	113 kA
	0.33	10 kA	64 kA
	0.50	NR	39 kA
208	0.05	200 kA*	Not applicable
	0.10	104 kA	200 kA*

Table E-4: (Table D.9.1 of NFPA 70E) Low-Voltage Systems—Maximum Three-Phase Bolted-Fault Current Limits (in kiloamperes), at Various System Voltages and Fault-Clearing Times of Circuit Breakers, for the Recommended Use of Hazard / Risk Category (HRC) 2 and HRC 4 Personal Protective Equipment in an "Arc in a Box" Situation (see Notes below). (2 of 2)

Notes:
1. Three-phase "Bolted Fault" value is at the terminals of the equipment on which work is to be done.
2. "Upstream Protection Fault-Clearing Time" is normally the "short-time delay" setting on the trip unit of the low-voltage power circuit breaker upstream of the equipment on which work is to be done.
3. For application of this table, the recommended maximum setting (pick-up) of either the instantaneous or short-delay protection of the circuit breaker's trip unit is 30% of the actual available three-phase bolted fault current at the specific work location
4. Working distance for the above arc-flash exposures is assumed to be 455 mm (18 in.)
5. Flash Protection Boundary (threshold distance for a second-degree skin burn) is 1.7 m (6 ft.) for HRC 2 and 4.9 m (16 ft.) for HRC 4. PPE is required for all personnel working within the Flash Protection Boundary.
6. Instantaneous circuit breaker trip unit(s) have no intentional time delay, and the circuit breaker will clear the fault within 0.050 sec of initiation. Application of circuit breakers with faster clearing times or the use of current-limiting circuit breakers or fuses should permit the use of HRC 2 and HRC 4 PPE at greater fault currents than listed.
7. Systems are assumed to be resistance grounded, except for 208V (solidly grounded system). This assumption results in conservative application if the table is used on a solidly grounded system since the incident energy on a solidly grounded system is lower for the same bolted fault current availability.

(*) maximum equipment short-circuit current rating available

"NR" Not Recommended

Table E-5: (Table D.9.2 of NFPA 70E) High-Voltage Systems—Maximum Three-Phase Bolted-Fault Current Limits (in kiloamperes), at Various System Voltages and Fault-Clearing Times of Circuit Breakers, for the Recommended Use of Hazard / Risk Category (HRC) 2 and HRC 4 Personal Protective Equipment in an "Arc in a Box" Situation (see Notes below).

System Voltage (volts, phase-to-phase)	Upstream Protection Fault-Clearing Time (seconds)	Maximum Three-Phase Bolted-Fault Current for use of HRC 2 PPE (8 cal/cm^2)	Maximum Three-Phase Bolted-Fault Current for use of HRC 4 PPE (40 cal/cm^2)
15 kV Class and 12 kV Class	0.10	45 kA	63 kA*(11.4 cal/cm^2)
	0.35	13 kA	63 kA
	0.70	7 kA	32 kA
	1.0	5 KA	23 kA
5 kV Class	0.10	50 kA	63 kA* (10 cal/cm^2)
	0.35	15 kA	63 kA*(35 cal/cm^2)
	0.70	8 kA	37 kA
	1.0	5 kA	26 kA

Notes:
1. "Upstream Protection Fault-Clearing Time" is the protective relaying operating time at 90% of the actual available three-phase bolted fault current at the specific work location (the time for the output contact operating the trip coil of the circuit breaker to be closed), plus the circuit breaker operating time (upstream of the equipment on which work is to be done).
2. Working distance for the above arc-flash exposures is assumed to be 0.92 m (3 ft.).
3. Systems are assumed to be resistance grounded. This assumption results in conservative application if the table is used on a solidly grounded system, since the incident energy on a solidly grounded system is lower.
4. The cal/cm^2 in parentheses in the last column are calculated at the maximum equipment short-circuit current ratings available.

(*) Maximum equipment short-circuit current rating available.

ANNEX F

SIMPLE CALCULATION OF ARC FLASH PROTECTION BOUNDARY D_c, ARC IN OPEN AIR E_{ma}, AND ARC IN CUBIC BOX E_{mb}

Note *D_c = distance in feet of person from arc source for a just curable burn*

For systems that operate at 600 volts and below, the arc flash protection boundary is 4.0 feet, based on the product of clearing times of 2 cycles (0.033 second) and the available fault bolted current of 50 kA or any combination not to exceed 100 kA cycles (1667 ampere seconds).

At voltage levels above 600 volts, the arc flash protection boundary is the distance at which the incident energy level equals 5 J/cm^2 (1.2 cal/cm^2).

The arc flash protection boundary can alternatively be calculated as shown below.

F.1 Sample Calculation—Arc Flash Protection Boundary D_c (just curable burn distance)

1. Calculation is on a 4,160-volt bus.
2. Transformer MVA (and base MVA) = 10 MVA.
3. Transformer impedance on 10 MVA base = 5.5%.
4. Circuit breaker clearing time = 6 cycles.

Note *Required formulas are located in NFPA 70E-2009, Annex D.*

Calculate the short-circuit current:

I_{sc} = $[\text{MVA Base} \times 10^6] / [1.732 \times V]\} \times \{100 / \%Z\}$

= $\{[10 \times 10^6] / [1.732 \times 4,160]\} \times \{100 / 5.5\}$

= 25,000

Calculate the power in the arc:

$P = 1.732 \times V \times I_{sc} \times 10^{-6} \times 0.707^2$

$P = 1.732 \times 4,160 \times 25,000 \times 10^{-6} \times 0.707^2$

P = 90 MW

Calculate the curable burn distance D_c

$D_c = \{ 2.65 \times [1.732 \times V \times I_{sc} \times 10^{-6}] \times t\}^{1/2}$

$D_c = \{ 2.65 \times [1.732 \times 4,160 \times 25,000 \times 10^{-6}] \times 0.1\}^{1/2}$

= 6.9 or 7 feet

Or, calculate the curable burn distance D_c using an alternative method:

$D_c = [53 \times MVA_{txmr} \times t]^{1/2}$

$D_c = [53 \times 10 \times 0.1]^{1/2} = 7.28$ feet

F.2 Sample Calculation—Arc in Open Air E_{ma}

Incident Energy produced by a three-phase arc on systems rated 600 volts and below:

Calculate Maximum open arc incident energy E_{ma}

E_{ma} = $(5271)(D_A)^{-1.9593}(t_A)[0.0016(I_{sc})^2 - 0.0076(I_{sc}) + 0.8938] = E_{ma}$ in cal/cm^2

E_{ma} = maximum open arc incident energy, cal/cm^2

D_A = distance from arc electrodes, inches (for distances 18 inches and greater)

t_A = arc duration, seconds

I_{sc} = bolted fault short circuit current, kA (for the range of 16 to 50 kA)

For I_{sc} = 25 kA, t_A = 0.1 seconds, D_A = 24 inches

E_{ma} = $(5271)(24)^{-1.9593}(0.1)[0.0016(25)^2 - 0.0076(25) + 0.8938] = 1.8$ cal/cm^2

Note *This would require a Category 0 PPE system*

For I_{sc} = 50 kA, t_A = 0.1 seconds, D_A = 24 inches

E_{ma} = $(5271)(24)^{-1.9593}(0.1)[0.0016(50)^2 - 0.0076(50) + 0.8938] = 4.7$ cal/cm^2

Note *This would require a Category 2 PPE system, since 4 cal/cm^2 is exceeded.*

F.3 Sample Calculation—Arc in Cubic Box E_{mb}

Incident Energy produced by a three-phase arc on systems rated 600 volts and below:

Calculate Maximum arc in cubic box incident energy E_{mb}

E_{mb} = $(1038.7)(D_B)^{-1.4738}(t_A)[0.0093(I_{sc})^2 - 0.3453(I_{sc}) + 5.9675] = E_{mb}$ in cal/cm^2

E_{mb} = maximum 20 in. cubic box incident energy, cal/cm^2

D_B = distance from arc electrodes, inches (for distances 18 inches and greater)

t_A = arc duration, seconds

I_{sc} = bolted fault short circuit current, kA (for the range of 16 to 50 kA)

For I_{sc} = 25 kA, t_A = 0.1 seconds, D_B = 24 inches

E_{mb} = $(1038.7)(24)^{-1.4738}(0.1)[0.0093(25)^2 - 0.3453(25) + 5.9675] = 3.0$ cal/cm^2

This would require a Category 1 PPE system.

For I_{sc} = 50 kA, t_A = 0.1 seconds, D_B = 24 inches

E_{mb} = $(1038.7)(24)^{-1.4738}(0.1)[0.0093(50)^2 - 0.3453(50) + 5.9675] = 11.5$ cal/cm^2

Note *This would require a Category 3 PPE system.*

F.4 Sample Calculation—Arc in Cubic Box E_{mb} 480 volt motor starter "bucket" with upstream protection time of 0.18 second

Incident Energy produced by a three-phase arc on systems rated 600 volts and below:

Calculate Maximum arc in cubic box incident energy E_{mb}

E_{mb} = $(1038.7)(D_B)^{-1.4738}(t_A)[0.0093(I_{sc})^2 - 0.3453(I_{sc}) + 5.9675] = E_{mb}$ in cal/cm^2

For I_{sc} = 24 kA, t_A = 0.18 seconds, D_B = 18 inches

E_{mb} = $(1038.7)(18)^{-1.4738}(0.18)[0.0093(24)^2 - 0.3453(24) + 5.9675]$ = 8.0 cal/cm^2

Note *This would require a Category 2 PPE system.*

F.5 Sample Calculation — Arc in Cubic Box E_{mb} 480 volt motor starter “bucket” with upstream protection time of 0.10 second

Incident Energy produced by a three-phase arc on systems rated 600 volts and below:

Calculate Maximum arc in cubic box incident energy E_{mb}

E_{mb} = $(1038.7)(D_B)^{-1.4738}(t_A)[0.0093(I_{sc})^2 - 0.3453(I_{sc}) + 5.9675] = E_{mb}$ in cal/cm^2

For I_{sc} = 35 kA, t_A = 0.10 seconds, D_B = 18 inches

E_{mb} = $(1038.7)(18)^{-1.4738}(0.10)[0.0093(35)^2 - 0.3453(35) + 5.9675]$ = 7.7 cal/cm^2

Note *This would require a Category 2 PPE system.*

ANNEX G

RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

Item	Manufacturer and Model No. (Note 6)	Available Sizes	Color
Clothing (Notes 1 and 2)			
Men's Coveralls 7.0 oz Indura Ultra Soft® (Arc rating 8.7)	Workrite, 131UT70	Chest sizes 38 – 54 Length: Regular or Long	Khaki, Navy, Royal, Red
Men's Coveralls 9.5 oz Indura® (Arc rating 10.8)	Workrite, 131ID95	Chest sizes 38 – 56 Length: Regular or Long	Khaki, Medium Gray, Navy, Orange, Royal
Men's Coveralls 6.5 oz Protera™ (Arc Rating 8.5)	Workrite, 133PO65	Chest sizes S – 3XL Length: Regular or Long	Medium Blue, Khaki
Deluxe Contractor Coverall 7 oz CoolTouch® 2 (Arc rating 8.4)	Bulwark, CMD6	Chest sizes 38 – 58 Length: Regular or Long	Khaki, Navy
Women's Coveralls 7.0 oz. Indura Ultra Soft® (Arc rating 8.7)	Workrite, 119UT70	Sizes S – XXL Length: Average or Tall	Navy
Women's Coveralls 9.5oz. Indura® (Arc rating 10.8)	Workrite, 119ID95	Sizes S – XXL Length: Average or Tall	Navy, Royal
Insulated Coveralls, 11 oz Ultra Soft® Brown Duck outershell and 10 oz Moda-Quilt insulation (Arc rating 47)	Workrite, 590UT11	Sizes S – XXL Length: Regular or Long	Brown
Insulated Hood 8.5 oz Epic Ultra Soft® shell fabric and 10 oz. Moda-Quilt® insulation (Arc Rating 36.7)	Workrite, 577EC85	One size	Navy
Men's Western Style Shirt (long sleeve), 9.5 oz. Indura® (Arc Rating 10.2)	Workrite, 228ID95	Lengths: Short, Regular, Long Chest sizes S – XXL	Khaki, Navy, Red
Men's Work Shirt 7.0 oz. Indura Ultra Soft® (Arc rating 8.7)	Workrite, 231UT70	Lengths: Regular, Long Chest sizes S – XXL	Charc. Gray, Khaki, Medium Blue, Navy, Royal, Silver Gray, Orange
Men's Dress Shirt 7.0 oz Indura Ultra Soft® (Arc rating 8.7)	Workrite, 258UT70	Lengths: Regular, Long Chest sizes S – XXL	Khaki, Medium Blue

Item	Manufacturer and Model No. (Note 6)	Available Sizes	Color
Men's/Women's Dress Uniform Shirt Cool Touch® 2, 7.0 oz (Arc rating 8.4)	Bulwark, SMU2/3	Lengths: Regular, Long Sizes S – 3XL	Khaki, Light Blue, Navy
Men's Work Shirt (long sleeve) 6.5 oz Protera™ (Arc Rating 8.5)	Workrite, 235PO65	Lengths: Regular, Long Chest sizes S – XXL	Medium Blue, Khaki
Women's Utility Shirt (long sleeve) 7.0 oz Indura Ultra Soft® (Arc rating 8.7)	Workrite, 291UT70	Sizes S – XXL	Khaki, Medium Blue, Navy
Men's Jean-cut Denim Pants 9.5 oz Indura® (Arc Rating 10.8)	Workrite, 418ID95	Waist 28 – 50 Inseam to 36	Navy, Red
Men's Relaxed-fit Jean 12 oz Indura® (Arc Rating 14.4)	Workrite, 428ID12	Waist 28 – 50 Inseam to 36	Denim
Men's Double Knee Pant 8 oz Ultra Soft® Basket Weave. (Arc Rating 9.8)	Workrite, 416UT80	Waist 28 – 50 Inseam to 36	Navy
Men's Work Pant 8 oz Protera™ (Arc Rating 12.3)	Workrite, 433PO80	Waist 28 – 50 Inseam to 36	Navy
Cargo Pants 9.5 oz Ultra Soft® (Arc Rating 10.8)	Workrite, 434UT95	Waist 28 – 50 Inseam to 36	Khaki
Women's Denim Jean Pant 14 oz Indura® (Arc Rating 18.3)	Workrite, 419ID14	Sizes 4 – 24 Inseam to 34	Denim
Women's Industrial Pants 9.5 oz Indura Ultra Soft® (Arc rating 12.4)	Workrite, 409UT95	Sizes 4 – 24 Inseam to 34	Navy
Women's Industrial Pants 9.5 oz Indura® (Arc rating 10.8)	Workrite, 409ID95	Sizes 4 – 24 Inseam to 34	Navy
Sock Hood (Balaclava) Two-ply, 6 oz Nomex® IIIA (Arc rating – not tested)	Workrite, 574NX60	One size fits all	Natural
Hard Hat Liner 6 oz Nomex® IIIA outershell fabric and 9 oz Nomex batt insulation (Arc rating 54.7 E_{BT})	Workrite, 570NX60	One size fits all: Fits in any standard hard hat. Snaps onto collar of Bomber Jacket, Field Coat, Parka or Insulated Coverall	Black

Item	Manufacturer and Model No. (Note 6)	Available Sizes	Color
Kevlar® Gloves			
Ansell Cut-Resistant Gloves (Golden Needles Line)	Ansell Pn# 70225 L, M, or S. The above, and many other cut-resistant Kevlar® gloves, are available through many internet sites	Large, Medium and Small	N/A
Safety Labels			
Danger – Arc Flash Hazard labels. Word Message: “Arc Flash Hazard. Follow requirements in NFPA 70E for safe work practices and appropriate PPE. Failure to comply can result in death or injury.”	Safety Label Solutions (SLS) C8002-42DHYD (Roll of 500)	(All types of labels available, including custom label wording) Size: 2” X 4”	N/A
Electrical Testers			
1000V – Voltage, Continuity and Current Tester	Fluke T5-1000 (available though many sources)	N/A	N/A
High-voltage testers	HD Electric “MARK” series (phase-to-phase) or “EM” models (phase to ground)	MARK: to 75 kV EM: to 25 kV	N/A
Cable Piercing Tool			
Manual, hot-stick operated	Hubbell/Chance Catalog No. T6002233	Spiked Set with Ground Rod	N/A
Hydraulic operated	Salisbury Model 24321	Hydraulic Cable Spike with piercing tip assy., 1.12" Aluminum C-clamp, and 8 ft. of 4/0 AWG cable (6 to 10 ft length available)	N/A
Insulated Rescue Hook			
Fiberglass pole	Salisbury Model 24401	Insulated rescue hook, 6 ft long (2 to 8 ft length available)	N/A
Rainwear			
PVC on a 1.6 oz Nomex/ Kevlar Blend. (Note 4)	Nasco, ArcLite™ 1000 Series (1103JBO for jacket, 1101TBO for overall)	Small – 5X Large (contact Nasco for sizing)	Burnt Orange
PVC on a 2.7 oz Nomex/ Kevlar Blend. (Note 4)	Nasco, ArcTuff™ 2000 Series	Small – 5X Large (contact Nasco for sizing)	Yellow, Fluorescent Orange

Item	Manufacturer and Model No. (Note 6)	Available Sizes	Color
Arc Flash Suit (Rated 49 cal/cm^2)			
ARC40™ Flash Jacket Multiple layer	Oberon, ARC40-CT-S-xxx	xxx = L (42-44), XL (46-48), 2XL (50-52), 3XL (54-56), 4XL (58-60), 5XL (62-64)	Green
ARC40™ Flash Bib Overalls (pants). Multiple Layer	Oberon, ARC40-BIB-S	xxx = L (36-38), XL (40-42), 2XL (44-46), 3XL (48-50), 4XL (52-54), 5XL (56-58)	Green
Note: Arc flash suits and hoods rated 25 cal/cm^2, 65 cal/cm^2, and 100 cal/cm^2, and 140 cal/cm^2 are also available from Oberon. See the Oberon website/catalog.			
Faceshield (for up to 12 cal/cm^2 exposure—i.e., Hazard/Risk Category 2)			
Oberon ArcFlash Faceshield - 12cal ATPV - Deluxe Model w/ Hard Cap and NRR22 Ear Muffs.	Oberon, 21ARC12AF-C+M22		Slight yellow tint
Arc Flash Hood			
ARC40™ Multiple-Layer Flash Hood – 7 x 13 inches, dual-layer Arc-X™ Resin with polycarbonate insert 0.080 inch thick window, with anti-fog coating. Rated 49 cal/cm^2	Oberon, ARC40-C	For use with integral Hard Cap (supplied)	Green tint window
Replacement Window for Hood, with anti-fog coating – Arc-X™ Resin with polycarbonate insert 0.080 inch thick window	Oberon, ARC40-AFH	N/A	Green tint
Hand Protection – Voltage-Rated Gloves			
Low-Voltage Rubber Gloves, Class 00 (500 VAC, 750 VDC), 11 inches	Salisbury, E0011xx/y (“xx” is the type/color “y” is the glove size)	7 – 12	R=red, B=black, Type I Natural Rubber; BL=blue BLO=blue in, orange out Type II SALCOR®
Low-Voltage Rubber Gloves, Class 0 (1000 VAC), 11 inches	Salisbury, E011xx/y (“xx” is the type/color “y” is the glove size)	7 – 12	R=red, B=black, Y=yellow, BY=black in, yellow out Type I Natural Rubber; BL=blue BLO=blue in, orange out Type II SALCOR®
Leather Protectors for Class 00 and 0 Rubber Gloves, 10 inches	Salisbury, ILP10 (elastic back) or ILP10A (pull strap)	7 – 12	N/A

Item	Manufacturer and Model No. (Note 6)	Available Sizes	Color
Glove Bag for Low-Voltage 11-inch Gloves	Salisbury, GB112	N/A	N/A
High-Voltage Rubber Gloves, Class 2 (17,000 VAC), 14 inches. (Note 5)	Salisbury, E214xxyy/z (“xx” is the cuff type “yy” is the type/color “z” is the glove size)	7 – 12 FC=flare cuff, BC=bell cuff, C=contour cuff	B=black, YB=Y inside, B out, RB=R inside, B out Type I Natural Rubber
Leather Protectors (for Class 2 Rubber Gloves), 12 inches	Salisbury, ILP3S	7 – 12	N/A
Glove Bag for High-Voltage 14-inch Gloves	Salisbury, GB114	N/A	N/A
Glove Liners for use with all rubber gloves under various weather conditions (cotton, fleece, wool, and thermal)	Salisbury (see Salisbury catalog)	One size fits all	N/A

Notes:

1. Other women's workwear is available for maternity wear; contact Workrite.
2. The clothing listed is not all-inclusive and the listing is representative of clothing that can be used to satisfy the “Hazard/Risk Category” (HRC 2) NFPA 70E-2009 requirements of at least 8 cal/cm^2 as “everyday work clothing.” Note that the following fabrics have an arc rating of at least 8 cal/cm^2: 7 oz CoolTouch® 2, 9.5 oz Indura®, 7.0 oz Indura Ultra Soft®, and 6.5 oz Protera™. Other FR fabrics may exist or may be developed in the future that will satisfy an arc rating of at least 8 cal/cm^2.
3. This garment qualifies as “2 layers” of FR clothing. A cost-effective “Hazard/Risk Category 4” FR clothing system could include this garment worn over at least 4.5 oz Nomex coveralls (arc rating of at least 4 cal/cm^2) and non-melting or untreated natural fiber shirt underlayers, and worn with an arc-rated arc flash suit hood.
4. A cost-effective “Hazard/Risk Category 4” FR clothing system could include this garment worn over at least 4.5 oz Nomex fabric (arc rating of at least 4 cal/cm^2), worn over non-melting or untreated natural fiber fabric, and worn with an appropriately rated switching hood. The burnt-orange ArcLite™/Nomex layered system has been tested and met an ATPV of 40.
5. Where more than one “high voltage” level exists at a facility (e.g., 4.16 kV and 13.8 kV), recommend keeping only the highest “Class” of high voltage glove available for use.
6. Personal protective equipment is evolving and catalog numbers change often. Contact the following companies to obtain current information. Company addresses, phone numbers, and website links:

Bulwark®
545 Marriott Drive
Nashville, TN 37214
(615) 565-5000 or (800) 223-3372
(United States and Canada: call toll free)
http://www.bulwark.com/

Fluke Corporation
P.O. Box 9090
6920 Seaway Blvd.
Everett, Washington, 98206-9090
(425) 347-6100 or (800) 443-5853
http://us.fluke.com/usen/Products/default.htm

HD Electric Company
1475 Lakeside Drive
Waukegan, IL 60085
(847) 473-4980
http://www.hdelectriccompany.com/

Hubbell/Chance
210 North Allen Street
Centralia, MO 65240-1395
http://www.hubbellpowersystems.com/

Nasco, Inc.
3 NE Twenty-First Street
P.O. Box 427
Washington, IN 47501
(812) 254-7393 or (800) 767-4288
(United States and Canada: call toll free)
http://www.nascoinc.com

Oberon Company
22 Logan Street
New Bedford, MA 02740
(508) 999-4442 or (800) 322-3348
http://www.oberoncompany.com

Item	Manufacturer and Model No. (Note 6)	Available Sizes	Color
Safety Label Solutions (SLS) (800) 226-0642 http://www.safetylabelsolutions.com W. H. Salisbury & Company 7520 N. Long Avenue P.O. Box 1060 Skokie, IL 60077 (847) 679-6700 http://www.whsalisbury.com/		Workrite® 500 East Third Street P.O. Box 1192 Oxnard, CA 93032-1192 (805) 483-0175 or (800) 521-1888 (United States and Canada: call toll free) http://www.workrite.com/	

ANNEX H

PROTECTIVE GROUND CABLE, FERRULE, AND ASSEMBLY RATINGS

Adapted from ASTM F 855-04, Table 2, with added metric data in first column.

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Calculated Short Circuit Properties[ab] — Symmetrical kA RMS 60 HZ							
Copper Grounding Cable Size, AWG (equivalent "nominal" metric size in mm²)[c,d]	Withstand Rating[e]		Ultimate Capacity[e,f,g]				Continuous Current Rating, Amperes RMS 60 Hz
	15 cycles (250 ms)	30 cycles (500 ms)	6 cycles (100 ms)	15 cycles (250 ms)	30 cycles (500 ms)	60 cycles (1 s)	
#2 (35)	14	10	28	18	13	9	200
1/0 (50)	21	15	47	29	21	14	250
2/0 (70)	27	20	59	37	26	18	300
3/0 (95)	34	25	74	47	33	23	350
4/0 (–)	43	30	94	59	42	29	400
250 MCM (120)	54	39	111	70	49	35	450
350 MCM (185)	74	54	155	98	69	49	550

a. The table provides guidance only. If the short circuit current is highly asymmetrical, as it could be near a substation transformer or a generator above a rating of approximately 1000 kVA, the short-circuit "ultimate capacity" is less than listed above. Refer to ASTM F 855 for details.

b. Withstand and ultimate short circuit properties are based on performance with surges not exceeding 20% asymmetry factor.

c. The nominal metric sizes listed in parentheses in the first column are approximate and for information only, and will have slightly different short circuit properties than the AWG sized conductors.

d. Grounding cables are commercially available only up to size 4/0 AWG. Larger sized conductors are difficult to manipulate.

e. The following terminology is defined in ASTM F 855:
"Ultimate capacity—this represents a current which it is calculated the component is capable of conducting for the specified time. It is expected that component damage may result. The component shall not be reused, except in test situations."
"Withstand rating—this represents a near symmetrical current which shall be conducted without any component being damaged sufficiently to prevent being operable and reusable. The protective ground shall be capable of passing a second test at this current after being cooled to ambient temperature."

f. Ultimate rating represents a symmetrical current which the ferule shall carry for the time specified.

g. Ultimate value based on application of Onderdonk's equation to 98% of nominal circular mil area.

ANNEX I INSPECTION OF INSULATING RUBBER GLOVES, SLEEVES, AND BLANKETS

I.1 Testing and Inspection of Insulating Rubber Gloves, Sleeves, and Blankets

Gloves or sleeves that have been electrically tested but not issued for service shall not be placed into service unless they have been electrically tested within the previous twelve months.

I.1.1 Insulating Gloves

Rubber insulating gloves shall be carefully inspected before and after each use. Rubber gloves shall be field air-tested before use each day and more frequently if there is cause to suspect any damage. See one technique illustrated below. The gloves shall be inspected inside and out. Gloves should always be stored with the bead on the outside and never inside out. Gloves should be stored in a glove bag, while sleeves should be stored in a bag or roll-up to protect against mechanical and chemical damage. The ASTM Standard F 496 requires that the electrical retest interval not exceed six months from date of issue for gloves.

I.1.2 Insulating Sleeves

When inspecting sleeves, the entire inner and outer surface of the sleeves should be examined to locate pinholes, cuts, scratches, abrasions, aging, corona cutting, oil markings or other mechanical injuries. Stretching or rolling the rubber between the fingers, or on a flat surface, will aid in revealing defects. If any of the above defects are found, the sleeves should be tagged and withdrawn from service. The ASTM Standard F 496 requires that the electrical retest interval not exceed twelve months from date of issue for sleeves.

I.1.3 Insulating Blankets

When inspecting blankets, the entire surface of both sides of the blanket should be examined to locate pinholes, cuts, scratches, abrasions, aging, corona cutting, oil markings or other mechanical injuries. Stretching or rolling the rubber from corner to corner, or on a flat surface, will aid in revealing defects. If any of the above defects are found, the blanket should be tagged and withdrawn from service. The ASTM Standard F 479 requires that the electrical retest interval not exceed twelve months from date of issue.

I.1.4 Contact with Petroleum-Based Products

If contact has been made with any petroleum-based products, such as inhibitors, hydraulic fluids and transformer oils, the gloves or sleeves should be wiped clean with a rag as soon after the contact as possible. Failure to remove the petroleum-based product promptly will result in the rubber swelling and ultimately deteriorating. The swelling will eventually disappear but it may result in a considerable reduction of mechanical strength and deteriorating of insulating capability at the point where swelling occurred.

I.2 Test Procedure for Inspection of Insulating Rubber Gloves

Inspect insulating rubber gloves and air test the gloves daily, before use, and any other time when it could be reasonably suspected that damage has occurred.

The following procedure outlines the air test:

1. Hold each glove with the thumb and forefingers as illustrated.

2. Twirl the glove around quickly to fill with air.

3. Trap the air by squeezing the gauntlet with one hand. Use the other hand to squeeze the palm, fingers and thumb while looking for weaknesses or defects.

4. Hold the glove to the face to detect air leakage or hold it to the ear and listen for escaping air.

5. Remove insulating gloves suspected of being defective from service immediately and return the gloves for testing.

ANNEX J

ELECTRICAL SAFETY PRINCIPLES

My Electrical Safety Principles:

- Plan Every Job
- Anticipate Unexpected Events
- Use the Right Tool for the Job
- Use Procedures as Tools
- Isolate the Equipment
- Identify the Hazard
- Minimize the Hazard
- Protect the Person
- Assess People's Abilities
- Audit These Principles

"Test Before Touch"

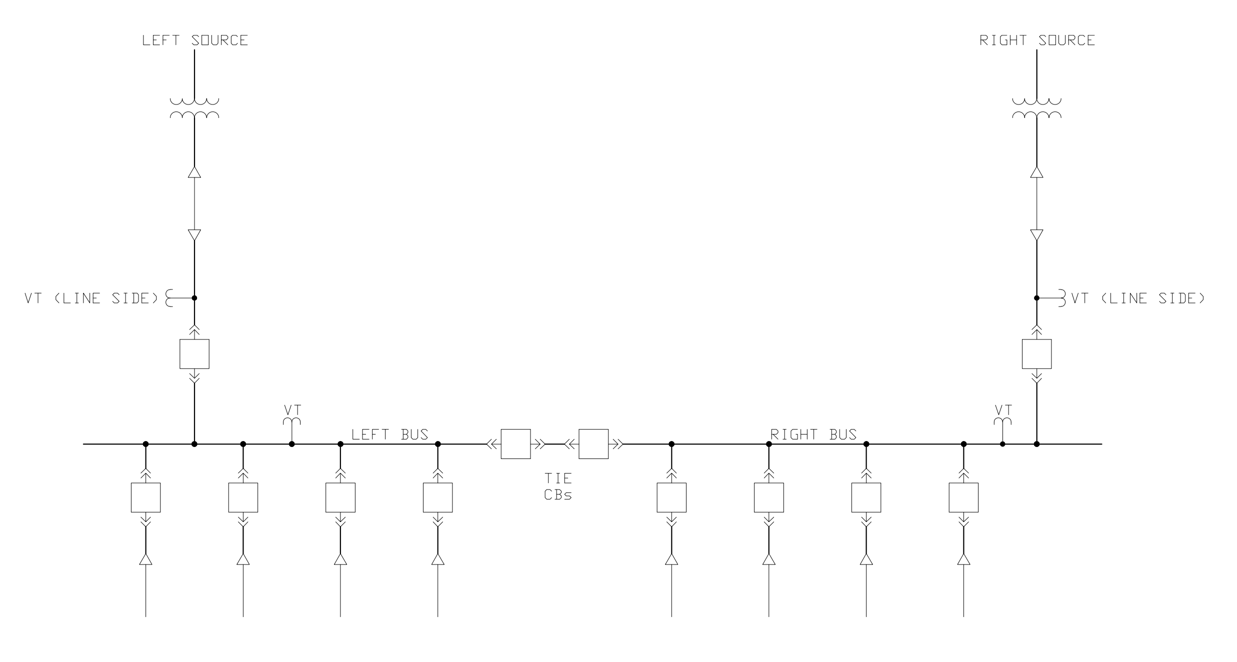
ANNEX K PHASING THROUGH THE USE OF VOLTAGE TRANSFORMERS AND SECONDARY VOLTAGES VERSUS "PHASING HOTSTICKS"

K.1 The Phasing Process

When a system is being commissioned, it is important to assure that the power system on either side of a main or tie circuit breaker or switch has the correct phase relationship or phase sequence. If the switching device is closed under an incorrect phasing condition, this will result in the equivalent of a short circuit on the system—with potentially damaging results to equipment or the interruption of a processing plant's operations. The traditional approach has been for a qualified electrical worker to use hotsticks to prove the phasing. The hotstick probes are placed on the primary (high voltage) stabs within a circuit breaker cubicle to measure that there is zero voltage between each of the phases before an attempt is made to close a circuit breaker. This hotstick process can expose the worker to high incident energy levels from an arc flash, if a fault were to occur by accident during the operation.

K.2 Recommended Approach Using Instrument Voltage Transformers

Figure K-1: Representative Double-Ended Substation Arrangement



Following is an outline that could be adapted as a procedure on a double-ended substation (see Figure K-1) or other arrangement depending on the specifics of the installation:

- The use of the secondary, low voltage, side of voltage transformers (VTs) depends on the specification and supply of VTs on both the "line side" and "bus side" of the circuit breakers to be phased.
- Initially, open all circuit breakers. Insert only the circuit breakers necessary to perform the operation in each step described below. All other circuit breakers not involved in that step should be withdrawn from their cubicles to the "test position," where the primary voltage stabs are not engaged. One source VT will be used as the reference VT for each measurement. In this example, the left-side source VT is used as the reference.

- First, insert and close the left-side source circuit breaker onto the left-side bus and measure that proper line-to-line voltages are present. Then measure the voltages between the respective A, B, and C phase secondary terminals (A to A, B to B, and C to C) of the left-side sourceside VT and the left-side bus VT. All voltages should be zero.
- Insert and close the tie circuit breaker onto the “dead” right-side bus and assure that proper line-to-line voltages are present. Measure the voltages between the respective A, B, and C phase terminals of the left-side source VT and the right-side bus VT. All voltages should be zero.
- Open the tie and left-side source circuit breakers and withdraw the circuit breakers to the test positions.
- Measure the voltages between the respective A, B, and C phase terminals of the left-side source VT and the right-side source VT. All voltages should be zero.
- Insert and close the right-side source onto the right bus and measure that proper line-to-line voltages are present. Then measure the voltages between the respective A, B, and C phase terminals of the left-side source side VT and the right-side bus VT. All voltages should be zero.
- Insert and close the tie circuit breaker onto the “dead” left-side bus and assure that proper line-to-line voltages are present. Measure the voltages between the respective A, B, and C phase terminals of the left-side source VT and the left-side bus VT. All voltages should be zero.
- The phase relationships of all the VTs have been proven if the above steps have been followed.
- Open the tie circuit breaker and withdraw it, then insert and close the left-side circuit breaker.
- As a final verification step, measure that proper line-to-line voltages are present on the bus VTs on both sides of the open tie circuit breaker. Then measure the voltages between the respective A, B, and C phase terminals of the left-side bus VT and the right-side bus VT. All voltages should be zero.
- If the voltages measured in the above step are zero, the phasing is correct and the tie circuit breaker can be inserted and safely closed, as during a closed-transition bus transfer or for a normally-closed tie configuration.

ANNEX L EXAMPLE INDUSTRIAL PROCEDURES AND POLICIES FOR WORKING NEAR OVERHEAD ELECTRICAL LINES AND EQUIPMENT

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

N.1 Introduction. This annex is an example of an industrial procedure for working near overhead electrical systems.Areas covered include operations that could expose employees or equipment to contact with overhead electrical systems.

When working near electrical lines or equipment, avoid direct or indirect contact. Direct contact is contact with any part of the body. Indirect contact is when part of the body touches or is in dangerous proximity to any object in contact with energized electrical equipment. Two assumptions should always be made: (1) Lines are “live” (energized), and (2) lines are operating at high voltage (over 1000 volts).

As the voltage increases, the minimum working clearances increase. Through arc-over, injuries or fatalities may occur even if actual contact with high voltage lines or equipment is not made. Potential for arc-over increases as the voltage increases.

N.2 Overhead Powerline Policy (OPP). This annex applies to all overhead conductors, regardless of voltage and requires the following:

(1) That employees not place themselves in close proximity to overhead powerlines. “Close proximity” is within a distance of 10 ft for systems up to 50 kilovolts, and 4 in. for every 10 kilovolts above 50 kilovolts.

(2) That employees be informed of the hazards and precautions when working near overhead lines.

(3) That warning decals be posted on cranes and similar equipment regarding minimum clearance of 10 ft.

(4) That a “spotter” be designated when equipment is working near the proximity of overhead lines. This person’s responsibility is to observe safe working clearances around all overhead lines and to direct the operator accordingly.

(5) That warning cones be used as visible indicators of the 10 ft safety zone when working near overhead powerlines.
Note: “Working near,” for the purpose of this annex, is defined as working within a distance from any overhead powerline that is less than the combined height or length of the lifting device, the associated load length, and the required minimum clearance distance [as stated in N.2(1)].

Required Clearance = Lift Equipment Height or Length + Load Length + At Least 10 ft

(6) Notify the local responsible person at least 24 hours before any work begins to allow time to identify voltages and clearances, or to place the line in an electrically safe work condition.

N.3 Policy. All employees and contractors shall conform to the OPP. The first line of defense in preventing electrical contact accidents is to remain outside the Limited Approach Boundary. Because most company and contractor employees are not qualified to determine the system voltage level, a qualified person shall be called to establish voltages and minimum clearances, and take appropriate action to make the work zone safe.

N.4 Procedures.

N.4.1 General. Prior to the start of all operations where potential contact with overhead electrical systems is possible, the person in charge shall identify overhead lines or equipment, reference their location with respect to prominent physical features, or physically mark the area directly in front of the overhead lines with safety cones, survey tape, or other means. Electrical line location shall be discussed at a pre-work safety meeting of all employees on the job (through a job briefing). All company employees and contractors shall attend this meeting and require their employees to conform to electrical safety standards. New or transferred employees shall be informed of electrical hazards and proper procedures during orientations.

On construction projects, the contractor shall identify and reference all potential electrical hazards and document such actions with the on-site employers. The location of overhead electrical lines and equipment shall be conspicuously marked by the person in charge. New employees shall be informed of electrical hazards and of proper precautions and procedures.

Where there is potential for contact with overhead electrical systems, local area management shall be called to decide whether to place the line in an electrically safe work condition, or to otherwise protect the line against accidental contact. Where there is a suspicion of lines with low clearance (height under 20 ft), the local on-site electrical supervisor shall be notified to verify and take appropriate action.

All electrical contact incidents, including “near misses,” shall be reported to the local area health and safety specialist.

N.4.2 LOOK UP AND LIVE Flags. In order to prevent accidental contacts of overhead lines, all aerial lifts, cranes, boom trucks, service rigs, and similar equipment shall use “LOOK UP AND LIVE” flags. The flags are visual indicators that the equipment is currently being used or has been returned to its “stowed or cradled” position. The flags shall be yellow with black lettering and shall state in bold lettering “LOOK UP AND LIVE.”

The procedure for the use of the flag shall be:

(1) When the boom or lift is in its stowed or cradled position, the flag shall be located on the load hook or boom end.

(2) Prior to operation of the boom or lift, the operator of the equipment shall assess the work area to determine the location of all overhead lines and communicate this information to all crews on site. Once completed, the operator shall remove the flag from the load hook or boom and transfer the flag to the steering wheel of the vehicle. Once the flag is placed on the steering wheel, the operator may begin to operate the equipment.

(3) After successfully completing the work activity and returning the equipment to its stowed or cradled position, the operator shall return the flag to the load hook.

(4) The operator of the equipment is responsible for the placement of the “LOOK UP AND LIVE” flag.

N.4.3 High Risk Tasks.

N.4.3.1 Heavy Mobile Equipment. Prior to the start of each workday, a high visibility marker (orange safety cones or other devices) shall be temporarily placed on the ground to mark the location of overhead wires. The supervisors shall discuss electrical safety with appropriate crew members at on-site tailgate safety talks. When working in the proximity of overhead lines, a spotter shall be positioned in a conspicuous location to direct movement and observe for contact with the overhead wires. The spotter, equipment operator, and all other employees working on the job location shall be alert for overhead wires and remain at least 3 m (10 ft) from the mobile equipment. All mobile equipment shall display a warning decal regarding electrical contact. Independent truck drivers delivering materials to field locations shall be cautioned about overhead electrical line before beginning work, and a properly trained on-site or contractor employee shall assist in the loading or off-loading operation. Trucks that have emptied their material shall not leave the work location until the boom, lift, or box is down and is safely secured.

N.4.3.2 Aerial Lifts, Cranes, and Boom Devices. Where there is potential for near operation or contact with overhead lines or equipment, work shall not begin until a safety meeting is conducted and appropriate steps taken to identify, mark, and warn against accidental contact. The supervisor will review operations daily to ensure compliance. Where the operator's visibility is impaired, a spotter shall guide the operator. Hand signals shall be used and clearly understood between operator and spotter. When visual contact is impaired, the spotter and operator shall be in radio contact. Aerial lifts, cranes, and boom devices shall have appropriate warning decals and shall use warning cones or similar devices to indicate the location of overhead lines and identify the 3 m (10 ft) minimum safe working boundary.

N.4.3.3 Tree Work. Wires shall be treated as live and operating at high voltage until verified as otherwise by the local area on-site employer. The local maintenance organization or an approved electrical contractor shall remove branches touching wires before work begins. Limbs and branches shall not be dropped onto overhead wires. If limbs or branches fall across electrical wires, all work shall stop immediately and the local area maintenance organization called. When climbing or working in trees, pruners shall try to position themselves so that the trunk or limbs are between their bodies and electrical wires. If possible, pruners shall not work with their backs toward electrical wires. An insulated bucket truck is the preferential method of pruning when climbing poses a greater threat of electrical contact. Personal protective equipment shall be used while working on or near lines.

N.4.4 Underground Electrical Lines and Equipment. Before excavation starts and where there exists reasonable possibility of contacting electrical or utility lines or equipment, the local area supervision (or USA DIG organization, when appropriate), shall be called and a request made for identifying/marking the line location(s). When USA DIG is called, telephone operators will need the following:

(1) Minimum of 2 working days' notice prior to start of work, name of county, name of city, name and number of street or highway marker, and nearest intersection

(2) Type of work

(3) Date and time work is to begin

(4) Caller's name, contractor/department name and address

(5) Telephone number for contact

(6) Special instructions

Utilities that do not belong to USA DIG must be contacted separately. USA DIG may not have a complete list of utility owners. Utilities discovered shall be marked before work begins. Supervisors shall periodically refer their location to all workers, including new employees, subject to exposure.

N.4.5 Vehicles with Loads in Excess of a Height of 4.25 m (14 ft). This policy requires that all vehicles with loads in excess of 4.25 m (14 ft) use specific procedures to maintain safe working clearances when in transit below overhead lines.

The specific procedures for moving loads in excess of 4.25 m (14 ft) or via routes with lower clearance heights are listed below:

(1) Prior to movement of any load in excess of 4.25 m (14 ft), the local health and safety department, along with the local person in charge, shall be notified of the equipment move.

(2) An on-site electrician, electrical construction representative, or qualified electrical contractor should check the intended route to the next location before relocation.

(3) Check the new site for overhead lines and clearances.

(4) Powerlines and communication lines shall be noted and extreme care used when traveling beneath the lines.

(5) The company moving the load or equipment will provide a driver responsible for measuring each load and ensuring each load is secured and transported in a safe manner.

(6) An on-site electrician, electrical construction representative, or qualified electrical contractor shall escort the first load to the new location, ensuring safe clearances. A service company representative shall be responsible for subsequent loads to follow the same safe route. If proper working clearances cannot be maintained, the job must be shut down until a safe route can be established or the necessary repairs or relocations have been completed to ensure that a safe working clearance has been achieved. All work requiring movement of loads in excess of 4.25 m (14 ft) are required to begin only after a General Work Permit has been completed, detailing all pertinent information about the move.

N.4.6 Emergency Response. If an overhead line falls or is contacted, the following precautions should be taken:

(1) Keep everyone at least 3 m (10 ft) away.

(2) Use flagging to protect motorists, spectators, and other individuals from fallen or low wires.

(3) Call the local area electrical department or electric utility immediately.

(4) Place barriers around the area.

(5) Do not attempt to move the wire(s).

(6) Do not touch anything that is touching the wire(s).

(7) Be alert to water or other conductors present.

(8) Crews shall have emergency numbers readily available. These numbers shall include local area electrical department, utility, police/fire, and medical assistance.

(9) If an individual becomes energized, DO NOT TOUCH the individual or anything in contact with the person. Call for emergency medical assistance and call the local utility immediately. If the individual is no longer in contact with the energized conductors, CPR, rescue breathing, or first aid should be administered immediately, but only by a trained person. It is safe to touch the victim once contact is broken or the source is known to be de-energized.

(10) Wires that contact vehicles or equipment will cause arcing, smoke, and possibly fire. Occupants should remain in the cab and wait for the local area electrical department or utility. If it becomes necessary to exit the vehicle, leap with both feet as far away from the vehicle as possible, without touching the equipment. Jumping free of the vehicle is the last resort.

(11) If operating the equipment and an overhead wire is contacted, stop the equipment immediately and if safe to do so jump free and clear of the equipment. Maintain your balance, keep your feet together and either shuffle or bunny hop away from the vehicle another 3 m (10 ft) or more. Do not return to the vehicle or allow anyone else for any reason to return to the vehicle until the local utility has removed the powerline from the vehicle and has confirmed that the vehicle is no longer in contact with the overhead lines.

Instructions for Working with PDF Interactive Forms
(please print this page)

This document contains interactive form fields. These fields can be filled in and the document re-saved as a customized version of the "parent" document. The following instructions detail the process of saving and modifying a copy of this document for further distribution. **Acrobat Standard or Professional is required for this process** (and is available from the Chevron GIL Options Panel)**.**

1. Save a copy of this document to your desktop or other location.

   If you do not have the "File" menu or the "Save" icon in your browser window, select the "Tools" icon (usually in the upper right corner of the browser window), then select "Menu Bar." Once you have the menu bar, you will be able to select File>Save As to save your document.

2. CLOSE THE BROWSER and open the saved ("local") copy with either Acrobat Standard or Professional.
3. The first form field (highlighted in blue) is located on page 7; highlight the default text in the form field and type over it. Scroll through the rest of the document to locate and complete the remaining form fields.
4. Use Document>Delete Pages to delete these instructions from the end of your document if you prefer.
5. Also optional, on the first (title) page, right-click on and delete the Comment (Sticky Note).
6. Use File>Save As to save the modified document with a different name (this option preserves an original copy of the document for future use).

The modified file (with form fields completed) is now ready for distribution. As long as this modified version is distributed only to users with Acrobat Reader, the form fields will not longer be editable. However, *if* it is possible that some users *may* have Acrobat Standard or Acrobat Professional, and *if* you want to protect the document against further modification, complete the following steps:

1. Open the modified version (the file with the new name).
2. Go to File>Properties and select the Security tab.
3. For Security Method, select "Password Security."
4. On the Password Security – Settings dialog box, choose the following settings:
   a. Select "Encrypt all document contents except metadata…"
   b. Do NOT select "Require a password to open the document."
   c. Select "Restrict editing and printing of the document…" and enter a password of your choice.
   d. Set "Printing Allowed" to either Low or High Resolution (your choice).
   e. Set "Changes Allowed" to none.
   f. OPTIONAL: Sselect the checkbox for "Enable copying of text, images, and other content."
5. Once you have completed making the appropriate selections in the dialog box, select OK. You will be prompted to answer "OK" to several dialog boxes and to re-enter your password.
6. Save the document one final time (any type of Save action is sufficient).

Your document is now ready for distribution.