



# Electrical Safe Work Practices Standard

University of Minnesota

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# 1.0 SCOPE

Incidents and injuries are preventable. The safe work practices covered in this standard are designed to avoid all incidents and injuries related to electrical systems. Besides the personal pain of suffering an injury, incidents can result in lost time, medical costs, equipment damage, production loss, and legal costs.

This standard sets minimum safety rules and safe work practices for the design, installation, removal, inspection, operation, maintenance, and demolition of high and low voltage systems at all University of Minnesota facilities.

This standard **shall** apply to all employees, contractors, and visitors while in near proximity to energized conductors, energized exposed parts of electrical equipment, or such conductors and equipment that potentially may become energized. For the purpose of this standard, low voltage means 600 volts nominal or less phase-to-phase or conductor-to-conductor, and high voltage means voltages above 600 volts A.C., phase-to-phase.

The intent of this document is to provide the individual and location with the minimum safety techniques and knowledge to work with, or in near proximity to, energized high and low voltage sources. However, each individual, or location **shall** be responsible for details and activities specific to the affected facility.

This standard **shall** apply to new or modified high and low voltage installations. However, existing installations need not be physically modified to comply with this standard unless such modification is considered necessary by qualified personnel to protect affected persons from a recognized hazard.

Knowledge of this standard in itself does not make a person a qualified electrical worker. Guidelines **shall** be established by The University of Minnesota management concerning informal and formal training, as well as levels of experience in the electrical field using training outlines for electrical workers, or other workers whose job function would expose them to a potential electrical hazard.

The safety considerations contained in this standard **shall** serve as minimum guidelines in the design, maintenance and operation of systems and equipment. It is imperative that the applicable design and safety code guidelines are met or exceeded to enhance employee safety.

If there are local governmental codes, or accepted employee safety standards, design criteria, etc., that are more stringent than those identified within this standard, then those **shall** be considered more appropriate, and **shall** be followed.

## 2.0 DEFINITIONS

The terms listed in this section are used throughout this standard. You should be familiar with their definitions before reading further.

### **Affected Employee (or Affected Person)**

An employee whose job requires him or her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him or her to work in an area in which such servicing or maintenance is being performed.

An employee whose job includes activities such as erecting, installing constructing, repairing, adjusting, inspecting, operating, or maintaining the equipment or process from a non-electrical perspective.

### **ANSI**

American National Standards Institute

### **Approved**

Methods, devices, tools, equipment or practices acceptable to the Company and/or regulatory body having jurisdiction.

### **Arc Flash Protective Equipment**

Equipment used to safeguard personnel from momentary electrical arcs. The equipment may include Arc-resistant clothing, flash suits, face protection, hand protection, and foot protection.

### **ASTM**

American Society for Testing and Materials

### **Attendant**

An employee assigned to remain immediately outside the entrance to an enclosed or other space to render assistance as needed to employees inside the space.

## **Authorized Employee (or Authorized Person)**

An employee who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing service or maintenance covered under this standard.

An employee to whom the employer has assigned the authority and responsibility to perform a specific assignment in an electrical area. One who can demonstrate by experience and training (as stated in section 8 of this standard) the ability to recognize potentially hazardous electrical energy. "Authorized Employees" could include electricians, mechanics, supervisors, operators, engineers, custodians, painters, etc.

## **Automatic Circuit Recloser**

A self-controlled device for interrupting and reclosing an alternating current circuit with a predetermined sequence of opening and reclosing, followed by a resetting, hold-closed, or lockout operation.

## **Barricade**

A physical obstruction such as tapes, ropes, 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 live parts or to prevent unauthorized access to a work area.

## **Bond**

The electrical interconnection of conductive parts designed to maintain a common electrical potential across the connection.

## **Boundary, Arc Flash.**

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. Informational Note: A second degree burn is possible by an exposure of unprotected skin to an electric arc flash above the incident energy level of 5 J/cm<sup>2</sup> (1.2 cal/cm<sup>2</sup>).

## **Boundary, Limited Approach.**

An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

## **Boundary, Prohibited Approach.**

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

## **Boundary, Restricted Approach.**

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

## **Bus**

A conductor or group of conductors that serves as a common connection for two or more circuits.

## **Bushing**

An insulating structure, including a through conductor (or providing a passageway for such a conductor) with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

## **Cable**

A conductor with insulation, or a stranded conductor with or without insulation and other coverings (single-conductor cable), or a combination of conductors insulated from one another (multiple-conductor cable).

## **Cable Sheath**

A conductive, protective covering applied to cables (may be multiple layers, of which one or more may be conductive).

## **Card Protector**

Plastic, 5" x 9-1/2" is available for Hold, Secure or Unsafe tags providing weather protection where the tags will be exposed for any length of time. It is a durable, clear plastic and has a weathersealed hole which can accept a padlock hasp, string, wire or rope to tie it on.

## **Circuit**

A conductor or system of conductors through which an electric current is intended to flow.

### **Clearance (Between Objects)**

The clear distance between two objects measured surface to surface.

### **Clearance (For Work)**

Authorization by the proper authority that a specified line or piece of equipment is de-energized, drained, purged, depressurized or whatever is necessary to make equipment safe to work on or in and that the line or equipment is being turned over to the person in charge.

### **Clearance (From Hazard)**

Separation from energized lines or equipment.

### **Close Proximity**

Close enough to reach, fall in to, or otherwise accidentally contact.

### **Common Lockout System**

A system which permits the use of locking devices not considered unique or uniquely controlled.

### **Communications Lines (Lines, Communications)**

The conductors and their supporting or containing structures that are 1) used for public or private signal or communication service and which 2) operate at potentials not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and 3) the transmitted power of which does not exceed 150 watts. If the lines are operating at less than 150 volts, no limit is placed on the transmitted power of the system. Under certain conditions communication cables may include communication circuits exceeding these limitations, where such circuits are also used to supply power solely to communication equipment.

### **Competent Person**

A person who through training or experience, is capable of safely performing the work assigned.

### **Conductor**

A material, usually in the form of a wire, cable, or bus bar, suitable for carrying electric current.

### **Covered Conductor**

A conductor covered with a dielectric having no rated insulating strength or having a rated insulating strength less than the voltage of the circuit in which the conductor is used.

### **CPR**

Cardiopulmonary Resuscitation

### **Current-Carrying Part**

A conducting part intended to be connected in an electric circuit to a source of voltage. Non-current-carrying parts are those not intended to be so connected.

### **Deenergized**

Free from any electrical connection to a source of potential difference and from electric charge; not having a potential different from that of the earth.

### **Designated Person**

An employee who is designated by the employer to perform specific duties and who is knowledgeable in the construction and operation of the equipment and the hazards involved.

### **Dielectric Testing**

A controlled method used to test the electrical safety integrity of personal protective and live-line equipment.

### **Disconnect**

A device designed to connect or disconnect machines, equipment, and/or other installations from an electrical energy source.

### **EHV (Extra High Voltages)**

For the purposes of this standard, EHV is any voltage above 230 kV.

### **Electric Line Truck**

A truck used to transport personnel, tools, and material for electric supply line work.

### **Electrical Hazard**

A dangerous condition such that contact or equipment failure can result in electrical shock, arc flash burn, thermal burn, or arc blast injury.

### **Electric Utility**

An organization responsible for the installation, operation, and maintenance of an electric supply system.

### **Electrically Safe Work Condition**

A state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded in accordance with section 4.11

### **Employee**

One employed by another, usually for wages or salary.

### **Enclosed Space**

A working space, such as a manhole, vault, tunnel, or shaft, that has a limited means of egress or entry and that is designed for periodic employee entry under normal conditions, and it does not contain a hazardous atmosphere; but it may contain a hazardous atmosphere under abnormal conditions.

Note: Spaces that are enclosed but not designed for employee entry under normal operating conditions are not considered enclosed spaces for the purposes of this standard. Similarly, spaces that are enclosed and that are expected to contain a hazardous atmosphere are not considered to be enclosed spaces for the purposes of this standard.

### **Energized (Alive, Live)**

Electrically connected to a source of potential difference, or electrically charged so as to have a potential significantly different from that of earth in the vicinity.

## **Energy Isolating Device**

A physical device that prevents the transmission or release of energy, including, but not limited to, the following: a manually operated electric circuit breaker, a disconnect switch, a manually operated switch, a slide gate, a slip blind, a line valve, blocks, and any similar device with a visible indication of the position of the device. (Push buttons, selector switches, and other control-circuit-type devices are not energy isolating devices.)

## **Energy Source**

Any electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, or other energy source that could cause injury to personnel.

## **Equipotential Grounding (Earthing)**

A grounding (earthing) scheme which places the worker in an envelope of equal potential. When **everything** that can be touched by the worker is of the same potential, no current can flow through the worker between two different touch points.

## **Equipment (Electrical)**

A general term including material (fittings, devices, appliances, fixtures, and the like) used as part of, or in connection with, an electrical installation.

## **Escort**

A qualified person accompanying non-qualified employees or visitors in the vicinity of electrical equipment or lines.

## **Exposed Energized Electrical Conductors or Circuit Parts (Live Parts)**

Electric conductors, buses, terminals, or components that are uninsulated or exposed and a shock hazard exists.

## **Exposed (As applies to energized electrical conductors or circuit parts)**

Capable of being inadvertently touched or approached nearer than a safe distance by a person. It applies to parts that are not suitably guarded, or isolated, or insulated.

## **Flash Hazard**

A dangerous condition associated with the possible release of energy caused by an electrical arc.

## **Ground (Earth)**

A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

## **Grounded (Earthed)**

Connected to earth or to some conducting body that serves in place of the earth.

## **Grounding (Earthing)**

The act of providing an intentional connection to earth through a ground connection of sufficiently low impedance and having sufficient current carrying capacity to prevent build-up of voltage that could result in undue hazard to connected equipment or to persons.

Note: For non North American installations, earthing is the common terminology.

## **Guarded**

Covered, shielded, fenced, enclosed, or otherwise protected, by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.

## **Hazard Risk Analysis**

The decision-making process required to determine the degree and extent of the hazard, the appropriate protective equipment, and the job planning necessary to complete a task safely.

## **Hazardous Atmosphere (As applied to confined/enclosed spaces, 29 CFR 1910.269)**

An atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from an enclosed space), injury, or acute illness from one or more of the following causes:

1. Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);
2. Airborne combustible dust at a concentration that meets or exceeds its LFL;
3. Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;

4. Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, *Occupational Health and Environmental Control*, or in Subpart Z, *Toxic and Hazardous Substances*, of Part 1910 of *Occupational Safety and Health Standards for General Industry*, and which could result in employee exposure in excess of its dose or permissible exposure limit.
5. Any other atmospheric condition that is immediately dangerous to life or health.

## **High-Power Tests**

Tests in which fault currents, load currents, magnetizing currents, and line-dropping currents are used to test equipment, either at the equipment's rated voltage or at lower voltages.

## **High Voltage**

A.C. voltage above 600 volts, phase-to-phase, or conductor-to-conductor.

## **High-Voltage Tests**

Tests in which voltages of approximately 600 volts are used as a practical minimum and in which the voltage has sufficient energy to cause injury.

## **IEEE**

Institute of Electrical and Electronic Engineers

## **Immediately Dangerous to Life or Health**

Any condition that poses an immediate threat to life or that is likely to result in acute or immediate severe health effects.

## **Insulated**

Separated from other conducting surfaces by a dielectric substance (including air space) that offers a high resistance to the passage of current.

## **Insulated Conductor**

A conductor covered with a dielectric material that has a rated insulating strength equal to or greater than the voltage of the circuit in which it is used.

## **Insulation (Cable)**

That which is relied upon to insulate the conductor from other conductors, conducting parts, or ground.

## **ISO**

International Standards Organization

## **Isolated**

1. Any object that is not readily accessible to persons unless special means of access are used.
2. All sources of supply have been removed, that is, all isolation devices are locked open and any fuses associated with potential devices or other power supplies are removed.

## **Limited (hazardous) Work**

Any work other than prohibited or restricted work that requires approach to exposed, energized conductors or circuit parts with conductive objects or unguarded body parts closer than the "limited approach boundary" distance listed in Table 6.

## **Line Clearance Tree Trimming**

The pruning, trimming, repairing, maintaining, removing, or clearing of trees or cutting of brush that is within 10 feet (305 cm) of live parts.

## **Live Parts**

Electric conductors, buses, terminals, or components that are uninsulated or exposed and a shock hazard exists

## **Live-Line Tool**

A live-line tool is a wooden or fiberglass rod, handle, or pole rated for the voltage involved and used to touch or come in close proximity to live parts.

## **Lockout**

The placement of a lockout device on an energy-isolating device in accordance with an established procedure, ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. (See Unique Lockout System.)

## **Lockout Device**

A device that utilizes a positive means (such as a keyed lock) to hold an energy-isolating device in the safe position (to prevent the energizing of a machine or equipment).

## **Location Manager**

General Manager of the facility.

## **Low Voltage**

Any electrical circuit that normally operates at 600 volts nominal or less phase to phase or conductor to conductor.

## **Manhole**

A subsurface enclosure which personnel may enter and which is used for the purpose of installing, operating, and maintaining submersible equipment or cable.

## **Manhole Steps**

A series of steps individually attached to or set into the walls of a manhole structure.

## **Mobile Equipment**

Includes but is not limited to cranes, bucket trucks, aerial lifts, and similar types of equipment.

## **Near Proximity**

A minimum clearance of 10 feet (305 cm) to energized lines and equipment operating at 50 kV, or less. This distance increases 4 inches (10 cm) for every 10 kV over 50 kV.

## **Non-hazardous Work**

Work that does not fit in the categories of “prohibited,” “restricted,” or “limited” work. An example is working on control circuits below 50 VAC or DC to ground.

**Note:** Energized parts that operate at less than 50 volts are not required to be de-energized to satisfy an “electrically safe work condition.” However, consideration should be given to the capacity of the source, any overcurrent protection between the energy source and the worker, and whether the work task related to the source operating at less than 50 volts increases exposure to electrical burns or to explosion from an electric arc.

## **Non-Insulated Conductor**

A conductor that has no insulating properties other than air.

## **Operating System Lock**

A keyed lock placed on an electrical distribution system to prevent unintentional opening of a disconnect device. Operating system locks may be unique or common lock systems. This is not a personal safety lock.

## **Person in Charge**

(Supervisor, Foreman, Lineman in charge, lead people, etc.): A qualified employee who has been authorized and designated to be locally in charge of company work. (A person who is in charge of the work or other employees, regardless of title.)

## **Potentially Energized**

A non-insulated conductor or device that, by nature of design or location, may be energized by an adjacent energized conductor, switch closure, or back-feed.

## **Prohibited (live) Work**

Work that requires intentional hand, body, or tool contact with exposed conductors or circuit parts operating at 50 VAC or DC or above, conductor-to-conductor or conductor-to-ground, or work that requires approach of exposed, energized conductors or circuit parts to conductive objects or unguarded body parts closer than the “prohibited approach boundary” distance listed in Table 6.

## **Qualified Employee (or Qualified Person)**

One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved.

A person who is trained and knowledgeable of the construction and operation of the equipment or the specific work method, and is trained to recognize and avoid the electrical hazards that might be present with respect to the equipment or work method.

The University of Minnesota management **shall** certify qualified personnel.

## **Restricted (proximity) work**

Work that requires approach of exposed, energized (50 VAC or DC or above) conductors or circuit parts to conductive objects or unguarded body parts closer than the “restricted approach boundary” distance listed in Table 6.

## **Rights-of-way (Power Lines)**

The area under a power line within ten foot (305 cm) horizontal to the nearest conductor for lines rated 50 kV and below. This distance shall increase 4 inches (10cm) for each 10 kV above 50 kV.

## **Risk**

A combination of the likelihood of occurrence of injury or damage to health that results from a hazard.

## **Risk Assessment**

An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.

## **Rubber Protective Equipment**

Insulating material which includes elastomers and elastomer compounds, regardless of origin.

## **Safety Lock**

A lock that is a controlled keyed lock (intended for personnel protection only) that would be installed at each tagout/lockout location. This is a unique lock system.

## **Safety Tag**

Tags which are attached to equipment to prevent its operation. They are of five types:

- a. Personal Danger Tag: For use by an individual for protection from injury by prohibiting the operation of the equipment controlled by the device to which their Personal Danger Tag is attached.
- b. Hold Card: A card attached to a switch, a device serving as a switch, or to a valve when it is required that the switch or valve be maintained in a specified position to safeguard human life. A switch or valve is referred to as being Held Open or Held Closed when it is in that position and a Hold Card is attached.
- c. Secure Card: A card attached to a switch, a device serving as a switch or to a valve to protect equipment, to prevent service interruption, but never where protection of people is involved. A switch is referred to as being Secured Open or Secured Closed when it is in that position and a Secure Card is attached.
- d. Unsafe Card: A card used on equipment, tools or devices to inform personnel that the equipment is unsafe for use.
- e. Grounding Point Tag: Tags used to show that temporary safety grounds are attached and states the location of the temporary safety ground.

## **Shall**

In the context of this standard, always means “Mandatory.”

## **Shock Hazard**

A source of possible injury or damage to health associated with current through the body caused by contact or approach to energized electrical conductors or circuit parts.

## **Should**

In this standard, means optional, but recommended.

## **Stand-by Person**

A person whose sole responsibility is to observe the actions of the person performing the task. This person ensures that the person performing the task is aware of the associated potential hazards. The stand-by person shall be trained in how to recognize and avoid electrical hazards, emergency response techniques (such as CPR), and techniques to free a person from energized conductors or circuit parts.

## **Step Potential**

A ground potential gradient difference that can cause current flow from foot to foot through the body.

## **Switch**

A device for opening and closing or for changing the connection of a circuit. In this standard, a switch is understood to be manually operable, unless otherwise stated.

## **Switching Authority**

A designated employee responsible for carrying out a switching operation on the electrical distribution system. This may be a crew electrician, the crew subforeman, or the utility supervisor.

## **Switching Transients**

Distortions in the flow of electricity that can be caused by switching and can cause problems for electronic equipment, electronic machinery, or processes that are controlled by micro-processors.

## **System Operator**

A qualified person designated to operate the system or its parts.

## **Tagout**

The placement of a tagout device on an energy-isolating device (in accordance with an established procedure) to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

## **Tagout Device**

A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy-isolating device in accordance with an established procedure, to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

## **Ten (10) Foot Rule**

An unqualified person must maintain a distance of 10 foot minimum from exposed energized movable conductors (see Limited Approach Boundary, Section 11, Table 6)

To prevent physical contact with energized or isolated ungrounded power lines, equipment or machines shall be operated as follows: The minimum clearance between the lines and every part of the equipment or machine or its load shall be 10 foot (305 cm) for lines rated 50 kV or below. This distance shall increase 4 inches (10 cm) for each 10 kV above 50 kV.

## **Touch Potential**

A ground potential gradient difference that can cause current flow from hand to hand or hand to foot through the body.

## **Unique Lockout System**

A controlled lockout system (unique lock/one key or unique lock group/one key) requiring special authorization for use. (Also see Lockout.)

## **Unqualified Person**

A person who is not a qualified person.

## **Vault**

An enclosure, above or below ground, which personnel may enter and which is used for the purpose of installing, operating, or maintaining equipment or cable.

## **Voltage**

The effective (rms) potential difference between any two conductors or between a conductor and ground. Voltages are expressed in nominal values unless otherwise indicated. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class under normal conditions. The operating voltage of the system may vary above or below this value.

### **Working Near (Live parts)**

Any activity inside the limited approach boundary.

### **Working On (Live Parts)**

Coming in contact with live 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. These are as follows:

Diagnostic (testing) – The taking of readings or measurements of electrical equipment that does not require making any physical change to the equipment.

Repair – Any physical alteration of electrical equipment such as making or tightening connections, removing or replacing components, etc.

### **Work Zone**

The space required to safeguard personnel. An area temporarily marked off by rope, tape, or other barricading devices. Entry into this area is prohibited by all personnel other than those authorized by the person in charge of the work zone.

## 3.0 RESPONSIBILITIES

### 3.1 Location Management

The location manager or his or her designee shall appoint a qualified person as the location resource who **shall** remain current on this document and associated references. The person appointed shall have the responsibility and authority for implementation of this standard.

Location management may also designate a qualified person for each functional or operational area, to be responsible for meeting all administrative, design, construction, maintenance, and documentation requirements of this standard. This responsibility includes system electrical planning, operation and control. This person **shall** also be responsible for obtaining, reading, understanding/interpreting, implementing, and maintaining mandated (under law) governmental codes, policies and standards.

### 3.2 Task Supervisor or Person-in-Charge

This individual **shall**:

1. Be qualified.
2. Adopt such precautions as are within the individual's authority to prevent accidents, and to take positive action to obtain necessary precautions for those concerns not within the individual's authority in order to insure employee safety.
3. See that the location safety rules along with the training requirements and operating procedures as contained in this, or other standards, are observed by the employees under the direction of this individual.
4. Ensure that all the necessary documentation required exists. (i.e. Work Permits, Switching Procedures, Confined Space Procedures, Digging Permits, Welding Permits, etc.)
5. Prevent unauthorized persons from approaching places where electrical work requiring qualification is being performed.
6. Ensure that tools or devices used are suited for the work at hand, and that applicable tools have been inspected and tested, as required.
7. Determine and communicate at pre-work briefing and before work begins all existing conditions. These include but are not limited to nominal voltages, maximum switching transient voltages, induced voltages, temporary safety grounds, environmental conditions affecting safety, locations of circuits and other equipment.
8. Ensure that first aid supplies are available and are stored in a weatherproof container if exposed to the weather. Ensure that these supplies are as approved by a consulting physician and are readily available for use. Ensure that expended supplies are replaced and that supplies are inspected at least annually.

### 3.3 Employee

The employee is the person most responsible for his or her own safety. Qualified and Authorized employees **shall** remain knowledgeable in applicable electrical safety concerns as contained in this, or other standards.

Affected employees **shall** consider electrical hazards where electrical work is not the primary task, but, where the opportunity for contact exists such as during lockout/tagout, working near open crane rails, near motor control centers and switchgear, construction around cable ladders, and resetting devices and equipment.

### 3.4 Escort

The escort (a qualified person) **shall** safeguard the people in his or her care and **shall** ensure that safety regulations are observed.

### 3.5 Contractors and Visitors

Contractors and visitors **shall** follow, as a minimum, all safety regulations of this facility as contained in this, and other standards.

#### 3.5.1 Host Employer and Contract Employer Responsibilities

- (1) The host employer shall inform contractor management of the following:
  - a. Known hazards that are covered by this standard, that are related to the contract employer's work, and that might not be recognized by the contract employer or its employees
  - b. Information about the employer's installation that the contract employer needs to make the assessments required for safety
- (2) The host employer shall report observed contract employee related violations of this standard to the contract employer.

#### 3.5.2 Contract Employer Responsibilities.

- (1) The contract employer shall ensure that each of his or her employees is instructed in the hazards communicated to the contract employer by the host employer. This instruction shall be in addition to the basic training required by this standard.
- (2) The contract employer shall ensure that each of his or her employees follows the work practices required by this standard and safety-related work rules required by the host employer.
- (3) The contract employer shall advise the host employer of the following:
  - a. Any unique hazards presented by the contract employer's work

- b. Any unanticipated hazards found during the contract employer's work that the host employer did not mention
- c. The measures the contractor took to correct any violations reported by the host employer and to prevent such violation from recurring in the future

**3.5.3 Documentation.** There shall be a documented meeting between the host employer and the contract employer before start of work on the project.

## 4.0 SAFE WORK PRACTICES

### 4.1 Energized Electrical Work Policy

4.1.1 It is the general policy that NO maintenance or construction/installation work is to be performed on any conductors and/or exposed equipment parts at 50 volts and above while they are energized.

4.1.2 Any energized work performed above 50 volts shall require an energized electrical work permit. Energized work above 50 volts shall be permitted only if it is infeasible to perform the task deenergized or if it creates a greater hazard or increased risk to deenergize. (see exceptions in 4.1.3)

Electrical servicing (for example: maintenance trouble shooting and testing) activities that require electrical equipment to be energized will require special precautions by the worker performing these activities.

However, where **repair work** is taking place inside the restricted approach boundary and a **shock hazard exists** two employees (one who must be qualified and one who must be either qualified or authorized) must be present.

Electrical equipment and lines **shall** be considered energized until isolated, locked/tagged/tried, tested for the absence of voltage, and grounded in accordance with section 4.4.1 (Establish an electrically safe work condition).

4.1.3 Exceptions to the energized electrical work policy, other than those noted below, **shall** require the approval of the location manager or his or her designee. A documented plan **shall** also be required.

Exception #1 - A qualified person may:

- Use high voltage detectors
- Attach grounds
- Perform high and low voltage phasing
- Take voltage readings
- Use hot sticks for switching operations.

- Perform thermography, ultrasound, or visible inspections if the restricted approach boundary is not crossed
- Access and egress an area with energized electrical equipment if no electrical work is being performed and the restricted approach boundary is not crossed
- Perform general housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed.

Note: The qualified person shall be provided with and use appropriate safe work practices and PPE required for the task.

Exception #2 - Electrical servicing (maintenance trouble shooting and testing) activities that require electrical equipment to be energized will require special precautions by the worker performing these activities. Activities covered by this practice may include:

- Voltage phasing
- Preventive maintenance observations and meter checks
- System component adjustment
- Voltage readings
- Troubleshooting
- Re-setting device overloads.

When these activities are performed and will place the worker in close proximity to exposed electrical conductors or circuit parts, appropriate personal protective equipment **shall** be utilized. Such PPE, in addition to the minimum basic requirements for electrical personnel, may include:

- An arc-rated Face shield
- Rubber insulating gloves with leather protectors
- Arc-rated clothing or arc-rated flash suit

Location management **shall** approve the PPE selection.

All test equipment used **shall** be approved by location management.

All tools and/or handling equipment used **shall** be insulated and of an approved design, if the tools or handling equipment might make contact with exposed energized electrical conductors or circuit parts.

- 4.1.4. Before beginning any construction work or maintenance work that requires activities, other than those covered above, that will place the worker(s) in close proximity to exposed electrical conductors or circuit parts, the electrical equipment **shall** be totally de-energized or the area of work **shall** be isolated and

insulated. The decision to isolate and insulate instead of de-energizing **shall** be made by the Task Supervisor or Person-in-Charge and approved by the location manager or his or her Designee.

- 4.1.5 Only persons qualified in the techniques required to work on energized electrical conductors or circuit parts shall be utilized for this work. Safety conditions outlined in this standard **shall** be utilized for all work on or near energized electrical conductors or circuit parts.
- 4.1.6 When persons qualified for energized work must do work on energized electrical conductors or circuit parts, an energized electrical work permit (EEWP) **shall** be required. The permit shall be signed by upper management. See an example of an energized electrical work permit (EEWP) in Appendix E.
- 4.1.7 To cross the prohibited approach boundary and enter the prohibited space is considered the same as making contact with live parts. Any work on live parts shall utilize the procedures defined under “working inside the prohibited approach boundary” (see Appendix B, item D).

## 4.2 Working On Or Near Energized Equipment

- 4.2.1 Hazard and Risk Analysis - Three primary hazards to consider when working on or near energized equipment are:
  - Flash Hazard
  - Shock Hazard
  - Arc Blast Hazard

Examples of activities, which have the risk of creating an electrical arc flash or arc blast are listed below:

- When doing any switching on switchgear or motor starters
  - When installing or removing circuit breakers or motor starter contractors with the switchgear bus energized
  - When working on motor control centers with open doors (unless the power components at 480 or 600 volts are well guarded) or when removing or installing starters
  - When installing or removing safety grounds
  - When taking voltage measurements
  - When working on energized electrical conductors or circuit parts
- 4.2.2 Flash Hazard Analysis and Arc Flash Protective Equipment

An arc flash risk assessment **shall** be performed before a person approaches any exposed electrical conductor or circuit part that has not been placed in an electrically safe work condition.

Establish the arc flash boundary and require that all personnel crossing the boundary wear appropriate arc flash protective equipment. This procedure will provide protection from vaporized metal, arc radiation, or hot gases should an arc flash occur on the equipment. The size of the arc flash boundary is determined by:

- The size of the source transformer or the available short circuit MVA
- The clearing time of the protective device (fuse or circuit breaker) upstream

Use NFPA 70E, article 130.5 and annex D of NFPA 70E to determine the arc flash boundary for a particular application.

Note: The arc flash boundary may also be calculated by using the formulas in Section 11, Appendix D of this standard.

#### 4.2.3 Working near energized exposed electrical conductors or circuit parts - (Approach Distances)

- a. Affected persons (persons who are not authorized or qualified) **shall** adhere to the limited approach boundary (10 Foot Rule for exposed movable conductors).
- b. Authorized persons, specific task trained, may work inside the limited approach boundary. In no case **shall** an authorized person be allowed to work as close to live parts as the restricted approach boundary allowed for a qualified person, as shown in Table 6.
- c. Qualified persons may work up to the restricted approach boundary distances listed in Table 6. If a person is working near the restricted approach boundary for an extended period of time, it is recommended that special precautions such as insulating and barricading be used. If a person crosses the restricted approach boundary they shall follow the requirements outlined in appendix B, item C.

A covered conductor **shall** be considered as having no insulating strength whatsoever and **shall** be treated as non-insulated.

#### **Note 1. See Section 11, Appendix B – Limits of Approach**

#### 4.2.4 Working on energized electrical conductors or circuit parts

Only persons qualified in the techniques required to work on energized electrical conductors or circuit parts shall be utilized for this work. When persons qualified for energized work must do work on energized parts, they shall do so only after an energized electrical work permit (EEWP) has been issued by management.

The employees shall insulate and/or isolate as required for the task. Any work on live parts shall utilize the procedures defined under “working inside the restricted approach boundary” (see Appendix B, Item C).

#### 4.2.5 Insulated Armored High Voltage Cable

The 10 foot rule does not apply to armored insulated High Voltage Cable. Work activities may be performed adjacent to this type of cable while it is energized. This type of cable **shall** not be disturbed or moved while it is energized without a documented plan that has been approved by the location manager or his or her designee.

#### 4.2.6 Insulated Non-Armored High Voltage Cable

This type of cable does not have the added protection of armor and the integrity of the insulation must be considered, the approval of the location manager or his or her designee and a documented plan is required before work activities may be performed within 10 feet of this type of cable while it is energized. This type of cable **shall** not be disturbed or moved while it is energized.

Note: Exceptions to the above movement of cables are special applications such as mining dragline and other moveable substation cables, ship unloader cable reels and equivalent applications for mobile equipment.

#### 4.2.7 Climbing Structures

##### a. Fall Prevention/Protection

Fall prevention/protection **shall** be used anytime an employee is working 6 feet or more above the ground. Follow the facility’s fall protection program.

##### b. Raising/Lowering Material/Equipment

All small equipment and tools to be used aloft or in manholes **shall** be raised and lowered by means of a handline, a canvas bucket or other suitable container. Care **shall** be taken by employees working in the area to prevent dropping and falling of tools or material. Employees on the ground **shall** stay clear of overhead work to reduce the potential of being struck by falling pieces.

#### 4.2.8 Only qualified employees may work on or near, or in an area where there are live parts operating at 50 volts or more. Electric lines and equipment **shall** be considered energized unless they have been isolated, locked out or tagged out, and grounded as required in the Section on Safe Work Practices. Operating voltages of equipment and lines **shall** be determined before work is performed on or near energized parts.

Except when performing routine switching or using live-line tools, two employees **shall** be present to perform the following types of work:

- a. Installation, removal, or repair of lines that are energized at more than 600 volts.
- b. Installation, removal, or repair of de-energized lines if there is exposure to contact with other parts energized at more than 600 volts.
- c. Installation, removal, or repair of any other equipment if the employee is exposed to parts energized at more than 600 volts.
- d. If there is work using mechanical equipment (other than insulated aerial lifts) near parts energized at more than 600 volts.

As noted above, two qualified employees are not required to be present to perform the following work functions:

- a. Routine switching if employer verifies that site conditions allow this function to be performed safely.
- b. Work using live-line tools, as long as the employee cannot make contact to live parts.

4.2.9 Unless an approved insulating handle is used, no employees may approach or take any conductive object closer to live parts than the restricted approach boundary shown in Table 6, except when:

- a. The employee is insulated from the energized part (rubber insulating gloves or rubber insulating gloves and sleeves, rated for the voltage, are considered to be insulation of the employee only from the energized part upon which work is being performed): **OR**
- b. The energized part is insulated from the employee and any other conductive object at a different potential; **OR**
- c. The employee is insulated from any other exposed conductive objects at a different potential (as in working on live parts).

If the employee is to be insulated from the live parts by use of rubber insulating gloves, insulating sleeves **should** also be used. However, sleeves are not required for the following conditions:

1. If live parts are insulated from the employee and these parts are not being worked upon; **AND**
2. If the employee's upper arms are not exposed to non-insulated energized electrical conductors or circuit parts.

4.2.10 Employees may not enter spaces that contain live parts unless adequate illumination is provided.

The employer **shall** ensure that, to the extent that other safety-related conditions permit, the employee works in a position so that a slip or shock will not bring the employee into contact with live parts.

- 4.2.11 When an employee works in a confined or an enclosed space that contains live parts, insulating materials such as protective shields or barriers **shall** be used to prevent inadvertent contact.
- 4.2.12 Employees shall use insulated tools or handling equipment, or both, when working inside the restricted approach boundary of exposed energized electrical conductors or circuit parts where tools or handling equipment might make accidental contact. Rubber insulated gloves with leather protectors shall also be used.
- Tools **shall** be rated for the voltage involved. Commercially available insulated hand tools (pliers, screwdrivers) are typically rated up to 1000 volts A.C.
- 4.2.13 Non current-carrying metal parts, such as transformer cases or circuit breaker housings, are considered energized to the highest voltage to which they are exposed until they are known by test to be totally free of voltage unless they are grounded by an equipment grounding conductor.
- 4.2.14 Employees **shall** remove all jewelry and similar conductive apparel while working within the restricted approach boundary or where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts.
- 4.2.15 When fuses are installed or removed with one or more terminals energized at more than 300 volts or with exposed parts energized at more than 50 volts, tools and gloves rated for the voltage **shall** be used.
- 4.2.16 Only devices designed to interrupt the current levels under load **shall** be opened under load.
- 4.2.17 When work is performed in the proximity of covered (non-insulated) wires, the work will proceed utilizing the same precautions as when working with live parts.

### 4.3 Equipment/Line Status

#### 4.3.1 Basic Rule

Electrical equipment and lines **shall** be considered energized until isolated, tested, locked out and/or tagged out, and grounded in accordance with section 4.4.1

#### 4.3.2 Proper Work Environment

Preferred Approach is to “deenergize”

Identify all potential voltage sources and make plans to positively control all conductors and isolating devices. See section 4.4 for steps to create an electrically safe work condition.

#### 4.3.3 Testing and Verification Techniques for Isolation

- Test for the absence of voltage before you touch exposed electrical conductors or circuit parts
- Check for absence of voltage on molded-case circuit breakers (600 volts and less) since they cannot be visually verified
  - + **Caution.** *Test for voltage both phase-to-ground and phase-to-phase.*
- Purchase panel boards (600 volts and less) pre-equipped with locking devices and use these devices
- Remove fuses from low-voltage switches that have covered blades, if applicable, after verifying there is no voltage
- Withdraw draw-out circuit breakers to the farthest position in the cubicle (with the line and load stabs disconnected) and completely remove the circuit breaker if a ground-and-test device will be applied
- Open isolation disconnects on circuit breakers within open-air switchyards. Remove any fuses for additional isolation
- Do not rely on control circuit isolation for lock out purposes. Provide primary circuit isolation on circuit breakers and motor starters (i.e., withdraw, or “rack out,” circuit breakers or open disconnect devices).

Consider all circuits energized until positively verified as de-energized by a voltage test. Use the concept “TEST BEFORE TOUCH.” Recognize that once no voltage is verified, there are still ways voltage can reappear on a de-energized system. Consider:

- Backfeeds from voltage transformers or control power transformers
- Undocumented alternate sources
- Missed lockouts
- Equipment not operating at the time of test
- Lightning
- Induced voltage
- Energized line contacting a de-energized line
- Insulation failure

#### 4.3.4 Temporary Safety Grounds - Grounding

Visible temporary safety grounds that are of adequate size to withstand the available short circuit current assure that the conductors tested as de-energized remain safe. The following procedure lists appropriate grounding techniques:

- a. Require grounding as final protection against backfeeds on:
  1. All switchgear buses
  2. All feeders from substations
  3. All open wire lines
- + **Caution.** *Grounds left on equipment when re-energized present a short circuit hazard. A positive method of control shall be used to assure removal before re-energizing (tags, leaving doors or covers open, leaving the ground cables clearly visible, use of magnetic ground signs, etc.)*
- b. Ground all motors equipped with power factor correction capacitors.
- c. Ground all motor circuits above 600 volts before working on the motor. Use a switchgear “ground and test device,” or connect grounds at the load-side cable connections of the circuit breaker or starter.
- d. Apply grounds as if the circuit were energized. Insulated cables can retain a capacitive charge and open wire lines can have induced voltage—both represent a shock hazard.
- e. When installing temporary safety grounds always attach temporary safety grounds to the ground conductor first and then connect the temporary safety ground to the circuit conductors. Always remove the temporary safety ground from the ground conductor last.
- f. Special situations:
  1. Ungrounded systems - Test for voltage both phase-to-ground and phase-to-phase before applying grounds.
  2. Cable cutting - Ground both ends where practical. Use a cable penetrator tool (such as A. B. Chance Company’s catalog number C600-1625) to penetrate the insulation at the point of the cut if the cable cannot be visibly traced from the point of the cut to one of the two ends.
- g. Special precautions:
  1. Disconnect all auxiliary devices, such as voltage transformers or control power transformers, by removing all fuses (primary and secondary) or by racking out.
  2. Account for and remove all grounds prior to re-energizing.
  3. Be aware of other voltage sources when isolating motor starter circuits.
  4. Remember that motor space heaters are usually supplied from “foreign” voltage sources.

## Routine vs complex work

Equipment to be worked on **shall** normally be tested, de-energized, locked out and tagged out according to established practices. While low voltages do not typically require the formalized procedures and written switching instructions required for high voltage work, a disciplined, thought-through procedure **shall** be followed. If the work to be done is extensive and complex, then a formal written switching order **shall** be followed to de-energize and lockout the equipment.

## 4.4 De-energizing lines and equipment for Employee Protection

4.4.1 An electrically safe work condition **shall** be achieved and verified by the following process:

- a. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
- b. After properly interrupting the load current, open the disconnecting device(s) for each source.
- c. Where it is possible, visually verify that all the blades of the disconnecting devices are fully open or that drawout type circuit breakers are withdrawn to the fully disconnected position.
- d. Apply lockout/tagout devices in accordance with a documented and established policy.
- e. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Before and after each test, determine that the voltage detector is operating satisfactorily.
- f. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.
- g. Mark the boundary of the electrically isolated work area (See section 4.9 on establishing work zones).

### 4.4.2 General Information

This section applies to the de-energization of transmission and distribution lines and equipment. See the Section on Lockout/Tagout for requirements of other equipment.

If an employee **must** depend on others to operate switches to de-energize lines or equipment, or if the employee **must** get special authorization to operate such switches, the requirements of De-energizing Lines and Equipment **must** be followed, in their exact order, before work may begin.

When an employee other than the system operator is in sole charge of the lines or equipment and the means of disconnection, that employee **must** comply with the requirements of De-energizing Lines and Equipment, taking the place of the system operator as necessary and being in charge of the clearance.

Each person **shall** install their personal lock/tag before start of work and remove their personal lock/tag when they complete work.

All disconnecting means accessible to persons (such as the general public) outside the employee's control, **shall** be rendered inoperable while they are open.

#### 4.4.3 De-Energizing Lines and Equipment

Follow these steps:

- a. A designated employee (who will be called "the employee in charge") **shall** request that a particular section of line or equipment be de-energized by the system operator. The employee in charge is responsible for the clearance.
- b. All switches, disconnectors, jumpers, taps, and any other means by which the energy is supplied to the particular lines or equipment **shall** be opened. These **shall** be rendered inoperable, by locks or other methods, to prohibit their further operation and **shall** be appropriately tagged to indicate that employees are at work.
- c. Automatically and remotely controlled switches that could cause the opened disconnection to close **shall** be tagged at the control point and **shall** be rendered inoperable, as design permits.
- d. Tags **shall** prohibit operation of all disconnecting means and **shall** indicate that employees are at work.
- e. After requirements 2(a) through (d) have been successfully concluded, the employee in charge will be given a clearance by the system operator. Then the employee in charge **shall** verify by appropriate tests that the lines and equipment to be worked on are isolated (de-energized).
- f. Appropriate grounds **shall** be installed as required. (See the Section 4.11 on Grounding.)
- g. Guards or barriers to adjacent energized lines and equipment **shall** be erected as necessary.
- h. After the grounds are installed as required, work may begin on the lines/equipment as de-energized.
- i. If two or more crews are working on the same lines or equipment, each crew **shall** have an independent clearance assigned to its employee in charge and each crew's protective grounds **shall** be installed.

- j. To transfer a clearance, the employee in charge, or the supervisor of the employee, in charge (in case of an emergency which would bring about an absence of the employee in charge), **shall** inform the system operator. Notification of transfer **shall** also be given to each crew member, and a new employee in charge **shall** be made responsible for the clearance.

#### 4.4.4 Releasing the Clearance

To release a clearance, the employee in charge **shall**:

- a. Notify employees under his/her direction that the clearance is to be released;  
AND
- b. Ensure all safety locks and tags have been removed, AND
- c. Ensure that all employees in the crew are clear of lines and equipment; AND
- d. Ensure that all protective grounds installed by the crew have been removed;  
AND
- e. Report this information to the system operator, hereby releasing the clearance.

#### 4.4.5 Re-Energizing the Lines

Prior to re-energizing the lines or equipment, the following steps **shall** be taken:

- a. All protective grounds **shall** be removed.
  - + **Caution.** *Grounds left on equipment when re-energized present a short circuit hazard. A positive method of control shall be used to assure removal before re-energizing (tags, leaving doors or covers open, leaving the ground cables clearly visible, use of magnetic ground signs, etc.)*
- b. All protective tags **shall** be removed from points of disconnection.
- c. All associated clearances **shall** be released.
- d. All employees **shall** be clear of the lines and equipment.

Unless responsibility has been transferred with the clearance as noted above, the employee requesting removal of the tags **shall** be the same employee that requested placement.

- e. Re-energize lines and equipment following the facility's procedures.

### 4.5 Power System Switching Procedures

- 4.5.1 A written switching order is required before any switching can be performed on the high voltage distribution power system (i.e. this does not include switching of individual motors). The switching order **shall** be written by a qualified person

and reviewed by at least one other qualified person. Both people **shall** sign and date the switching order before it may be used.

4.5.2 Before the start of any switching, A job briefing **shall** be held by the person in charge of the switching order. All employees that will be involved in the switching **shall** attend the job briefing. As a minimum the following items **shall** be reviewed:

- a. Reason switching is being performed.
- b. Review one line drawing and/or power system status board to assure that all involved understand what will occur.
- c. Discuss each step of the switching order.
- d. Make job assignments to all involved (who will do what).
- e. Discuss safety issues and required PPE.
- f. Review the following (if required).
  1. Electrical clearance requirements and/or Lockout/tagout issues.
  2. Location of safety grounds – to be installed or removed and by who.
  3. Other issues (such as operational limitations).

4.5.3 During switching the switching order **shall** be followed in the order that it is written (step 1, 2, 3, etc.). Each switching step **shall** be checked off when completed. It is recommended that the time the switching step is completed be recorded. The following switching procedures and information items are recommended:

- a. The person receiving a switching command should repeat the switching command and have it confirmed by the person issuing the order before executing the command.
- b. If switching commands are given by radio, a unique switching channel should be used. Cross talk on the radio during switching could cause a switching error.
- c. When the switching is complete the status of the power system should be documented. Use of a status board or pin board is one method of accomplishing this issue.
- d. Information on abnormalities of the power system should be documented in order to inform off shift personnel who may be involved in responding to power system problems. It is recommended that this information be posted near a power system status board or pin board.
- e. It is recommended that open electrical clearances (or parts of the power system under lockout/tagout), the location of any safety grounds, and other

power system safety issues be posted near the power system status board or pin board.

- f. 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.

## 4.6 Job Safety Planning and Job Briefings

4.6.1 Before starting each job that involves exposure to an electrical hazard, the employee in charge shall complete a job safety plan and conduct a job briefing with all employees involved in the job. The job safety plan shall be completed by a qualified person, documented, and include the following information as a minimum;

- a. A description of the job and individual tasks
- b. Identification of electrical hazards associated with each task
- c. A shock and arc flash risk assessment
- d. Work procedures involved, special precautions, and energy source controls

Additional job safety planning and job briefings shall be held if changes occur during the course of the work that might affect the safety of employees.

4.6.2 The shock and risk assessment shall address employee exposure to all electrical hazards and shall identify the process to be used by the employee before work is started. The risk assessment shall include the following items as a minimum:

- a. Identify hazards
- b. Assess risk
- c. Address the potential for human error
- d. Implement risk control according to the hierarchy of risk control measures.

4.6.3 The risk assessment procedure shall require that preventive and protective risk control methods be implemented in accordance with the following hierarchy:

- a. Elimination
- b. Substitution
- c. Engineering Controls
- d. Awareness
- e. Administrative Controls
- f. Personal Protective Equipment (PPE)

Informational Note: Elimination, substitution, and engineering controls are the most effective methods to reduce risk as they are usually applied during the design stage to address possible injury or damage to health and they are less likely to be affected by human error. Awareness, administrative controls, and PPE are the least effective methods to reduce risk as they depend on human performance and are more likely to be affected by human error.

4.6.4 The job briefing **shall** cover at least the following subjects:

- a. Hazards associated with the job.
- b. Work procedures involved.
- c. Special precautions.
- d. Energy source controls.
- e. Personal protective equipment requirements.
- f. The use of barricades to identify the work area.

4.6.5 During the job briefing, each person involved **shall** be able to answer the following questions in the affirmative before beginning the jobs:

- 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 possibly 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?

4.6.6 A person working alone **shall** plan their work as though a briefing is required.

Note: See Job Briefing Checklist in Appendix F

## 4.7 Personal Protective Equipment

4.7.1 Arc Flash Labels and Incident Energy Analysis

4.7.1.1 Arc Flash Label Requirements – Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized shall be marked with a label containing all the following information:

- Nominal system voltage
- Arc flash boundary
- At least one of the following:
  - Available incident energy and the corresponding working distance, or the arc flash PPE category
  - The incident energy calculated or the PPE category but not both
  - Minimum arc rating of clothing

- Site-specific level of PPE

Exception – In supervised industrial installations where conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system, the information required for arc flash protection shall be permitted to be documented in a manner that is readily available to persons likely to perform examination. Servicing, maintenance, and operation of equipment while energized.

4.7.1.2 Incident Energy Analysis Method - The incident energy exposure level shall be based on the working distance of the employees face and chest area from the prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task. Incident energy increases as the distance from the arc flash decreases. Additional PPE shall be used for any parts of the body that are closer than the working distance at which the incident energy was determined.

- The incident energy analysis shall take into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance.
- The incident energy analysis shall be updated when changes occur in the electrical distribution system that could affect the results of the analysis. The incident energy analysis shall be reviewed for accuracy at intervals not to exceed 5 years.

The following personal protective equipment is recommended. Specific personal protective equipment requirements will be designated during the job briefing before start of each job. (see “PPE Category Tables” and “Incident Energy Analysis Tables” in section 11, Appendix C)

#### 4.7.2 Clothing/Apparel

- a. The employer **shall** ensure that employees who are exposed are trained in the hazards of arcs and flames of arcs.
- b. A shock hazard analysis and flash hazard analysis **shall** be performed before a person approaches an exposed electrical conductor or circuit part that has not been placed in an electrically safe work condition.
- c. It has been demonstrated that wearing arc-rated clothing (long sleeves and long pants) may reduce the severity of burns if an electrical flash occurs. No clothing made, either alone or in blends, of acetate, nylon, polyester, or spandex is permitted unless the fabric has been treated to withstand the conditions that may be encountered. No clothing, including undergarments, may be worn that will increase the extent of an injury sustained from a flame or arc. Meltable fabrics **shall** not be permitted in fabric underlayers (underwear) next to the skin.

- d. The employer **must** ensure that conductive articles **shall not** be worn in close proximity or within reaching distance of energized electrical conductors or circuit parts. This **shall** include such items as rings, metal watch bands, unrestrained metal-framed eyewear, metal dangling jewelry and key chains.

4.7.3 Head Protection

- a. Class E hard hats **shall** be worn as required when working in near proximity to energized or potentially energized conductors or non-insulated, exposed equipment parts (See ANSI Z89.1).
- b. Hard hats **shall** be kept clean and in good condition and **shall not** be altered in any manner except for the addition of company approved markings.

4.7.4 Eye Protection

Approved safety glasses, with non-conductive sideshields, **shall** be worn at all times when working with or in close proximity to potentially energized conductors or exposed non-insulated parts. (See ANSI Z87.1). Goggles and/or face shields may also be required.

4.7.5 Hand Protection

- a. Rubber insulating gloves with leather protectors **shall** be worn any time an employee is working with energized, or potentially energized, conductors or equipment. At no time **shall** the rating on the glove be exceeded.

**INSULATING RUBBER GLOVES**

<b>CLASS</b>	<b>MAXIMUM USE VOLTAGE (AC)</b>	<b>TEST VOLTAGE (AC)</b>
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

- b. Rubber insulating gloves with protectors **shall** be worn as an added means of protection any time an employee is using live-line tools or test probes.
- c. Rubber insulating gloves with protectors **shall** be worn during the installation or removal of safety grounds.
- d. Only gloves dielectrically tested within the previous six (6) months **shall** be used. (ref. ASTM F496)

- e. Gloves **shall** be inspected and air tested before each use and immediately following any incident that can reasonably be suspected as having caused damage. Air testing is performed by trapping air in the glove and examining for pin hole or other apparent leakage. (see appendix O)
- f. Gloves **shall** be worn with approved protectors.
- g. Gloves **shall** be stored in an approved glove bag or an equivalent protective location.
- h. If possible, store gloves with the cuffs down.

## 4.8 Tools

### 4.8.1 Live-Line Tools

- a. Each live-line tool **shall** be wiped clean and visually inspected for defects before use each day.
- b. If, after wiping, the tool has contaminants which could affect its insulating qualities or if its mechanical integrity is questionable, the tool **shall** be removed from service and repaired. The tool **shall** then be retested, using the testing program procedures described below.
- c. Each live-line tool **shall** be removed from service at least every two years and **shall** be given the following examination and tests:
  - 1. Each tool **shall** be thoroughly examined for defects.
  - 2. If defects or contaminants that could affect the insulating qualities or mechanical integrity of the tool are found, the tool may be repaired and refinished or the tool **shall** be permanently removed from service.
  - 3. If no defects are detected and no contaminants found, the tool **shall** be cleaned and waxed. (use wax approved for live line tools)
  - 4. The test method **shall** test the entire working length of the tool.
  - 5. If the tool is made of fiberglass-reinforced plastic, it **shall** be tested under wet conditions over the entire working length of the tool.
  - 6. If the tool is made of fiberglass-reinforced plastic (FRP), the test **shall** consist of applying 100,000 volts per foot of length for 5 minutes. (ref. 29 CFR 1910.269 section j.1.i, IEEE 978)
  - 7. Other high voltage tests are acceptable if the employer can demonstrate that these are equivalent (such as IEEE Std. 978-1984).
- d. Live line tools **shall** be stored in a clean and dry location. Live line tools **should** not be placed on the ground.

### 4.8.2 Tools (General)

- a. Ground fault circuit interrupters **shall** be used when using cord connected portable power tools or other cord connected equipment.
- b. Cord connected portable power tools, extension cords, and other cord connected equipment **shall** be inspected before each use. All extension cords **shall** be periodically inspected.
- c. Hand and Portable Power Tools

Any cord- and plug-connected equipment not supplied by premises wiring **shall**:

1. Be equipped with a cord containing an equipment-grounding conductor connected to the tool frame and to a ground at the other end. (If the ground in the work environment increases the hazard, it may be omitted);  
OR
  2. Be of the double-insulated type; OR
  3. Be connected to the power supply through an isolating transformer with an ungrounded secondary.
- d. Portable and vehicle-mounted generators being used to supply cord- and plug-connected equipment **shall** meet the following requirements:
    1. The generator can supply only the equipment located on the generator or vehicle and cord- and plug-connected equipment through receptacles mounted on generator or vehicle.
    2. The non-current-carrying metal parts of the equipment and the equipment-grounding conductor terminals of the receptacles **shall** be bonded to the generator frame.
    3. With vehicle-mounted generators, the frame of the generator **shall** be bonded to the vehicle frame.
    4. Any neutral conductor **shall** be bonded to the generator frame.

Note: Portable generators may be used for temporary power to switchgear and/or motor control centers.

- e. Hydraulic and Pneumatic Tools

Hydraulic and pneumatic tools **shall** meet the following requirements:

1. Safe operating pressures may not be exceeded for hydraulic and pneumatic tools, hoses, valves, pipes, filters, and fittings.
2. A hydraulic or pneumatic tool used where it may contact live parts **shall** be designed and maintained for such use.

3. The hydraulic system supplying a hydraulic tool that may contact live parts **shall** provide protection against loss of insulating value for the voltage involved due to formation of a partial vacuum in the hydraulic line. (35 feet or more elevation between reservoir and hose end, if there are no check valves, promotes formation of a partial vacuum.)
  4. A pneumatic tool used on energized lines or equipment or where it could contact live parts **shall** provide protection against the accumulation of moisture in the air supply.
  5. Pressure **shall** be released before connections are broken, unless quick acting, self-closing connectors are used. Hoses **shall not** be kinked.
  6. Employees **shall not** use any part of their bodies to locate or attempt to stop a hydraulic leak.
- f. Ladders and Platforms
1. Ladders and platforms **shall** comply with Subpart D of 1910.
    - a. They **shall** be properly secured to prevent their becoming dislodged.
    - b. They **shall** be used only in applications for which they were designed.
    - c. They **shall** be capable of supporting without failure at least 2.5 times the maximum working load.
    - d. They **shall** not be loaded in excess of the working load for which they were designed.
  2. Ladders and platforms **shall** be non-conductive when used for electrical tasks. Ladders and platforms shall be secured to prevent their becoming accidentally dislodged.

## 4.9 Barricades/Work Zones

Barricades may be required to mark the work zone to safeguard personnel from potential hazards. Barricades in conjunction with safety signs shall be used to limit or prevent access to work areas where hazards may exist.

In some instances it will be necessary to barricade or otherwise identify a work area as containing electrical hazards not normally encountered during routine operation of the equipment and/or conductors located therein. This would normally be the case during maintenance, renovations to existing installations, and additions to installations where electrical equipment and/or conductors are located. Appropriate identification makes employees more aware of the hazards in their work areas.

### 4.9.1 Area Protection

- a. Areas accessible to qualified employees only:

1. If the work exposes energized or moving parts that are normally protected, danger signs **shall** be displayed. Suitable barricades **shall** be erected to restrict other personnel from entering the area.
2. When working in a restricted section that adjoins other such sections, a qualified employee **shall** mark the work area conspicuously and **shall** place barriers to prevent accidental contact with exposed energized parts in adjacent sections. Such sections can include a portion of a substation, one section of switchgear, a row of transformers or breakers, or one panel of a switchboard.

**Note: Use designated work zones around “look alike” equipment.**

3. Qualified people shall determine the size of the work zone, and shall consider the types and size of conductive materials and equipment to be used in the area, the limited approach boundary (Table 6), and the flash protection boundary.

- b. Areas accessible to vehicular and pedestrian traffic:

Where vehicles and non-qualified pedestrian traffic may pass adjacent to electrical equipment that is under maintenance, operating, or construction activity which could compromise the safety of these vehicles and pedestrians, appropriate warning signs and/or barricades **shall** be used.

#### 4.9.2 Use of Electrical Hazard Barricade Tape/Rope

- a. Electrical hazard barricade tape/rope is intended to be used as a temporary hazard warning. Temporary may be defined as the duration of any work assignment where there is an active effort to complete a permanent installation and employee safety is not compromised.
- b. The recommended color is red.

It is further recommended that the red tape be imprinted with wording such as “Danger -- Do Not Enter”.

#### 4.9.3 Enclosed Spaces

These requirements apply only to enclosed spaces, such as manholes, unvented vaults, tunnels, etc. that can be entered by employees. All other confined spaces are covered by 29 CFR 1910.146.

- a. The employer **shall** ensure that the employee uses safe work practices for entry into and work within enclosed spaces and for rescue of employees from such places. Furthermore, if hazards remain after the precautions taken for enclosed space are exercised or if the escape procedures cannot be met, then entry into enclosed spaces **shall** meet the requirements of permit-space or confined space requirements of 29 CFR 1910.146.

- b. Employees who enter enclosed spaces or serve as attendants **shall** be trained in the following:
  - 1. The hazards of enclosed space entry.
  - 2. Enclosed space entry procedures.
  - 3. Enclosed space rescue procedures.
- c. Employees **shall** be provided equipment to ensure prompt and safe rescue.
- d. Before removal of any entrance cover to an enclosed space, the employer **shall**:
  - 1. Check for atmospheric pressure and temperature differences
  - 2. Determine whether there is a hazardous atmosphere in the enclosed space
  - 3. Eliminate any conditions that make it unsafe to remove the cover.
- e. After the removal of a cover to an enclosed space, the opening **shall** be guarded by a railing or a temporary cover/barrier.

Such precautions will help to prevent an employee from falling into the enclosed space and will help to prevent objects from falling into the enclosed space and causing injury to the employee.

- f. An employee cannot enter an enclosed space which contains a hazardous atmosphere (confined space hazardous atmosphere) unless the entry meets requirements of 29 CFR 1910.146.
- g. If, while work is being performed in the space, there is reason to believe that a hazard may exist in the space or that traffic may cause a hazardous condition, an attendant with first aid training **shall** be immediately available to render emergency assistance. This attendant may perform tasks outside the enclosed space.
- h. All test equipment used to monitor atmosphere in enclosed spaces **shall** be kept in calibration.

+ **Caution:** *Test devices shall be approved as intrinsically safe.*

- i. Before an employee enters the space, the following tests **shall be performed**.
  - 1. The internal atmosphere **shall** first be tested for oxygen deficiency.
  - 2. The internal atmosphere **shall** then be tested for flammable gases and vapors.
  - 3. Each test **shall** use a direct-reading meter that is capable of collection and immediate analysis of data samples, thus eliminating the need for off-site

evaluation. Oxygen deficiency testing **is not required** if continuous forced air ventilation is provided.

- j. If flammable gases or vapors are found to be present or an oxygen deficiency exists, then forced air ventilation **shall** be used to maintain a safe level of oxygen and to prevent the accumulation of flammable gases or vapors from reaching a hazardous concentration.
- k. If flammable gases or vapors are found to be at a safe level, forced ventilation may be waived, providing there is continuous monitoring to ensure that there is no increase of either.
- l. If continuous forced air ventilation is used, it **shall** meet the following criteria:
  - 1. It **shall** begin and be maintained long enough before workers are allowed to enter the enclosed space to ensure that a safe atmosphere exists.
  - 2. It **shall** be directed to the employees' immediate area.
  - 3. It **shall** continue until all employees have left the enclosed space.
  - 4. The supply for the continuous forced air ventilation **shall** be from a clean source and **shall not** contribute to the hazard in the enclosed space.
- m. If open flames are used in the enclosed space, a test for flammable gases or vapors **shall** be made immediately before the open flame device is used and at least once each hour while the device is being used in the enclosed space. More frequent tests **shall** be conducted if there is an indication that one hour periods are insufficient.

Note: Local "Hot Work" procedures shall be used.

#### 4.9.4 Underground Electrical Facilities

The following are additional requirements for work on underground electrical installations in manholes and/or vaults:

- a. Ladders or other climbing devices **shall** be used to enter or exit manholes or subsurface vaults that exceed 4 feet (122cm) in depth. Employees **shall not** use cables or hangers as steps to climb in or out of manholes and vaults.
- b. Equipment used to lower materials and tools **shall** be capable of supporting the weight and **shall** be checked for defects before use. Employees working in manholes and vaults **shall** stand clear of the area directly underneath openings while tools or materials are lowered or raised.

- c. While work is being performed in a manhole that contains energized electric equipment, an employee capable of rendering emergency assistance **shall** be on duty in the immediate vicinity of the manhole opening. The attendant **shall** be trained in CPR, first aid, hazards of enclosed space entry, enclosed space entry procedures, and enclosed space rescue procedures.

Rescue equipment **shall** be present at the worksite to ensure the prompt and safe rescue of employees from the enclosed space if the enclosed space contains live parts. Rescue equipment shall include a mechanical device to retrieve personnel, a full body harness (wristlets may be used in lieu of the harness), and a retrieval line.

An employee working alone may enter a manhole where energized cables or equipment are in service if the nature of the visit does not involve the energized cables or equipment but is for the purpose of housekeeping, inspection, meter reading, or similar activities. This is permitted only if it can be done safely.

When working in a manhole or vault with energized electrical cables or equipment, all employees **shall** be in constant communication. This can consist of visual, voice, or signal-line communication.

- d. If pulling tapes are to be used, pulling tapes **shall** be installed in the direction that presents the least amount of hazard to employees. An employee **shall** be stationed at the far end of the duct line to ensure that required minimum approach distances are maintained to protect employees.
- e. An energized cable may be moved only under the direct supervision of a qualified employee. It **shall** first be inspected for defects.
- f. When multiple cables are present, exact identification **is required** by electric means unless identification is obvious. All other cables not being worked on **shall** be protected against damage.
- g. Cable cutting - Ground both ends where practical. Use a cable penetrator tool (such as A. B. Chance Company's catalog number C600-1625) to penetrate the insulation at the point of the cut if the cable cannot be visibly traced from the point of the cut to one of the two ends.
- h. Cables may be defective when any of the following abnormalities are observed:
  - 1. Oil or compound leaking from cable or joints
  - 2. Broken cable sheaths
  - 3. Broken joint sleeves
  - 4. Hot surface temperatures
  - 5. Joints swollen beyond normal tolerances.

When any one of these conditions occurs, no employees are permitted in the manhole while the cable is energized. However, if de-energizing the cable is not possible, employees **shall** be protected against effects of the failure by shields that are capable of containing the adverse effects of a fault in the joint.

- i. Sheath continuity **shall** be maintained while work is performed on buried cable or on cables in manholes, or the sheath **shall** be treated as energized.

#### 4.9.5 Trenches and Excavation

All trenching and excavation **shall** be preceded by notification to others having underground installations in the affected location. Normal trenches or excavations less than 4 feet deep do not require a protection system if a competent person has determined there is no cave-in potential.

Otherwise, all trenching and excavation operations **shall** comply with 29CFR 1926.650, 1926.651 and 1926.652.

### 4.10 Lockout/Tagout

#### 4.10.1 General Industry Lockout/Tagout

The procedures in this section apply to the servicing and maintenance of machines and equipment in which the unexpected startup of the equipment or the release of stored energy could cause injury to employees (reference 29 CFR 1910.147 and 1910.333).

- a. Management **shall** establish a program of energy control procedures, training, and periodic inspections to ensure that before an employee services a machine or equipment all potentially hazardous energy sources are isolated and rendered inoperative.
  1. If equipment is capable of being locked out, it **shall** be locked out unless the employer can demonstrate that tagout alone will provide full employee protection.
  2. If equipment is not capable of being locked out, tagout only may be used. However, when that equipment is modified or undergoes major repair, it **shall** be retrofitted to accept a lockout device.
  3. If tagout only is utilized, additional safety measures **shall** be used, such as removal of an isolating element, blocking of a control switch, or removal of a valve handle to reduce the likelihood of inadvertent energization. The employer **shall** also demonstrate compliance with all tagout related requirements.
- b. Management **shall** ensure the development of lockout/tagout procedures that include:
  1. A specific statement of the intended use of the procedure.

2. Specific procedural steps for shutting down, isolating, blocking, and securing machines or equipment.

The procedure shall include requirements for releasing stored electric or mechanical energy that might endanger personnel. All capacitors shall be discharged, and high-capacitance elements shall also be short-circuited and grounded before the associated equipment is touched or worked on. Springs shall be released or physical restraint shall be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs. Other sources of stored energy shall be blocked or otherwise relieved.

3. Specific procedural steps for the placement, removal, and transfer of lockout or tagout devices and the responsibility for them.
  4. Requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other control measures.
- c. Management **shall** supply the lockout/tagout materials including locks, tags, chains, wedges, key locks, or other hardware for the isolating, securing, or blocking of equipment from energy sources.

Lockout/tagout devices **shall** meet the following criteria:

1. They **shall** be capable of withstanding the environment to which they are exposed.
2. Locks and tags **shall** be standardized in at least color, shape or size.
3. For tagout devices, print and format **shall** be standardized.
4. Lockout devices **shall** be substantial enough to prevent removal without the use of excessive force.
5. Tagout devices **shall** be substantial enough to prevent inadvertent removal.
6. Lockout and tagout devices **shall** have provisions for the identification of the person applying the devices.
7. Tags **shall** warn against the hazardous conditions if re-energized and **shall** include at least one of the following statements:

Do not start.  
Do not open.  
Do not close.  
Do not energize.  
Do not operate.

- d. Annual Inspections

1. Management **shall** conduct annual inspections. Authorized employees other than those applying the lockout/tagout devices **shall** conduct the inspections. Management **shall** certify that the inspections have been performed and **shall** record the identity of the machine, date of inspection, employees included in the inspection, and the name of the inspector.
  2. Where lockout and tagout are used, the annual inspection **shall** include a review between each authorized employee and the inspector responsible for monitoring that employees' responsibilities.
- e. Management **shall** provide training to ensure that the purpose and function of the energy control program is understood and that personnel with knowledge and skill are available for safe application, usage, and removal of energy control as necessary.
1. Authorized employees **shall** be trained to recognize the applicable hazardous energy sources, the type and magnitude of energy sources, and the proper techniques for energy isolation and control.
  2. Affected employees **shall** be instructed in the purpose and use of the energy control procedure.
  3. Other employees whose work may be in areas where energy control is utilized **shall** be instructed about the procedure and the prohibition against restarting machines which have been locked/tagged out.
  4. When tagout only is used, employees **shall** also be trained in the following limitations of tags:
    - a. Tags are warning devices only and do not provide physical protection.
    - b. A tag is not to be removed without the authorization of the person who applied it. It **shall not** be bypassed, ignored, or defeated.
    - c. Tags **shall** be legible and capable of being understood by all in the area.
    - d. Tags **shall** withstand the environment in the workplace.
    - e. Tags **shall** be securely attached.
    - f. Authorized and affected employees **shall** be retrained when their assignment changes, when equipment changes, or when energy control procedures change. Retraining is also required when a periodic inspection reveals inadequacies in the program.
    - g. Management **shall** certify that training has been accomplished.
    - h. Actual lockout/tagout **shall** be performed as follows:
      1. Lockout/tagout **shall** be performed only by the authorized employees who will be servicing the machine.

2. Affected employees **shall** be notified in advance of the application or removal of lockout or tagout devices.
3. The machine will be shut down in an orderly fashion using established procedures.
4. All energy isolating devices necessary **shall** be located and **shall** be operated in such a manner as to isolate the equipment from the energy source.
5. Locks will be installed to hold the energy isolating device in a “safe” or an “off” position. Tags will be installed to indicate that movement of energy isolating devices from the “safe” or “off” position is prohibited.
6. Where tagout devices are used with energy isolating devices capable of being locked, the tag will be affixed at the same point at which a lock would have been attached. If the tag cannot be attached directly to the energy isolating device, it will be located as close as possible to the device, in a position that will be immediately obvious to anyone trying to operate the device.
7. Following the application of the lock/tag, relieve all potentially hazardous sources of stored energy. If stored energy can re-accumulate, verification of the isolation **shall** continue as long as necessary.
8. Prior to servicing the machine, the authorized employee **shall** verify that the machine has been de-energized and isolated.
- i. Prior to removing lockout/tagout devices and re-energizing the equipment, the authorized employee **shall** do the following:
  1. Remove nonessential items from the work area.
  2. Ensure that all employees are safe. Notify affected employees that lockout/tagout devices are going to be removed.
  3. Lockout/tagout devices **shall** be removed only by the employee who applied them.

Exception: If the employee who applied the lockout/tagout devices is not available to remove them, the devices may be removed under the direction of the employer by another employee if management:

- a. Verifies that the authorized employee who applied the devices is not at the facility; AND
- b. Makes reasonable efforts to contact the employee who applied the devices; AND

- c. Ensures that the authorized employee is informed of the device removal before the employee resumes work.
- j. When lockout/tagout devices **must** be temporarily removed from the machine for testing or positioning, the following precautions **are required**:
  1. Clear equipment or process of nonessentials items.
  2. Ensure that all employees are removed from the area or are safely positioned.
  3. Remove lockout/tagout devices.
  4. Energize and proceed with testing/positioning.
  5. De-energize equipment and re-apply lockout/tagout devices.
- k. When contractors are involved in lockout/tagout, the on-site employer and the contractor **shall** inform each other of their respective procedures. Lockout/tagout procedure **shall** be strictly adhered to.
- l. The lockout/tagout program **shall** require each person to install their personal lock and tag before start of work and remove their personal lock and tag when they complete work. The use of “lockboxes” can be used for this purpose.
- m. When servicing is performed by a group of employees, procedures **shall** ensure a level of protection equal to that of individual lockout/tagout devices.
  1. Primary responsibility will be vested in one authorized employee for the group.
  2. The designated authorized employee **shall** be able to ascertain the exposure status of individual group members.
  3. When more than one crew is involved, one authorized employee **shall** be assigned responsibility to coordinate affected groups and ensure continuity of protection.
  4. Each person **shall** install a personal lock and tag before start of work on a machine or equipment. Each person shall remove their personal lock and tag at the end of work on a machine or equipment.
- n. During shift changes, procedures **shall** be in place to ensure the continuity of lockout/tagout protection. There **shall** be an orderly transfer of lockout/tagout devices between off-going and on-coming employees.

- o. The requirements above in the Section on General Industry Lockout/Tagout, apply to exposure to electrical hazards from work on, near or with conductors or equipment in electric utilization installations provided that:
  - 1. The procedures address electrical safety hazards.
  - 2. The procedures incorporate the following:
    - a. A tag used without a lock **shall** be supplemented with at least one additional safety measure that provides safety equivalent to that obtained by use of a lock (for example, removal of an isolating circuit element, blocking of a control switch, or opening of an extra disconnecting device).
    - b. A qualified person **shall** use voltage test equipment to test circuit elements and electrical parts of equipment to which employees will be exposed and **shall** verify that the circuits and parts are de-energized. The test **shall** also determine whether a hazard from induced voltage or voltage backfeed exists. The voltage test equipment **shall** be checked for proper operation immediately before and immediately after this test.
- p. Conductors and parts of electric equipment that have been de-energized but have not been locked out or tagged out in accordance with this standard **shall** be treated as energized parts. For information about work on energized parts, see the Section on Working on Energized Equipment.

#### 4.10.2 Power Generation Lockout/Tagout

##### Tagout and Lockout Procedures

The procedures below apply only to energy sources in installations for the purpose of electric power generation.

It **shall** be ensured that, before an employee begins any task that could result in injury from unexpected energization, startup, or release of stored energy, all potentially hazardous energy sources **shall** be isolated, locked out/tagged out, and disabled. Lockout/tagout is a required part of the de-energization process.

The employer **must** ensure that the installation has a documented lockout/tagout procedure and that it meets the following criteria:

- a. The procedure **shall** clearly cover at least the following topics:
  - 1. The scope, purpose, responsibility, authorization, rules, and techniques for the control of hazardous energy.
  - 2. The measures for enforcing compliance with the following guidelines, plus any other guidelines applicable:

- a) A specific statement for the intended use of the procedure.
  - b) Exact procedural steps for the shutting down, isolating, blocking, and securing of energy sources; exact procedural steps for the placement, removal, and transfer of locks and tags; and exact instructions concerning who is responsible for performing these steps.
  - c) Specific requirements for testing a system to determine the effectiveness of lockout/tagout.
- b. The employer is responsible for conducting inspections at least annually to ensure that the energy control procedures are being implemented. The inspection is to be performed by an authorized employee who is not using the energy control procedure and should be designed to identify and correct any deficiencies. The employer **shall** certify that these inspections have been accomplished.
  - c. The employer **shall** provide training to ensure that the purpose and function are understood and that personnel have acquired knowledge and skills for safe application, usage, and removal of energy controls, as necessary.
    1. Authorized employees **shall** be trained to recognize applicable hazardous energy sources and to use the proper techniques for isolation and control.
    2. Affected employees **shall** be instructed in the purpose and use of the energy control procedure.
    3. Other employees with access to areas affected **shall** be instructed about the control procedures and their effect on their work operation. These employees are prohibited from attempts to restart or re-energize locked out or tagged out equipment or machines.
    4. Management is responsible for periodic (at least annual) retraining (on-the-job or special training) to keep authorized and affected employees proficient and to provide current data on control methods and procedures. Also, retraining is required if a change of job assignment, a change of machine, a change of equipment, or a new hazard is introduced. Inadequacies discovered in inspection or observation **shall** require retraining.
    5. Management **must** certify that employee training is current. Documentation **must** indicate the employee's name and dates of training.
  - d. The lock and tag devices **must** meet the following criteria.
    1. They are provided by management and are the only authorized devices used for controlling energy.

2. They **must** be capable of withstanding exposure to their environment for the maximum period of time expected.
3. At least one of the following features of the locks and tags **shall** be standardized:
  - a. Color
  - b. Shape
  - c. Size
  - d. Type
  - e. Format.
4. Key codes for the locks will be complex and locks substantial enough that excessive force or heavy duty metal cutting tools would be required in place of the regular key. Tags and attachment mechanisms **shall** be designed so that the possibility of accidental removal is minimized.
5. Locks and tags **shall** have provisions for the identification of persons applying the devices or authorizing their application.
6. Tags **shall** specify the hazardous conditions that could occur if the equipment is re-energized and **shall** include at least one of the following statements (or statements worded similarly to these):
  - a. Do not start.
  - b. Do not open.
  - c. Do not close.
  - d. Do not energize.
7. Additional information on accident-prevention tags is provided in 29 CFR 1910.145.
8. Each energy-isolating device **shall** be labeled or marked to indicate its purpose unless the purpose is evident. These devices may only be operated by authorized employees or under the supervision of an authorized employee.
9. Affected employees **shall** be given notification of the application and removal of lockout/tagout devices. This notification **shall** be done by the employer or an authorized employee prior to the action itself.
10. Additional lockout/tagout requirements:

- a. If an energy isolating device is not capable of being locked, a tagout **shall** be used.
- b. If the device can be locked, it **must** be. However, if the employer can demonstrate in its program that a tagout provides the same level of employee protection, tagout is permissible providing the following requirements are made:
  1. The tag is affixed at the same location as the lock.
  2. The tagout program provides the same level of safety with additional measures, such as the removal of the circuit element, blocking a control switch, or opening an extra disconnect or removal of a valve handle.
- c. Major renovation or repair **shall** require that devices that cannot be locked be designed and fitted for a lock.
- e. The actual lockout/tagout application **shall** be performed as follows:
  1. Designated employees **shall** move the controls to the off or neutral position for the equipment on which work is to be performed.
  2. All energy-isolating control devices **shall** be operated to isolate the equipment from all energy sources.
  3. A lock and/or a tag **shall** be applied to each energy-isolating control device by an authorized employee.
  4. Locks **shall** be attached to the energy-isolating device in such a manner as to ensure that it is held in a safe position. Tags **shall** be placed to inhibit the device's operation. If direct attachment is impossible, the tag **shall** be placed in the position that best prohibits accidental operation.
  5. After application of a lock and/or a tag, all potentially hazardous stored or residual energy **shall** be detected and **shall** be disconnected, or restrained to ensure a safe work area.
  6. If there is a possibility of re-accumulation of stored energy, verification of isolation **shall** continue until a need no longer exists.
  7. Before work begins on equipment or processes that have been locked or tagged out, an authorized employee **shall** verify isolation and de-energization. If direct contact is to be made with normally energized parts, a test **shall** be performed to ensure that those parts are de-energized.
- f. Before energy can be restored to the equipment or process, the release **shall** proceed as follows:

1. An authorized employee **shall** establish that all nonessential items have been removed, that all components are operationally intact, and that no inadvertent startup can occur.
2. An authorized employee **shall** verify that all employees are in the clear.
3. A lock or tag **shall** be removed only by the employee who applied it. Locks and tags may be removed by a different authorized employee if the employer has documented the procedures and trained the employees on the specific procedures incorporated in the employer's energy control program and if the following specific conditions are met:
  - a. The employee who applied the locks and/or tags is not at the facility.
  - b. The employee who applied the locks and/or tags has knowledge of removal before returning to the facility.
  - c. There are unique operating conditions with complex systems, and the employer can prove it is not feasible to do otherwise.
- g. When energy-isolating devices are locked and/or tagged and a need arises to test or position the equipment or process, the following actions are required:
  1. Clear the equipment or process of nonessential items.
  2. Clear employees from the area.
  3. Clear the controls of locks and tags as prescribed.
  4. Energize the equipment or process; perform the test or positioning.
  5. De-energize all systems and re-apply energy control measures.
- h. Ensure that all locks and/or tags that protect areas, crews, or departments provide the same level of protection as would personal locks and/or tags. Personal lockout and tagout devices **shall** be affixed to group lock box or comparable mechanism.
- i. Specific procedures **must** be developed to provide continuity of protection during shift and employee changes.
- j. The employer **shall** ensure that contractors and their employees follow the lockout/tagout procedure in place at the work site. If the contractor does not have authorized employees properly trained in lockout/tagout procedures, the employer **shall** provide an authorized employee to operate or direct the procedure.

## 4.11 Grounding (Temporary Protective Grounds)

### Part 1 - Traditional Methods

This section applies to the grounding of transmission and distribution lines and equipment.

- 4.11.1 For employees to work on lines or equipment designated as de-energized, a clearance **shall** be issued or all isolating points locked and tagged and appropriate temporary protective grounds, as detailed in this section, **shall** be installed. (see item 4.11.9 below)
- 4.11.2 Before any ground is installed, the lines or equipment **shall** first be tested for absence of voltage unless a previously installed ground is present. Before installation of the grounds, the grounding equipment **shall** be visually inspected to confirm the equipment's integrity.
- + **Caution.** *Grounds left on equipment when re-energized present a short circuit hazard. A positive method of control shall be used to assure removal before re-energizing (tags, leaving doors or covers open, leaving the ground cables clearly visible, use of magnetic ground signs, etc.)*
- 4.11.3 Temporary protective grounding equipment **shall** be installed at the work location.
- If installation of grounds at the work location is not feasible, grounds **shall** be installed on each side of the work location, as close to it as possible.
  - Single-point grounding (equipotential grounding) is an acceptable means of grounding.
- 4.11.4 Protective grounding equipment **shall** be capable of conducting the maximum ground-fault current that could flow for the time necessary to clear the fault. This equipment **should** have an ampacity greater than, or equal to, that of no. 2/0 AWG copper. A larger conductor size may be required for higher capacity systems. See Section 11, Appendix P for information on grounding cable and jumper ratings.
- Protective grounds **shall** have an impedance to ground low enough to guarantee prompt operation of protective devices in case of accidental energization of the lines or equipment.
- 4.11.5 Before grounding any previously energized part, the employee **shall** first connect one end of the grounding device to an effective ground. Then test the previously energized parts for voltage. If the parts are free from voltage, the grounding may be completed. The grounding device should next be brought into contact with the previously energized part using live-line tools and be securely attached. If the test indicates that the parts are not free from voltage, then the grounds **must not** be attached to the part. Determine the source of the voltage to ensure that the presence of this voltage does not prohibit completion of the grounding.
- 4.11.6 When removing grounds, first remove the grounding devices from the de-energized parts using live-line tools. Then, remove the connection to the

ground. **Take extreme caution.** If the connection to the ground is removed first before the connection to the de-energized part, electric shock and injury may result.

- 4.11.7 Approved clothing (see the Section 11, Appendix C “PPE Category Classification Table”), rubber gloves with protectors, hard hat, and eye protection **shall** be worn when testing for voltage and placing/removing grounding devices.
- 4.11.8 Static capacitors (surge protection capacitors and power factor correction capacitors) **shall** be grounded (discharged) before work is done on them even if there is no possibility of their becoming energized. A five-minute waiting period **is required** between isolating the capacitor and applying the grounds.
- 4.11.9 If the employer can demonstrate that the installation of grounds is impractical or presents a greater hazard, the lines or equipment may be considered as de-energized if the following conditions are met:
- Lines have been de-energized as specified in the Section on De-Energizing Lines and Equipment, **AND**
  - There is no possibility of contact with another energized source, **AND**
  - There is no possibility of induced voltage.
- Exceptions to use of grounds:
- Grounding is impracticable
  - Grounding would present greater hazards
  - No possibility of contact with another energized source
  - Hazard of induced voltage is not present
- 4.11.10. Grounds may be removed temporarily for testing. During the test procedure, the previously grounded lines and equipment **shall** be considered as energized.

## Part 2 - Equipotential Grounding

- 4.11.11 Equipotential groundings are techniques used in transmission and distribution lines. These are the different methods:
- 4.11.12 Single-point grounding is where the employee has connected all three phases together with jumpers and to a cluster bar attached to the pole below the worker’s feet. The cluster bar is connected by a jumper to the neutral if available. If a ground fault should occur, the employee will be at the same voltage as the lines and current should not flow through their body.

- 4.11.13 Double-point grounding is necessary if work at the pole involves breaking the circuit, then it is necessary to ground faults that may come from either direction. On both sides of the employee, the phases are connected to each other, to the cluster bar below the worker's feet, and to the neutral.
- 4.11.14 Remote double-point grounding allows the employee more movement between the jumper sets but offers less protection than other methods. The grounds are connected to structures such as towers on each side of the work location. Fault current would flow through the towers into the earth. With this method, it is still possible to have potentially fatal current flow through the worker's body.
- 4.11.15 Personal grounds, is where a jumper is connected from the conductor being worked on to the cluster bar and to the neutral. These can be installed quickly and **may be used in addition to remote grounding** when full 3-phase grounding at the work site is inappropriate.

These grounding techniques require much skill. Hands-on training and qualification **is required** before practicing these methods.

NOTE: See Section 11, Appendix Q for figures that illustrate equipotential grounding.

## 4.12 Mobile Equipment Operation

- 4.12.1 The critical safety components of mechanical elevating and rotating equipment **shall** be inspected before use on each shift. The lower and upper controls shall be checked to ensure they are functioning correctly. The inspection **shall** follow the manufacturer's recommended checklist.

### 4.12.2 Operator Training

Mobile equipment operators who are not qualified in electrical work **shall** have the following training if their equipment has the potential of coming as close as 10 feet (see definition of 10 foot rule) to energized lines or equipment.

- a. Training in the potential electrical shock hazards associated with equipment operation under these conditions
- b. Training in techniques for proper equipment grounding.

### 4.12.3 Notification

- a. Any mobile equipment operators who notice that operation of their equipment may place that equipment to within 10 feet of energized or potentially energized conductors or circuit parts of electrical equipment **shall** notify the appropriate location management and wait for further safety instructions.
- b. Before the mobile equipment is moved to the job site, responsible engineering/location personnel **shall** notify contractors and location

employees of potential electrical hazards regarding mobile equipment operation (where this potential exposure can reasonably be anticipated before the job assignment starts).

- 4.12.4 No vehicular equipment with an obstructed view to the rear can be used on off-highway job sites unless one of the following provisions is met:
- a. The vehicle has a reverse signal alarm louder than the surrounding noise level **OR**
  - b. A designated employee signals that it is safe to make movements.
- 4.12.5 Heavy equipment, with or without attachments, **shall** have roll-over protection that meets the requirements of 29CFR 1926, Subpart W.
- 4.12.6 Outrigger-equipped vehicles **shall** be operated with outriggers extended and firmly set to provide stability for operation of the equipment. Outriggers may not be retracted or extended beyond the clear view of the operator unless all employees are outside the range of possible equipment motion. If the work area or terrain prohibits full use of outriggers, the equipment **shall** be operated according to the manufacturer's standards for operation without outriggers.
- 4.12.7 Lifting equipment **shall** be used within its maximum load rating.
- 4.12.8 Zero clearance is allowable for insulated cable.
- 4.12.9 Operating Zone

A potential electrical shock hazard exists when mobile equipment is operated within the 10' Rule area of energized, non-insulated, high-voltage conductors or to energized, exposed, high voltage current-carrying equipment parts (or to parts that have the potential for becoming energized).

In order to assist in the elimination of potential electrical shock hazard with mobile equipment operated adjacent to, or in near proximity to, energized or potentially energized overhead conductors and other exposed electrical parts, the following safety regulations **shall** be followed as a minimum standard to prevent vehicle contact by ground personnel.

- a. Non-Electric Operating Mobile Equipment
  1. For lines and equipment energized at 50 kV or less, employees may not bring materials or equipment closer than 10 feet to live parts. For more than 50 kV, the distance is 10 feet plus 4 inches for every 10 kV over 50 kV.
  2. Whenever it is possible that any part of a vehicle or its load could violate the 10' Rule by error, malfunctions, inadvertent operation, or any other cause, the vehicle **shall** be grounded or barricaded.

3. If it is difficult for the operator to accurately determine the distance between the equipment and the energized parts, another person **shall** observe the clearance and give timely warnings when the minimum clearance distance is approached.
4. It is the general policy that no equipment or material is to be hoisted over energized, non-insulated high voltage conductors or equipment. Any exception to this policy will require approval of the location manager or his or her designee. A documented plan will also be required.

b. Electric Operating Mobile Equipment

1. All mobile equipment that will be operated in close proximity to energized conductors or circuit parts **shall** be tested in accordance with the Section of this standard on Inspection and Testing of Mechanized Equipment. This equipment **shall** be properly grounded or barricaded in accordance with the Section on Mobile Equipment Grounding.

When a load that creates a hazard for any other employee is suspended, the operators of mobile equipment may not leave their position at the controls.

2. Minimum approach distances **shall** be printed on a plate of durable non-conductive material and **shall** be mounted so as to be visible to the operator.

c. Mobile Equipment in Transit

Except where lines have been de-energized and visibly grounded or where insulating barriers have been erected to prevent physical contact, equipment in transit with no load and the boom lowered **shall** observe a minimum clearance of 4 feet for voltages less than 50 kV. For voltages higher than 50 kV, the clearance **shall** be increased 4 inches for every 10 kV over that voltage. When visual conditions make it difficult for the operator to maintain the desired clearance, a person **shall** be designated to observe clearance for the operator.

## 4.13 Mobile Equipment Grounding

### 4.13.1 Grounding Methods

- a. On a vehicle, trailer, or other mobile equipment, a connection **shall** be made from a suitable ground plate or stud on the vehicle to the best ground available in the immediate work area. Examples of such equipment include but are not limited to cranes, line trucks, and aerial lifts.

On distribution circuits, the “best ground” available is normally the common neutral or ground grid system. The second choice is a tower or other grounded structure. A driven ground rod **shall** be used only as a final alternative. Workers **shall** be instructed to stay clear of the driven ground location; and other protective means, such as barricades, **shall** be used as necessary to

- avoid the “step potential” and “touch potential” hazards that may occur around the driven rod during a ground fault.
- b. Grounding **shall** be done prior to raising a crane or derrick boom or similar equipment.
  - c. The correct sequence calls for the lead to be attached to the best available ground source first then to the vehicle. When removing grounds, detach the ground lead from the vehicle first and then from the ground source.
  - d. The ground device **shall** be removed only after the crane, derrick boom, or similar parts of the equipment have been removed from the vicinity of the potentially energized conductors or equipment.
  - e. Only personnel trained in the proper grounding techniques are permitted to attach/detach grounding sets.

#### 4.13.2 Grounding Equipment and Material

Safety ground leads **shall** be applied to mobile equipment as directed by the applicable items in the Section of this standard on Grounding Mobile Equipment. Ground leads **shall not** be less than 2/0 flexible stranded copper, rubber-covered cable to provide physical strength. The cable jacket is for mechanical protection of the conductor only. Ground leads should be visually inspected for any type of damage or wear before installing.

### 4.14 Infrared Testing

4.14.1 Employees performing infrared testing on open high and low voltage systems **shall** wear approved hard hats, safety glasses with side shields, approved clothing and safety shoes. See Section 11, Appendix C for information on dressing for the task.

4.14.2 When performing infrared testing on metal-clad, enclosed switchgear that requires the enclosure to be open (exposing energized high voltage parts), employees **shall** wear, in addition to the items listed in item 1 above leather gloves, and a protective hood and face shield.

4.14.3 Where the defeating of safety interlocks **is required**, a temporary by-pass is allowed only with approval of the switching authority. Upon completion of the testing, the interlocking system **shall** be restored to full operable condition. (These systems offer a high degree of personnel safety and should be utilized in all designs. Generally the interlock system **shall not** be by-passed or otherwise rendered inoperative while energized.)

### 4.15 Cleaning Insulators/Bushings

Insulators, bushings, and similar equipment should be cleaned while they are de-energized. However, some operational limitations may dictate cleaning this type of equipment during routine maintenance procedures while the equipment is energized. If

this is an accepted practice at your location, the following minimum safety precautions **shall** be utilized:

- 4.15.1 The minimum approach distance for qualified employees **shall** be observed (see table 6).
- 4.15.2 All personal safety equipment (as specified in the Section of this standard on Personal Protective Equipment) required for working in close proximity to exposed, energized, high and low voltage electrical sources **shall** be worn.
- 4.15.3 All employees assigned to the job of performing maintenance (such as cleaning) on insulators, bushings, or similar energized equipment **shall** be trained and qualified in this type of operation.
- 4.15.4 All manufacturer's safety requirements for the equipment used in close proximity to energized, exposed, electrical sources **shall** be followed. If this information is not available, then the manufacturers of such equipment **shall** be asked to supply it.
- 4.15.5 If the cleaning equipment is mobile, grounding requirements **shall** be followed as specified under "Mobile Equipment Grounding" in this standard.

## 4.16 Line-Clearance Tree Trimming

- 4.16.1 Employees involved with line clearance **shall** follow these required guidelines:
  - a. Before any contact with a tree, employees **must** determine whether one or more energized conductors are within 10 feet of any part of the tree and **must** determine the highest or maximum nominal voltage posing a hazard to the employees.
  - b. Employees who are not qualified line-clearance tree trimmers **shall** maintain the following minimum distances from energized lines and equipment:
    1. For lines energized at 50 kV or less, the distance is 10 feet (305 cm).
    2. If the voltage is greater than 50 kV, the distance is 10 feet (305cm) plus 4 inches (10cm) for each 10 kV above 50 kV.
  - c. If minimum clearance above is not available, only a qualified line- clearance tree trimmer can perform the work on the tree.
  - d. If any of the following conditions exist, a second line-clearance tree trimmer **must** be present and close enough for voice communication:
    1. If the first line-clearance tree trimmer **must** come closer than 10 feet (305 cm) to lines energized at more than 750 volts potential.

2. If branches or limbs being removed are closer to the line than the minimum distances listed in Table 6 and if the lines are energized above 750 volts potential.
3. If roping is necessary to remove branches from lines.
- e. Minimum distances listed in Table 6 **shall** be maintained by qualified line-clearance tree trimmers.
- f. When branches are contacting energized conductors or are within the distance given in Table 6, only insulated equipment can be used to remove the branches.
- g. Ladders, platforms, and aerial devices **must** be kept at the minimum distances listed in Table 6.
- H Line-clearance tree trimming operations **must** not be performed during storms and other adverse weather conditions.
- i. Employees who perform work in the aftermath of storms and other adverse weather conditions **must** be trained in the special hazards related to this type of work.

#### 4.16.2 Brush chippers require the following compliance:

- a. They **shall** be equipped with a locking device in the ignition system.
- b. They **shall** have access panels for the maintenance and adjustment of blade and drive train in place and secure during operation.
- c. Unless they have a mechanical infeed system, they **shall** have an infeed hopper of sufficient length to prevent employee contact with blades and knives.
- d. Trailer chippers **shall** be chocked or secured if detached from truck.
- e. Employees in the immediate area **must** wear personal protective equipment as required in Subpart 1.

#### 4.16.3 Sprayers and related equipment **shall** have walking and working surfaces covered with slip-resistant material. If this does not completely eliminate slipping conditions, slip-resistant footwear or handrails and stair rails may be used as required in 29CFR 1910 Subpart D.

If employees **must** stand on the equipment to spray while the machine is in motion, the working area of the machine **must** be equipped with guardrails that meet the requirements of 29CFR 1910 Subpart D.

#### 4.16.4 All stump cutters **shall** be equipped with enclosures or guards to protect employees. Operators and others in the immediate area **shall** wear personal protective equipment as required in 29 CFR 1910 Subpart 1.

4.16.5 Gasoline-driven power saws **must**, while in operation, meet the requirements of 1910.266(C)(5) plus the following:

- a. Power saws weighing over 15 lbs. (6.8 KG) **must** be supported by a separate line when used in trees except when:
  1. Saws are used from an aerial lift OR
  2. Saws are used for topping or roundover, and no. supporting limbs are available.
- b. As noted earlier, employees **must** maintain proper distances from energized lines.
- c. Power saws **shall** be equipped with control that will return the saw to idling speed when released.
- d. Power saws **shall** be equipped with a clutch and **shall** be adjusted so that the clutch will not engage the chain drive while idling.
- e. Saws **must** be on the ground or firmly supported when started. The practice of drop-starting a saw is prohibited.
- f. Power saws **shall** be started or operated only when co-workers are clear of the saw.
- g. Employees **shall** not carry running power saws up a tree.
- h. Unless manufacturer's servicing procedures state otherwise, all power saw engines **shall** be stopped during cleaning, refueling, adjustment, or repair.

4.16.6 Backpack power units for use in pruning and clearing **must** be operated as follows:

- a. Unless manufacturer's servicing procedures state otherwise, engines of all backpack power units **shall** be stopped during cleaning, refueling, adjustment, or repair.
- b. Backpack power units **shall** have an easily accessible shutoff switch.
- c. During operation, no one except the operator **shall** be within 10 feet (305 cm) of the cutting head of the unit.

4.16.7 Climbing ropes **shall** be used by all employees working aloft in trees. These ropes **must** meet the following requirements and **must** receive the following care and maintenance:

- a. The rope **shall** have a minimum diameter of .5 inch (1.2 cm), with a minimum breaking strength of 2300 pounds (10.2 KN). Synthetic rope **shall** have elasticity of no more than 7 percent.

- b. Rope **shall** be inspected before each use; and, if found damaged or defective, **shall** not be used.
- c. Rope ends **shall** be secured to prevent unraveling.
- d. Climbing ropes **shall** not be spliced to repair.
- e. While stored, rope **must** be treated as follows:
  - 1. It **shall** be coiled and piled or suspended so that air may circulate through the coils.
  - 2. It **shall** be stored away from cutting edges; sharp tools; and corrosive chemicals, gas, or oils.
  - 3. A rope that is wet, or contaminated so that its insulation capacity is suspect, is not to be used near exposed energized lines.
- f. If a possibility exists that the rope may come closer to an energized exposed line than the distances noted in Table 6, the rope **must** be considered energized by ground personnel.
- g. Above the ground, all employees **must** be tied in with a climbing rope and saddle if not ascending the tree.

## 5.0 DESIGN AND OPERATION

### 5.1 Design and Construction

#### Substations

- 5.1.1 All new substations **shall** be designed and constructed in accordance with national and local codes and in such a manner as to afford maximum protection of the public, qualified persons, and non-qualified persons. When any modifications are made to existing substations, all efforts **shall** be made to upgrade the station to current standards. Sufficient access and working space **shall** be provided and maintained.
- 5.1.2 Designs that have no accessible conductors and which use insulated cable and dead-front switchgear should be given primary consideration for all new or revised 600 volt to 34 kV distribution systems (Generally this excludes incoming power feeds.)
- 5.1.3 Use “Safety by Design” concepts for all new electrical installations. Some examples are the use of arc-rated switchgear, remote racking devices for breaker installation and removal, remote switching, the use of maintenance switches to decrease tripping time when personnel are working on equipment, differential relays, zone selective interlocking (smart) relays, high resistant grounding, and grounding switches built into the switchgear.

Design considerations for personnel safety might also include:

- Isolate circuits having a large arc flash hazard distance from low-energy circuits
- Use ground-fault circuit interrupters to reduce shock hazards with portable equipment
- Apply current-limiting fuses, where appropriate, to reduce the arc flash hazard
- Design for the power system to include fast protection to clear faults as quickly as possible to reduce the arc exposure time. Differential protection, with a total fault clearing time of approximately 0.1 second, will greatly reduce arc exposure and the probability of escalation to a more severe fault involving two or more phases. Differential protection is recommended for all switchgear operating at over 1000 volts.
- Specify “remote closing and tripping” capability for all circuit breakers operating at over 1000 volts through the use of a plug-in cord and control, or a supervisory control panel switch (for remote-operation). This will enable the operator to be outside of the Flash Protection Boundary while closing or tripping a circuit breaker.
- Specify insulated bus for all electrical switchgear and control gear of all voltages. Insulated bus (which, for equipment rated 1000 volts or above is

- really making the bus a “covered conductor”) prevents or minimizes arc propagation within the gear after the fault initiates, and can reduce the arc flash hazard.
- Specify “grounding balls” (such as manufactured by A. B. Chance Company) on the load-side terminals of high-voltage circuit breakers to facilitate the connection of safety grounds.
  - Allow adequate access and working space around equipment
  - Specify all electrical disconnect devices with lockout capability
  - Provide adequate lighting around electrical equipment
- 5.1.4 All equipment and structures **shall** be connected to a common ground grid.
- 5.1.5 Draw-out-type breakers **shall** be in the open position when removed or inserted. The control circuit should also be blocked or rendered inoperative if design permits.
- 5.1.6 All energized parts, including the energized racks of static capacitors, **shall** be located to provide personnel clearance in accordance with Table 1 of this standard.
- 5.1.7 Guarding of energized parts – Energized parts operating at 50 volts or more shall be guarded against accidental contact by:
- Location in a cabinet or enclosure
  - Location in a room or vault accessible to only qualified people
  - Location on a balcony or platform
- For systems exceeding 1000 volts, the above applies with the following additions:
- Access to metal-enclosed equipment is controlled by a lock
  - Exposed live parts are accessible to qualified persons only
- 5.1.8 Guarding of live parts has the following requirements:
- a. Energized parts installed in rooms and similar spaces **shall** be enclosed by fences, screens, or walls.
  - b. Entrances not guarded by an attendant **shall** be kept locked.
  - c. Signs warning unqualified personnel to keep out **shall** be displayed at the entrance.
  - d. Unqualified persons may not enter these rooms and spaces while supply lines and equipment are energized.

- e. Guards **shall** be placed around all live parts that have voltages above 150 volts to ground and that have no insulation covering, unless the location of these parts gives enough horizontal and vertical clearance to prevent inadvertent contact.
  - f. Motor Control Centers should be purchased with guards covering internal live parts above 120 volts.
  - g. For protection of personnel and equipment, all live parts **shall** remain guarded during all functions except fuse replacement or other needed access permitted to qualified personnel only.
  - h. When guards are removed, barriers **shall** be placed to prevent harmful contact.
- 5.1.9 All new static capacitor banks **shall** have a permanently installed grounding switch that is key or mechanically interlocked, with the main line-disconnect switch connecting the capacitor bank to the system. The interlock **shall** ensure that both the line disconnect and the grounding switches are not closed at the same time. Conspicuous signage indicating that the capacitor bank frame is energized **shall** be placed on all sides of the frame that are accessible to personnel.
- 5.1.10 All equipment and devices subject to operation or manipulation **shall** be properly identified and **shall** use large, prominent, and therefore easily read lettering.
- 5.1.11 Substations that are not totally enclosed and that have exposed, energized parts **shall** be completely enclosed by fences at least seven (7) feet in height, with gates secured by suitable locks.
- a. Conductive fences around substations **shall** be grounded.
  - b. When fences are expanded or a section is removed, the grounding continuity **shall** be continued to prevent electrical discontinuity.
  - c. Bridging (bonding) conductors **shall** be used at all gates to ensure electrical continuity to the fence on each side of the gate and to the gate itself.
- 5.1.12 Substation auxiliary systems **shall** be installed in such a fashion that they do not require maintenance personnel to approach in close proximity to any non-insulated or unguarded, energized parts.
- 5.1.13. When entering an attended substation, employees other than those assigned to station work **shall** report to the employee in charge. Upon reporting, these employees **shall** receive special instructions on safety and a job briefing.
- 5.1.14 Equipment Design Considerations

Design considerations for personnel safety might also include:

- Isolate circuits having a large arc flash hazard distance from low-energy circuits
- Use ground-fault circuit interrupters to reduce shock hazards with portable equipment
- Apply current-limiting fuses, where appropriate, to reduce the arc flash hazard
- Design for the power system to include fast protection to clear faults as quickly as possible to reduce the arc exposure time. Differential protection, with a total fault clearing time of approximately 0.1 second, will greatly reduce arc exposure and the probability of escalation to a more severe fault involving two or more phases. Differential protection is recommended for all switchgear operating at over 1000 volts.
- Specify “remote closing and tripping” capability for all circuit breakers operating at over 1000 volts through the use of a plug-in cord and control, or a supervisory control panel switch (for remote-operation). This will enable the operator to be outside of the Flash Protection Boundary while closing or tripping a circuit breaker.
- Specify insulated bus for all electrical switchgear and control gear of all voltages. Insulated bus (which, for equipment rated 1000 volts or above is really making the bus a “covered conductor”) prevents or minimizes arc propagation within the gear after the fault initiates, and can reduce the arc flash hazard.
- Specify “grounding balls” (such as manufactured by A. B. Chance Company) on the load-side terminals of high-voltage circuit breakers to facilitate the connection of safety grounds.
- Allow adequate access and working space around equipment
- Specify all electrical disconnect devices with lockout capability
- Provide adequate lighting around electrical equipment

## Lines

5.1.15 All new lines **shall** be designed and constructed in accordance with national and local codes and in such a manner as to afford maximum protection for the safety of the public, qualified employees, and non-qualified employees. When any modifications are made to existing lines, all efforts **shall** be made to upgrade these lines to current standards.

5.1.16 Spacing and dimensional clearance **shall** be as follows:

1. Electrical supply stations and substations are to be in accordance with Table 1. In section 11 of this standard

2. Vertical clearance of wires, conductors and cables above ground, rails, or water are to be in accordance with Table 2 In section 11 of this standard.
  3. Lines adjacent to but not attached to buildings **shall** have clearances as shown in Table 3 In section 11 of this standard.
  4. Where multiple circuits are located on a common structure, communication circuits **shall** be located below supply circuits. Lower voltage circuits **shall** be located below higher voltage circuits, and clearances **shall** be as shown in Table 4 In section 11 of this standard.
  5. Where conductors supported on different structures cross each other, the vertical clearances **shall** be as shown in Table 5 In section 11 of this standard.
- 5.1.17 Primary consideration **shall** be given to installing insulated cables for all new or relocated distribution lines, if possible.
- 5.1.18 Non-electrical equipment **shall not** be located on electrical structures that have non-insulated conductors unless it observes the 10 foot rule.
- 5.1.19 Supply circuits **shall not** be designed to use the earth as a conductor for any part of the circuit.
- 5.1.20 All guy wires **shall** be equipped with guy guards constructed from highly visible material. Guys **shall** also be grounded and properly tensioned.
- 5.1.21 All circuit-neutral conductors and non-current-carrying parts of metal or metal reinforced supporting structures **shall** be effectively grounded.
- 5.1.22 Lighting and other auxiliary systems **should not** be installed on poles or structures that would require maintenance personnel to come in close proximity to high voltage, non-insulated lines and equipment.
- 5.1.23 Underground services **shall** be installed in accordance with national and local codes and **shall** be identified on drawings and with marking signs in the area above them.

## 5.2 Perimeter Fence Grounding

- 5.2.1 In order to minimize the shock hazard associated with induced or impressed voltages on perimeter fences, comply with the NESC Sections 92E and 93C6, as follows:
- a. Where high voltage power lines cross over fences, the fence **shall** be grounded at the point of crossing and at a distance not to exceed 150 feet (45m) on either side.
  - b. When fences run under or are parallel to high voltage power lines, they **shall** be grounded at intervals not to exceed 150 feet (45m).

- c. In the condition described in (a) or (b) above, any gate or other opening **shall** be bonded across by a buried bonding strap.
- d. When armored high voltage cables are used, the grounding practices described in this section need not apply.

### 5.3 Pipeline, Conveyors, and Metal Structures

- 5.3.1 Where these items are parallel to, or pass under, high voltage power lines, proper grounding design **shall** be followed.

### 5.4 Signage

- 5.4.1 Signs are essential for conveying information regarding a potential electrical shock hazard. They are also used to convey information regarding operation and/or maintenance.

This section of the standard makes no attempt (except as noted below) to catalog types of signs, all locations where signs may be required, or lettering on signs. The listing references within this standard should be used to obtain the necessary information for sign requirements at your location.

The following **shall** be considered for signage requirements:

#### 1. Material

The sign should be made of a durable material that is appropriate for the anticipated environmental conditions and the expected length of exposure.

#### 2. Colors and shapes

The color and shape of the sign **shall** be consistent with regulatory and consensus standards requirements.

#### 3. Lettering

Lettering **shall** be large and highly visible, anticipating dark or low-light situations.

#### 4. International symbols

It is recommended that internationally accepted symbols be used as much as practicable.

#### 5.4.2 Locations

As a minimum, signs of warning/information **shall** be placed as follows:

- 1. On all doors, gates, and fence locations for substations; on doors to switchgear rooms; and on other similar compartments where potentially energized exposed electrical parts are located.

2. On all transmission and/or distribution structures where employee or public presence may be expected.
3. In the case of multi-support structures, the signs **shall** be located on each supporting member.
4. Where a low-voltage bus is supplied from two (2) or more sources (and an interlock system is not provided), thus presenting a back-feed opportunity to the high-voltage system, a sign that warns of this potential problem **shall** be conspicuously displayed.
5. If temporary alterations **must** be made to secondary load supply systems in order to maintain power supply continuity at the secondary voltage level (thus presenting a back-feed opportunity), then a sign warning of this potential problem **shall** be conspicuously displayed until the need for the temporary alteration is abated.
6. At roadways or railways where horizontal or vertical clearance from energized or potentially energized sources is minimal. (Refer to Table 2.)
7. At all low profile electrical equipment installations where physical distance requirements for employees and/or the requirements for handling of conductive material cannot be met or are marginal.
8. At all overhead pipes, bridges, etc. where adjacent energized electrical conductors and parts exhibit potential electrical shock hazards to maintenance or construction personnel.
9. Where inadvertent electrical contact is possible.

## 5.5 Labeling, Marking, and Identification

### 5.5.1 Equipment at over 600 volts nominal

- Mark each cover or door behind which energized parts exist on switchgear, unit substations, transformers, pullboxes, covers for pullboxes, terminal and connection boxes, and motor starters with “DANGER HIGH VOLTAGE – KEEP OUT”
- Mark building services over 600 volts with “DANGER HIGH VOLTAGE – KEEP OUT”
- Mark the feeder or circuit number on the front and rear of permanent structure of the switchgear or equipment, *but not on removable enclosure covers to the equipment*

### 5.5.2 Equipment Operating at 600 Volts or Less, Nominal

Mark entrances to guarded rooms or locations with warning signs prohibiting entry by unqualified personnel

### 5.5.3 Other

- Indicate the voltage of exposed parts at outdoor switchgear or transformer locations
- Identify disconnects that have no load interrupting or fault closing rating with clear signs to prevent improper operation
- If a “backfeed” is possible, identify with a warning sign
- If there is an external or “foreign” voltage source, identify the source with a warning sign
- Identify clearly all disconnect devices and the equipment with which they are associated
- Identify clearly the rear doors of switchgear compartments

## 6.0 Operation and Maintenance

### 6.1 Substation Enclosures

Substation enclosures **shall** be kept locked at all times except while work is being performed.

### 6.2 Storage of Materials in Substations

Materials and equipment not necessary for distribution and transmission system repair and maintenance (R & M) **shall not** be stored in substation lots, and those lots **shall** be kept free of debris. Storage locations established for distribution and transmission of R & M materials **shall** be specifically identified, approved, and periodically inspected. Approval of this storage area **shall** be done by the location manager or his or her designee.

### 6.3 Substation Inspections

Substations **shall** be periodically inspected by qualified employees to determine the general condition of all equipment, including grounding systems.

### 6.4 Servicing Substation and High Voltage Yard Auxiliary Equipment

#### 6.4.1 Existing equipment:

- a. Where servicing such equipment compromises worker safety, consideration should be given to relocating such equipment.
- b. If the equipment cannot be relocated, alternate safety procedures **shall** be employed, such as de-energizing and/or requiring appropriate personal

safety equipment and clothing for work in close proximity to energized parts.

#### 6.4.2. New design:

Auxiliary equipment and services (area lighting, P.A. systems, etc.) **shall not** be mounted on, or in close proximity to, substation/high-voltage yard structures if such positioning will breach dimensional clearance restrictions defined elsewhere in this standard.

## 6.5 Guarding of Energized Electrical Conductors or Circuit Parts

Guards **shall** be provided around all live parts where the clearance requirements of Table 1 of this standard cannot be met. (Refer to NESC Section 124.)

- a. When necessary to ensure reasonable safety, certain parts **shall** be guarded or given clearances in excess of those specified. Those parts include those over or near passageways through which material may be carried and those on or near spaces such as corridors, storerooms, and boiler rooms used for non-electrical work. The guards **shall** be substantial and **shall** completely shield or enclose the energized parts without openings. Guards for spaces accessible to unqualified personnel should be removable only by means of tools or keys.
- b. Each portion of parts whose potential is unknown **shall** be guarded in accordance with “a” above, on the basis of the maximum voltage which may be present on the surface of that portion.

(Examples of such parts include telephone wires exposed to induction from high-voltage lines, ungrounded neutral connections, ungrounded frames, ungrounded parts of insulators or surge arresters, or ungrounded instrument cases connected directly to a high-voltage circuit.)

- c. Guards less than 4 inches outside the guard zone **shall** completely enclose the parts from contact up to the heights listed in column 2 of Table 1 of this standard. They **shall not** be closer to the exposed energized parts than the distance specified in Column 4 of Table 1 of this standard, except when suitable insulating material is used with circuits less than 2500 V to ground.
- d. Covers or guards that **must** at any time be removed while the parts they guard are energized **shall** be designed so that they cannot readily be brought into contact with the energized parts.

## 6.6 Rights-of-Way

Rights-of-way **shall** be maintained in a clear and orderly condition, with trees and brush kept well clear of overhead lines.

## 6.7 Storage of Materials in Rights-of-Way

Material and equipment shall not be stored on rights-of-way under non-insulated high voltage lines closer than 10 feet horizontal for lines energized at 50 kV or less. For lines energized at voltages above 50 kV add 4 inches for every 10 kV above 50 kV. Any vehicle that could inadvertently come within 10 feet of an energized line (see definition of 10 foot rule) shall be prohibited from parking in this area. Examples would be aerial lifts, mobile cranes, dump trucks, dumpsters, and high lift fork trucks.

In areas that are not restricted to qualified employees and that are located near exposed energized parts, materials and equipment **shall not** be stored closer than the distances stated below.

For lines and equipment energized at 50 kV or less, the distance is 10 feet (305cm). (10 foot rule).

For lines and equipment energized at more than 50 kV, the distance is 10 feet (305cm) plus 4 inches (10cm) for every 10 kV over 50 kV.

To these minimum clearances, enough distance **shall** be added to account for the following:

- a. Maximum sag and side swing by conductors.
- b. The space needed by the equipment used to handle the stored materials.

In areas restricted to qualified employees, material may not be stored within the working space around energized lines or equipment.

## 7.0 INSPECTIONS AND TESTING OF TOOLS AND EQUIPMENT

### 7.1 Testing of Insulating Rubber Products

#### 7.1.1 Insulating Rubber Gloves

Electrical testing of insulating rubber gloves **shall** be in accordance with the in-service care of insulating gloves and sleeves, per ASTM F496.

- a. **Shall** be dielectrically tested before their first use and every 6 months thereafter.
- b. **Shall** be visually inspected and air tested by the employee at the beginning of each use.
- c. **Shall**, if they might have become damaged, be dielectrically tested before their next use.

### 7.1.2 Insulating Rubber Sleeves

Electrical testing of insulating rubber sleeves **shall** be in accordance with the procedures for in-service care of insulating gloves and sleeves described in ASTM F496. Rubber sleeves **shall** be visually inspected at the start of each work day in which they will be used; and, when they are stored, they **shall** be stored in canvas bags designed for that purpose. They **shall** be dielectrically tested before their first use and every 12 months thereafter.

### 7.1.3 Insulating Blankets, Line Hoses, and Covers

Insulating blanket, line hose, and cover inspections and testing **shall** be in accordance with ASTM F478 and F479. Blankets **shall** be dielectrically tested before their first use and every 12 months thereafter. Line hoses and covers **shall** be tested upon indication that the insulating value is suspect.

Visually inspect this equipment for defects before use and installation on energized conductors, devices, or equipment, and at other times if damage is suspected. Don't use damaged or possibly damaged equipment until it has passed an electrical re-test. This equipment is not designed for permanent installation. Follow the manufacturer's standard for use, as exposure may result in ozone checking, corona cutting, or excessive weathering.

## 7.2 Live-Line Tools

- 7.2.1 A test schedule **must** be established that **shall** provide visual inspection for defects and contamination, and the tool **must** be waxed and then dielectrically tested every two years (24 months). Fiberglass tools are dielectrically tested while wet. See Section IV, item H, Live-Line Tools, for more details and requirements. IEEE Guide For In-Service Maintenance and Electrical Testing of Live-Line Tools 978-1984 may be used for reference.
- 7.2.2 A visual inspection for defective hardware attachments, cracks, deformities, contamination, proper operation, and cleanliness must be performed before use of the tool each day.

## 7.3 Insulated Tools

- 7.3.1 Employees shall use insulated tools and/or handling equipment when working inside the restricted approach boundary of live parts where tools or handling equipment might make accidental contact. Insulated gloves with leather protectors shall also be used. Insulated tools shall be protected from damage to the insulating material.

**Ensure that insulated tools meet the requirements of ASTM F1505  
"Standard for Insulated Hand Tools"**

## 7.4 Mechanized Equipment

- 7.4.1 Insulated, extendible-boom aerial personnel devices, articulating-boom aerial personnel devices, and any combination thereof (such as line trucks) **shall** be inspected annually (every 12 months) and **shall** follow the inspection and test methods as outlined by the manufacturer, ANSI A92.2, and ASTM Standard Designation F914.
- 7.4.2 Non-insulated, digger-derrick, extensible-boom equipment **shall** follow the inspection and test procedures reflected in ANSI A10.31.
- 7.4.3 Whenever the equipment identified in (1) above is to be used to elevate an employee into close proximity of energized or potentially energized lines or equipment, a basket liner should be inserted in the basket. This liner should totally cover all surfaces exposed to the employee and should be dielectrically tested per ANSI A92.2 annually (every 12 months).
- 7.4.4 The critical safety components of mechanical elevating and rotating equipment **shall** be inspected before use on each shift. The lower and upper controls shall be checked to ensure they are functioning correctly. The inspection **shall** follow the manufacturer's recommended checklist.

## 7.5 Records

Test records shall be maintained on all equipment, rubber goods, and live-line tools that require testing.

## 8.0 EMPLOYEE TRAINING

### 8.1. Employee Qualifications

#### 8.1.1 Certification:

Location management **shall** certify who is qualified, authorized, and who is qualified to work in each area.

Documentation of employee qualification to perform tasks shall be made when the employee demonstrates proficiency in the work practices involved.

#### 8.1.2 Responsibility:

- a. **Supervision.** Make sure procedures are in place and that employees are trained in those procedures.
- b. **Employee.** Follow procedures, including using PPE, and understand how an employee's qualification status relates to the current task.
- c. **Record Keeping.** Each site **shall** establish and maintain records for each person considered to be qualified. The records **shall** include:
  1. Name and identification
  2. Date and time of training
  3. Content of training (such as a course outline)
  4. Basis for acceptance as qualified (e.g., test grade, demonstration of skill, and work location)

#### 8.1.3 Training Required:

- a. **Skill Training.** Each worker **shall** have the following skills: basic mechanical skills, basics of electricity, troubleshooting and circuit analysis, job planning, job auditing, and CPR and emergency response.
- b. **Keep Training Current and Reinforce.** Frequent training and reinforcement of electrical safety is essential, especially for items such as power system components that are maintained infrequently.
- c. **Cardiopulmonary Resuscitation (CPR) and First Aid Training.** Those working on systems of 50 volts or greater **shall** be regularly instructed in methods of first aid and emergency procedures, such as approved methods of resuscitation. Refresher training shall occur at a frequency that satisfies the requirements of the certifying body.
- d. **Contact Release.** Employees exposed to shock hazards and those responsible for the safe release of victims from contact with energized

electrical conductors or circuit parts shall be trained in methods of safe release. Refresher training shall occur annually.

#### 8.1.4 Skills Required:

- a. **Selection and Safe Use of a Voltmeter.** Know the proper use of a voltmeter where measurement is expected, anticipated, or required to execute a task safely. This also applies to other instruments used within the minimum approach distance.
- b. **Recognition of Hazards.** Consider what, where, degree, method of exposure, and how to avoid all potential hazards.
- c. **Recognition of Arc Flash Boundary.** Take time to appreciate the hazard of radiated energy from sources of various energy levels.
- d. **Knowledge of Local Procedures and Lock-and-Tag Requirements.** Consider what is required to work on or near an energized electrical conductor.

#### 8.1.5 Personal Protective Equipment. Employees shall be familiar with the following information about PPE:

- a. The appropriate type to use
- b. The location where it is required
- c. Proper use of PPE

The employee is responsible for following PPE procedures and knowing when PPE is required. The employer is responsible for providing the equipment and defining procedures.

#### 8.1.6 Acceptable Methods of Insulating/Isolating Persons from Shock.

Know the most appropriate method for shock isolation/insulation during both work and rescue.

## 8.2 Qualified Employee

#### 8.2.1 Training in the following **is required**:

- a. Understanding of the specific hazards associated with electrical energy. Employees shall also be able to identify and understand the relationship between electrical hazards and possible injury.
- b. Safety-related work practices, safety procedures, and other personnel safety requirements that relate to their job or task assignments.
- c. Any other safety practices, including applicable emergency procedures that are related to their work and necessary for their safety.

- d. Cardiopulmonary resuscitation (CPR) and first aid.
- e. Skills and techniques necessary to distinguish energized parts from the other parts of electric equipment, machines, and processes.
- f. Skills and techniques necessary to determine the nominal voltage of exposed energized parts.
- g. Knowledge and understanding of the clearance and minimum approach distances required when working with the voltages to which employees will be exposed.
- h. Proper use of the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools, when required.
- i. Skills and techniques necessary for the understanding of induced, static, and impressed voltages, grounding integrity, condition of poles and structures, and circuit and equipment location.
- j. The decision making process necessary to determine the degree and extent of the hazard and the personal protection equipment and job planning necessary to perform the task safely.
- k. Methods of safe release of victims from contact with exposed energized electrical conductors or circuit parts.

**NOTE:** A person can be considered qualified with respect to certain equipment and methods (such as maintenance of HVAC equipment) but still be unqualified for others.

### **8.3 Authorized Employee**

#### **8.3.1 Training in the following is required:**

- a. Understanding of the specific hazards associated with electrical energy. Employees shall also be able to identify and understand the relationship between electrical hazards and possible injury.
- b. Safety-related work practices, safety procedures, and other personnel safety requirements that relate to their job assignments.
- c. Any other safety practices, including applicable emergency procedures that are related to their work and necessary for their safety.

#### **8.3.2 Training in the following is recommended:**

- a. Skills and techniques necessary to distinguish potential live parts from the other parts of electric equipment, machines, and processes.

- b. Skills and techniques necessary to determine the nominal voltage of live parts.
- c. Recognizing when the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools are needed.
- d. Methods of safe release of victims from contact with exposed energized electrical conductors or circuit parts.

## 8.4 Lockout/Tagout Training

8.4.1 This training applies to lockout/tagout only.

- a. Authorized employees **shall** be trained to recognize applicable hazardous energy sources, type and magnitude of energy sources, and the proper techniques for energy isolation and control.
- b. Affected employees **shall** be instructed in the purpose and use of the energy-control procedure.
- c. All other employees whose work may be in the area where lockout/tagout is utilized **shall** be instructed about the procedure and the prohibition against restarting machines that have been locked/tagged out.

## 8.5 Assessment

Employer **shall** determine through regular supervision and inspections conducted at least annually that each employee is complying with the required safety-related work practices.

## 8.6 Electrical Safety Audit

A periodic review of the electrical systems, maintenance procedures, training documentation and operating practices is required. This review **shall** be provided by qualified personnel and/or an outside consulting service knowledgeable in the electrical safety concerns of the review. Electrical safety reviews **should** be performed more often if changes (such as an increase in the frequency of electrical accidents, changes in the work force, renovation of the current system, or new construction) occur that are likely to increase the potential for electrical shock hazard.

**8.6.1 Electrical Safety Program.** The electrical safety program shall be audited to verify the principles and procedures of the electrical safety program are in compliance with this standard. Audit of the electrical safety program shall be performed at intervals not to exceed 3 years.

**Field Work.** Field work shall be audited to verify the requirements contained in the procedures of the electrical safety program are being followed. Audits of field work to verify compliance with the procedures of the electrical safety program must be performed at intervals not to exceed 1 year.

When the auditing determines that the principles and procedures of the electrical safety program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made.

**8.6.2 Audit Documentation.** The audits shall be documented.

## **8.7 Training Type**

All training **shall** be of the classroom and/or the on-the-job type.

## **8.8 Retraining**

Schedules **shall** be established for additional training or retraining of personnel:

- a. To keep abreast of technology, new types of equipment, and procedural changes.
- b. To maintain proficient skills.
- c. If supervisor, periodic audits, or the annual inspection reveals that the employees are not complying with required safety-related work practice.
- d. If the employee's job duties change
- e. If seldom used safety-related work practices are employed (OSHA considers these tasks that are performed less than once per year). Training or retraining **shall** precede the performance.
- f. Refresher training on this standard **shall** be conducted at least every two years.

## **8.9 Employee Certification and Record Keeping**

The employer shall document that each employee has received the electrical safety training required by this document. The employer shall certify that employees are qualified to perform the work tasks required when the employee has demonstrated proficiency in the work practice involved. Records of the training and certification **shall** be maintained for the duration of the employee's employment.

## **8.10 New and Temporary Employee Training Requirements**

New employees **shall not** be considered qualified until they pass requirements of a qualified employee and have been documented as a qualified employee.

## 9.0 ADMINISTRATIVE CONTROL

### 9.1 Location Management

#### 9.1.1 Design Criteria

Location management **shall** ensure that design for all existing, modification, and new construction meet as a minimum or exceed, all safety regulated requirements of this standards, along with required and consensus design and safety standards.

#### 9.1.2 Vendor Control (system design)

Location management **shall** ensure that vendor equipment and system design, as a minimum, **shall** meet or exceed all safety requirements for this standard, and required regulated and consensus design and safety standards.

#### 9.1.3 Construction/Maintenance Control

Location management **shall** ensure that all maintenance/construction projects (electrical or otherwise) at the location be performed with all electrical safety concerns of this standard followed.

### 9.2 Contractors

#### 9.2.1 Contractor Personnel

Contractor personnel **shall** follow all applicable Facility safety standards as a minimum.

#### 9.2.2 Contractor Equipment

Contractor equipment **shall** meet all Facility safety and health standards.

#### 9.2.3 Knowledge of Rules

Key contractor personnel should be trained in this Electrical Safe Work Practices Standard. Contractors **shall** be informed of, and understand the potential electrical shock hazards associated with their work.

#### 9.2.4 Changing Work Conditions

Changing work conditions as they may relate to potential electric shock hazards **shall** be communicated to the appropriate facility representative.

#### 9.2.5 New (replacement) Employees

As contractor employees are replaced or added, or contractor work is further sublet, the new contractor employees **shall** be advised of all electrical safety considerations that may apply to them under this, or other standards/standards.

### 9.3 Escorting Non-Qualified and Non-Authorized Personnel

In areas where physical safe work distance clearances (see Table 1 and 2, Appendix A of this standard) cannot be met (generally all secured electrical installations and conductor/bus minimal clearance from buildings, rooftops, or other structures), then any person without the appropriate electrical training, as specified by this standard, is deemed to be a non-qualified or non-authorized person, and **shall** be escorted by a qualified employee. Examples would be visitors, non-electrical maintenance employees (e.g., grass cutters, painters, roof repair personnel), potential contractor personnel, and equipment vendors.

### 9.4 Power System and Electrical Installation Security (Locking)

9.4.1 Required Locked Electrical Installations. The following locations **shall** be maintained as locked:

- a. Substations that have exposed energized, or potentially energized, parts.
- b. Switchgear room entrances that have exposed energized, or potentially energized parts.
- c. Other locations that have energized, or potentially energized high voltage conductor and exposed parts of electrical equipment.

9.4.2 Lock Classifications/Procedures

- a. Safety Lock

For personal protection on high and low voltage distribution systems, a lock is required to prevent unintentional operation of a switch or breaker. This lock is to be known as a SAFETY LOCK, and **shall** be a controlled lock (unique lock/one key or unique lock group/one key) and its intent is personal protection only, and is required to be installed on each tagout/lockout location.

- b. Operating System Lock

An operating system lock **shall** be used to prevent unintentional operation of a high voltage line switch. Unique one lock/one key locks are not required but are strongly recommended.

- c. Preferred Lock System

In the interest of overall employee safety, a one lock/one key system offers the highest degree of safety in any locking situation.

- d. Equipment Access Interlock Systems

These systems offer a high degree of personnel safety and **should** be utilized in all design considerations. Interlock systems SHALL NOT be bypassed or

otherwise rendered inoperative while the equipment is energized with the exception of:

1. Phasing of conductors following new or revised installations. When performing the phasing task additional personal protective equipment may be required.
  2. Electrical trouble shooting
  3. Thermography/Infrared testing
- e. Remote/Other Utility Operations (Clearance, Lockout/Tagout)

Where generating and switching locations are influenced by distance, personnel safety **shall** not be compromised by lack of a positive locking or rendering inoperative procedure. It is required that a formal written agreement be made between the parties outlining the agreed upon clearance or lockout/tagout procedure. All clearances **shall** be in writing. The clearance or lockout/tagout system associated with the remote location may be used but in no way compromise the safety of the Facility clearance or lockout/tagout policy.

## 9.5 Electrical System Safety for Operations

It is essential that general switching and controlling procedures for and between power generators and user locations, are well understood and documented.

## 9.6 Training Requirements

The location management **shall** ensure that all required training as referenced in section 8.0 of this standard is completed and documented.

## 9.7 Documentation

The location management **shall** ensure that all required documentation referenced in this standard is completed and maintained.

## 9.8 Safety Pre-Task Plan Card (SPPC) – Service Staff

The purpose of the Safety Pre-Task Plan Card (SPPC) is to assure that all maintenance employees of the University Of Minnesota Facilities Management are identifying and eliminating safety hazards prior to beginning each work activity. Refer to appendix S for the guide that has been developed to help you fill out the SPPC.

## 9.9 Policy for Vault Access by Qualified District/Energy/U-Construction Electricians

The University of Minnesota policy to be followed for volt access by Qualified District/Energy/U-Construction Electricians is stated in appendix T

## 9.10 Accident/Incident Investigation

All electrical contacts, near misses and switching errors **shall** be investigated to make recommendations, as may be necessary, to improve the electrical safety program. These recommendations **should** be sent to the Health and Safety department manager for further evaluation and distribution. It is important that these accidents/incidents and near misses be evaluated from a fact-finding, versus a fault-finding approach.

## 9.11 Periodic Electrical Safety Reviews (Audits)

A periodic review of electrical systems, maintenance procedures, and operating practices **shall** be completed not to exceed once every three years (see section 8.6 of this standard).

## 10.0 REFERENCES

### Engineering Standards, Latest Edition Applies

#### 10.1 ANSI (American National Standards Institute)

- a. A10.31 Digger Derricks-Safety Requirements, Definitions, and Specifications
- b. A92.5 Boom-Supported Elevated Work Platforms
- c. B30.5 Mobile and Locomotive Cranes
- d. Z87.1 Practice for Occupational and Educational Eye and Face Protection
- e. Z89.1 Requirements for Protective Headwear for Industrial Workers
- f. Z41 Safety-Toe Footwear

#### 10.2 ASTM (American Society for Testing and Materials) Standard on Electrical Protective Equipment for Workers, 7th Edition.

- a. F479 Standard Specification for the In-Service Care of Insulating Blankets
- b. F496 Standard Specification for the In-Service Care of Insulating Gloves and Sleeves
- c. F914 Standard Test Method for Acoustic Emission Insulated Aerial Personnel Devices
- d. F478 Specifications for In-Service Care of Insulating Line Hose and Covers
- e. F855 Specifications for Temporary Grounding Systems to be Used on De-energized Electric Power Lines and Equipment
- f. F1505 Specification for Insulated Hand Tools

#### 10.3 CFR (Code of Federal Regulations)

29CFR (Title 29 - Labor)

- a. Subpart J 1910.147 The control of hazardous energy (lockout/tagout)
- b. Subpart R 1910.268 Telecommunications
- c. Subpart R 1910.269 Electrical power generation, transmission, and distribution

- d. Subpart S1910.301 – 399 Electrical
- e. Subpart K1926.400 – 449 Construction Electrical
- f. Subpart E1926 Fall Protection

#### **10.4 IEEE (Institute of Electrical and Electronic Engineers)**

IEEE 978 Guide for In-Service Maintenance and Electrical Testing of Live-Line Tools.

#### **10.5 NESC (National Electrical Safety Code)**

IEEE C2 National Electric Safety Code

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#### **10.6 NFPA (National Fire Protection Association)**

NFPA 70 National Electrical Code

NFPA 70B Electrical Equipment Maintenance

NFPA 70E Standard for Electrical Safety in the Workplace

#### **10.7 Applicable State and Local Codes**

All facilities **shall** meet or exceed the above referenced guidelines, codes and regulations.

# 11.0 APPENDICES

## Appendix A – Tables and Figures

### CLEARANCE FROM LIVE PARTS

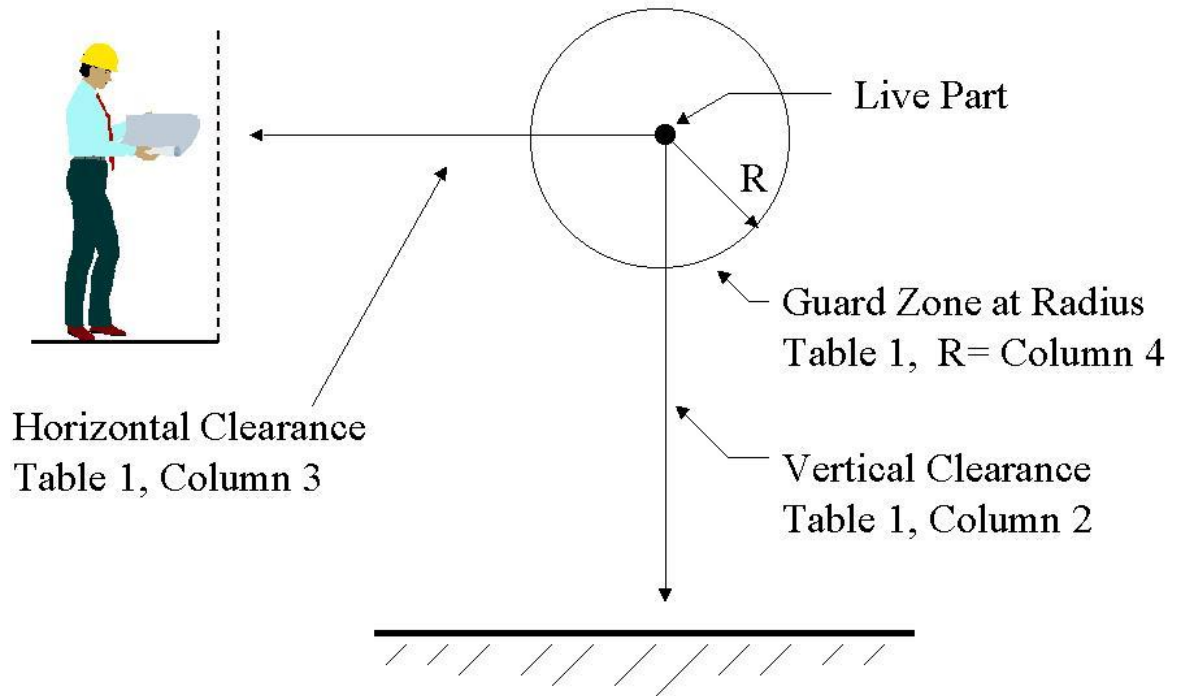


FIGURE 1.

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# Clearance from Live Parts

NOMINAL VOLTAGE PHASE TO PHASE	VERTICAL CLEARANCE OF UNGUARDED PARTS			HORIZONTAL CLEARANCE OF UNGUARDED PARTS			CLEARANCE GUARD TO LIVE PARTS		
	kV	Feet	In.	m	Feet	In.	m	Feet	In.
.151 to 2.4	8	9	2.67	3	4	1.02	0	3	7.6 cm
7.2	8	10	2.69	3	4	1.02	0	4	10.1 cm
13.8	9	0	2.74	3	6	1.07	0	6	15.2 cm
23.0	9	3	2.82	3	9	1.14	0	9	22.8 cm
34.5	9	6	2.90	4	0	1.22	1	0	30.4 cm
46.0	9	10	3.00	4	4	1.32	1	4	40.6 cm
69.0	10	5	3.18	4	11	1.50	1	11	58.4 cm
115.0	11	7	3.53	6	1	1.85	3	1	93.9 cm
138.0	12	2	3.71	6	8	2.03	3	8	1.12 m
161.0	12	10	3.91	7	4	2.24	4	4	1.32 m
230.0	14	10	4.52	9	4	2.84	6	4	1.93 m
362.0	20	2	6.1	14	8	4.5	11	8	3.6 m
550.0	28	4	8.6	22	10	7.0	19	10	6.0 m

Note: THE TABLE IS BASED ON Table 124-1 NESC 1997.

Note: OBTAIN DISTANCES FOR INTERMEDIATE VOLTAGES BY INTERPOLATION.

**TABLE 1.**

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# Minimum Basic Vertical Clearance

## MINIMUM BASIC VERTICAL CLEARANCE OF WIRES, CONDUCTORS, AND CABLES ABOVE GROUND, RAILS, OR WATER

(Voltages are phase-to-ground for effectively grounded circuits.)

Clearance Categories Where wires, conductors, or cables cross over or overhang	Neutrals and Grounded Guys		(Open Conductors)			
			0 to 750V (phase-to-gnd)		751V – 22kV <sup>1</sup> (phase-to-gnd)	
	Feet	Meters	Feet	Meters	Feet	Meters
1. Railroad tracks	23.5	7.2	24.5	7.5	26.5	8.1
2. Roads and other areas subject to truck traffic	15.5	4.7	16.5	5.0	18.5	5.6
3. Residential driveways	15.5	4.7	16.5	5.0	18.5	5.6
4. Other land traversed by vehicles	15.5	4.7	16.5	5.0	18.5	5.6
5. Spaces or ways accessible to pedestrians only	9.5	2.9	12.5	3.8	14.5	4.4
6. Water areas not subject to sailboating	14.0	4.3	15	4.6	17	5.2
7. Water areas subject to sailboating						
a. Less than 20 acres	17.5	5.3	18.5	5.6	20.5	6.2
b. 20 to 200 acres	25.5	7.8	26.5	8.1	28.5	8.7
c. 200 to 2,000 acres	31.5	9.6	32.5	9.9	34.5	10.5
d. Over 2,000 acres	37.5	11.4	38.5	11.7	40.5	12.4
8. Areas subject to sailboat launching	Clearances above ground shall be 5 feet (1.5 meters) greater than Item 7 above.					
Where wires, conductors, or cables run along and within the limits of highway or other road right-of-way, but do not overhand the roadway						
9. Roads in urban districts	15.5	4.9	16.5	5.0	18.5	5.6
10. Roads in rural districts where it is unlikely that vehicles will cross under the line	13.5	4.3	14.5	4.4	16.5	5.0

Note: The table is based on Table 232-1 NESC C2-1997

1. Distances shall increase 4 in. (10cm) for each 10 kV over 22 kV phase to ground.
2. For unguarded rigid live parts (fuse cutouts, pole transformer bushing, etc.) clearance, refer to NESC Table 232-2.
3. For clearances of insulated conductors see Table 232-1 NESC C2-1997.

TABLE 2.

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# Clearance of Exposed, Non-Insulated, Items

**CLEARANCE OF EXPOSED/NON-INSULATED WIRES, CONDUCTORS, CABLES AND UNGUARDED LIVE PARTS ADJACENT BUT NOT ATTACHED TO BUILDINGS AND OTHER INSTALLATIONS EXCEPT BRIDGES**

Application	Minimum Clearance 751 V – 22 kV <sup>1</sup> Phase to Ground	
	Feet	Meters
<b>A. Buildings</b>		
1. Horizontal	7.5	2.3
2. Vertical		
a. Over or under roofs of projections not accessible to pedestrians.	12.4	3.8
b. Over or under balconies and roofs accessible to pedestrians	13.4	4.1
c. Over roofs accessible to mobile equipment but not subject to truck traffic	13.4	4.1
d. Over roofs accessible to truck traffic	18.3	5.6
<b>B. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges</b>		
1. Horizontal	7.5	2.30
2. Vertical	13.4	4.1
3. Vertical:	7.5	2.30
Over or under catwalks and other surfaces upon which personnel walk		
Over or under other portions of such installations		

Note: The table is based on Table 234-1 NESC C2-1997.

1. Distances shall increase 4 in. (10 cm) for each 10 kV over 22 kV phase to ground.

**TABLE 3.**

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# Vertical Clearance Between Conductors

## VERTICAL CLEARANCE BETWEEN CONDUCTORS AT SUPPORTS ON SAME STRUCTURE

(DISTANCE IN INCHES & CM)

(Voltages are phase-to-ground for effectively grounded circuits.)

Upper Level Conductors	Open Supply Cables							
	0 - 8.7 kV		8.7 – 50 kV					
			Same Utility			Different Utilities		
Lower Level Conductors	in.	cm	in.		Cm	in.		cm
Communication Conductors	40	100	40		100	40	Plus "A"	100
Triplex & Quadplex 0-750 V Supply Cable	16 <sup>1.</sup>	41	16	Plus "A"	41	40	Plus "A"	100
750V – 8.7 kV Supply Cable	16	41	16	Plus "A"	41	40	Plus "A"	100
8.7 kV–22 kV Supply Cable			16	Plus "A"	41	16 <sup>2,3.</sup>	Plus "A"	41
>22 kV - 50kV Supply Cable			16	Plus "A"	41	16	Plus "A"	41

Note: This table is based on Table 235-5 NESC C2-1997.

"A" = 0.4 inches (1.0 cm) per kV over 8.7 kV

- Increase to 40" (100 cm) if conductors are operated by different utilities.
- Increase to 40" (100 cm) if live line maintenance is performed and adjacent circuits are neither de-energized nor covered.
- Example: Different utilities, other utility does live line maintenance 26.6 kV circuit above a 13.9 kV circuit. Phases may be displaced by 180 degrees, therefore voltage difference is considered to be  $26.6 + 13.9 = 40.5$  kV  
 $A = 0.4 (40.5 - 8.7) = 12.72"$  (32 cm)  
 Clearance =  $40 + 13 = 53"$  (133 cm)

**TABLE 4.**

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# Basic Vertical Clearance

## BASIC VERTICAL CLEARANCE OF WIRES, CONDUCTORS AND CABLES CARRIED ON DIFFERENT SUPPORTING STRUCTURES

(Voltages are phase-to-ground for effectively grounded circuits.)

Upper Level Conductors	Open Supply Conductors			
Lower Level Conductors	Cables meeting rule 230C1 and 0 to 750V meeting rule 230C2 or 230C3		751 V to 22 kV	
	Feet	Meters	Feet	Meters
Communication Conductors, Cables and Messengers	2	.6	5 <sup>1</sup>	1.5
Open Supply Conductors 0-750 V; meeting rule 230C1, 230C2, or 230C3	2	.6	2	.6
Open Supply Conductors 750V – 22 kV	2 <sup>2</sup>	.6	2	.6
Trolley and Electrified Railroad Conductors	4 <sup>3</sup>	1.8	6	2.1
Guys, span wires, neutral conductors and surge protection wires	2	.6	2	.6

Note: This table is based on Table 233-1 NESC C2-1997.

1. This clearance may be reduced to 4 ft. (1.2 m) where supply conductors of 750 V to 8.7 kV cross a communication line more than 6 ft. (1.8 m) horizontally from a communications structure.
2. This type crossing is not recommended.
3. Trolley and electrified railroad contact conductors of more than 750 V should have at least 6 ft. of clearance.

TABLE 5.

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# Limits of Approach

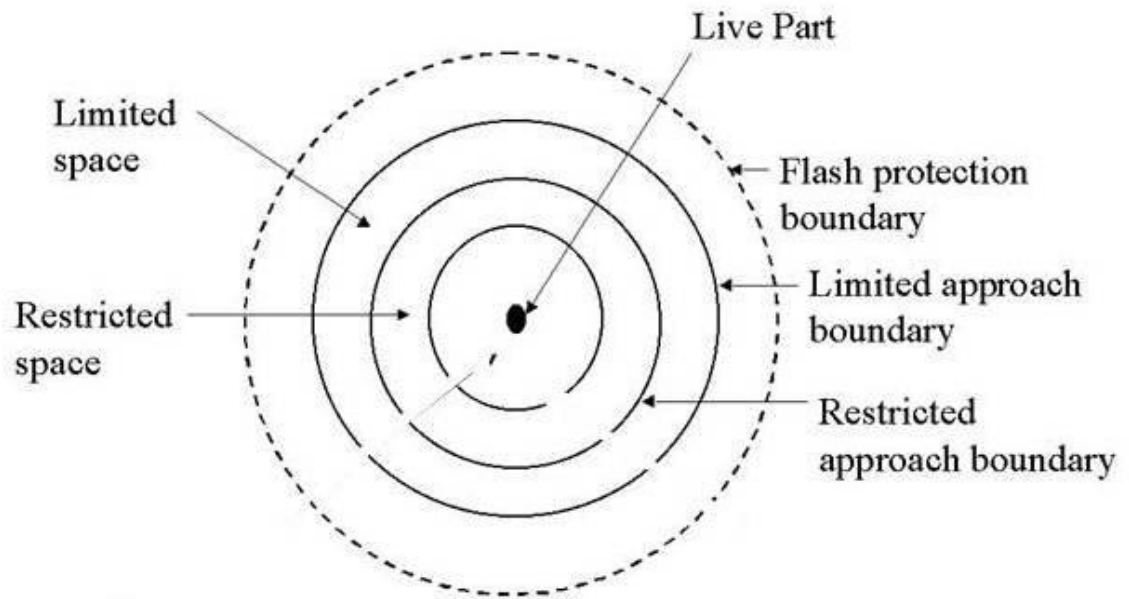


FIGURE 2.

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# Approach Boundaries

Nominal System Voltage Range	Limited Approach Boundary		Restricted Approach Boundary
	Exposed Moveable Conductor	Exposed Fixed Circuit Part	Includes Inadvertent Movement Adder
Phase to Phase			
Less than 100V	Not specified	Not specified	Not specified
100V – 300V	10 ft. 0 in.	3 ft.6 in.	Avoid contact
301 - 750	10 ft. 0 in.	3 ft.6 in.	1 ft. 0 in.
751 V – 15 kV	10 ft. 0 in.	5 ft.0 in.	2 ft. 2 in.
15.1 – 36 kV	10 ft. 0 in.	6 ft.0 in.	2 ft. 7 in.
36.1 –46 kV	10 ft. 0 in.	8 ft.0 in.	2 ft. 10 in.
46.1 – 72.5 kV	10 ft. 0 in.	8 ft.0 in.	3 ft. 3 in.
72.6 – 121 kV	10 ft. 8 in.	8 ft.0 in.	3 ft. 3 in.
138 – 145 kV	11 ft. 0 in.	10 ft.0 in.	3 ft. 7 in.
161 – 169 kV	11 ft. 8 in.	11 ft.8 in.	4 ft. 0 in.
230 – 242 kV	13 ft. 0 in.	13 ft.0 in.	5 ft. 3 in.
345 –362 kV	15 ft. 4 in.	15 ft.4 in.	8 ft. 6 in.
500 – 550 kV	19 ft. 0 in.	19 ft.0 in.	11 ft. 3 in.
765 – 800 kV	23 ft. 9 in.	23 ft. 9 in.	14 ft. 11 in.

Note: This table is based on NFPA 70E 2015 Approach Distances Table.

**Notes:**

1. Affected Persons, persons who are not authorized or qualified cannot cross the limited approach boundary. (see Section 11, Appendix B, item B; Section 4, item 4.2.3.a)
2. Authorized Persons, specifically task trained, may work inside the limited approach boundary. However, in no case **shall** an authorized person be allowed to work as close to live parts as the restricted approach boundary allowed for a qualified person. (see section 4, item 4.2.3.b)
3. Qualified persons may work up to the restricted approach boundary. For a qualified person to cross the restricted approach boundary he/she **shall** follow the rules outlined in section 11, Appendix B, item C. (see section 4, item 4.2.3.c)
4. Qualified Persons who cross the prohibited approach boundary **shall** follow work procedures required to make contact with live parts. To cross the prohibited approach boundary is considered the same as making contact with live parts. (see section 11 Appendix B, Item D)

**TABLE 6.**

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## Appendix B - Limits of Approach

### A. Preparation for Approach

Observing a safe approach distance from live parts is an effective means of maintaining electrical safety. As the distance between a person and the live parts is decreased, the potential for electrical accident increases.

### B. Unqualified Persons, Safe Approach Distance

Unqualified persons are safe when they maintain a distance from the live parts, including the longest conductive object being handled, so that they cannot contact or enter a specified air insulation distance to the live parts. This safe approach distance is the limited approach boundary. Further, unqualified persons shall not cross the arc flash boundary unless they are wearing appropriate personal protective clothing and are under the close supervision of a qualified person. Note that the arc flash boundary may be greater than the limited approach boundary for higher capacity systems.

### C. Qualified Persons, Safe Approach Distance

Determine the arc flash boundary **and**, if the boundary is to be crossed, appropriate PPE equipment and arc-rated clothing shall be utilized.

For a person to cross the limited approach boundary and enter the limited space, he or she shall be qualified to perform the job/task.

To cross the restricted approach boundary and enter the restricted space, the qualified person **shall:**

1. Have a **plan** that is documented and approved by authorized management.
2. Use personal protective equipment appropriate for working on live parts, and rated for the voltage and energy level involved.
3. Be certain that no part of the body shall enter the prohibited space.
4. Minimize the risk due to inadvertent movement by keeping as much of the body out of the restricted space, using only protected body parts in the space as necessary to accomplish the work.

## Appendix C - Arc-Resistant Clothing Recommendations

Tables 130.7(C) (15)(a) and 130.7(C)(15)(b) reprinted with permission from NFPA 70E – 2012, *Standard For Electrical Safety in the Workplace*, copyright © National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the NFPA on the referenced subject which is represented solely by the standard in its entirety.

A flash hazard analysis shall be done before a person approaches any exposed electrical conductor or circuit part that has not been placed in an electrically safe work condition. The arc flash boundary shall be utilized to initiate the need for personal protective equipment. Refer to IEEE 1584, NFPA 70E and appendix D of this document for formulas and other information needed to establish the arc flash boundary. Chapter 1 of NFPA 70E contains information and recommendations that address personal protective equipment required for personnel to cross inside the arc flash boundary.

Arc-rated Clothing and Personal Protective Equipment (PPE) shall be used by the employee based upon the incident energy exposure associated with the specific task [see table 130.5(G)]. As an alternative, the PPE Category requirements outlined in Tables 130.7(C) (15)(a) and 130.7(C)(15)(b) may be used. These tables (extracted from NFPA 70E) are shown below.

It is important to investigate the limitations of any programs used to calculate incident energy. Experience suggests that the calculation of arc flash exposure above 600 volts is conservative and become more conservative as the voltage increases. It should be noted that all present methods of calculating incident energy 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,” IEEE Sept 30, 1998.

NOTE: See D for Sample Calculation of Arc Flash Boundary  $D_c$ , Arc in Open Air  $E_{ma}$ , and Arc in Cubic Box  $E_{mb}$

**Table 130.7(C)(15)(a) Arc-Flash Hazard PPE Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools-Alternating Current Equipment**

<b>Tasks Performed on Energized Equipment</b>	<b>PPE Category</b>	<b>Rubber Insulating Gloves</b>	<b>Insulated and Insulating Hand Tools</b>
<b>Panelboards or other equipment rated 240 V and below</b> Parameters: Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
Circuit breaker (CB) or fused switch operation with covers on	1	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
<b>Panelboards or other equipment rated &gt; 240 V and up to 600 V</b> Parameters: Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 30 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
Circuit breaker (CB) or fused switch operation with covers on	1	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Remove/install CBs or fused switches	2	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	2	Y	Y
<b>600 V class motor control centers (MCCs)</b> Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N

Table 130.7(C)(15)(a) *Continued*

Tasks Performed on Energized Equipment	PPE Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
CB or fused switch or starter operation with enclosure doors closed	1	N	N
Reading a panel meter while operating a meter switch	N/A	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	N/A	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2	Y	Y
<b>600 V class motor control centers (MCCs)</b> Parameters: Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 165 in.			
Insertion or removal of individual starter “buckets” from MCC	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
<b>600 V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards</b> Parameters: Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec (30 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 233 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	1	N	N
Reading a panel meter while operating a meter switch	N/A	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	N/A	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2	Y	Y

Table 130.7C(15)(a) *Continued*

<b>Tasks Performed on Energized Equipment</b>	<b>PPE Category</b>	<b>Rubber Insulating Gloves</b>	<b>Insulated and Insulating Hand Tools</b>
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of temporary protective grounding equipment after voltage test	2	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
<b>Other 600 V class (277 V through 600 V, nominal) equipment</b> Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance (except as indicated) Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53 in.			
Lighting or small power transformers (600 V, maximum)	2	N	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	N
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Revenue meters (kW-hour, at primary voltage and current)—insertion or removal	2	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Insertion or removal of plug-in devices into or from busways	2	Y	N
<b>NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV</b> Parameters: Maximum of 35 kA short circuit current available; maximum of up to 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactor operation with enclosure doors closed	1	N	N
Reading a panel meter while operating a meter switch	N/A	N	N
Contactor operation with enclosure doors open	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	N/A	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	3	Y	Y



Table 130.7(C)(15)(a) *Continued*

<b>Tasks Performed on Energized Equipment</b>	<b>PPE Category</b>	<b>Rubber Insulating Gloves</b>	<b>Insulated and Insulating Hand Tools</b>
Insertion or removal (racking) of starters from cubicles, doors open or closed	4	N	N
Application of temporary protective grounding equipment, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	N/A	N	N
<b>Metal clad switchgear, 1 kV through 38 kV</b> Parameters: Maximum of 35 kA short circuit current available; maximum of up to 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
CB operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	N/A	N	N
CB operation with enclosure doors open	4	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of temporary protective grounding equipment, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N
<b>Arc-resistant switchgear Type 1 or 2 (for clearing times of &lt; 0.5 sec with a perspective fault current not to exceed the arc-resistant rating of the equipment)</b> Parameters: Maximum of 35 kA short circuit current available; maximum of up to 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
CB operation with enclosure door closed	1	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	1	N	N

Table 130.7(C)(15)(a) *Continued*

Tasks Performed on Energized Equipment	PPE Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	2	N	N
Insertion or removal (racking) of voltage transformers on or off the bus door closed	2	N	N
<b>Other equipment 1 kV through 38 kV</b> Parameters: Maximum of 35 kA short circuit current available; maximum of up to 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Metal-enclosed interrupter switchgear, fused or unfused	2	N	N
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only	2	N	N
Switch operation, doors closed	4	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

Y = Yes (required). N: No (not required). Notes:

(1) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.

(2) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools*.

(3) The use of "N" does not indicate that rubber insulating gloves and insulated and insulating hand tools are not required in all cases. Rubber insulating gloves and insulated and insulating hand tools may be required by 130.4, 130.7 (C) (7)(a), and 130.7(D)(1).

(4) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (½ cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in. (455 mm). Arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 18 in. (455 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.

(6) For power systems from 1 kV to 38 kV the arc fl boundary was determined by using the following information: No maximum values were given in the 2009 edition of NFPA 70E for short-circuit current or operating time. Two sets of equations were performed: 35 kA AIC and 0.2 second operating time and 26 kA AIC and 0.2 second operating time. 0.2 seconds was used by adding the typical maximum total clearing time of the circuit breaker to an estimated value for relay operation. This coincides with the IEEE 1584 values of 0.18 second operating time and 0.08 tripping time rounded off. A short-circuit current of 35 kA was used as a maximum (HRC-4 @ ~ 40 cal/cm<sup>2</sup>) and 26 kA was used to compare the effects of lowering the short circuit current (HRC-4 @ ~ 30 cal/cm<sup>2</sup>). Working distance used was 36 in. (909 mm), arc gap was 6 in. (455 mm), and protective device type 0 for all.



**Table 130.7(C)(15)(b) Arc-Flash Category PPE Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools — Direct Current Equipment**

Tasks Performed on Energized Equipment	PPE Category <sup>a</sup>	Rubber Insulating Gloves <sup>b</sup>	Insulated and Insulating Hand Tools
<b>Storage batteries, direct-current switchboards and other direct-current supply sources &gt;100 V &lt;250 V</b>			
Parameters: Voltage: 250 V Maximum arc duration and working distance: 2 sec @ 18 in.			
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 1$ kA and $< 4$ kA Potential arc flash boundary using above parameters at 4 kA: 36 in.	1	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 4$ kA and $< 7$ kA Potential arc flash boundary using above parameters at 7 kA: 48 in.	2	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 7$ kA and $< 15$ kA Potential arc flash boundary using above parameters at 15 kA: 72 in.	3	Y	Y
<b>Storage batteries, direct-current switchboards and other direct-current supply sources <math>\geq 250</math> V <math>\leq 600</math> V</b>			
Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 sec @ 18 in.			
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 1$ kA and $< 1.5$ kA Potential arc flash boundary using above parameters at 1.5 kA: 36 in.	1	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 1.5$ kA and $< 3$ kA Potential arc flash boundary using above parameters at 3 kA: 48 in.	2	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 3$ kA and $< 7$ kA Potential arc flash boundary using above parameters at 7 kA: 72 in.	3	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is $\geq 7$ kA and $< 10$ kA Potential arc flash boundary using above parameters at 10 kA: 96 in.	4	Y	Y

Y: Yes (required).

<sup>a</sup>If acid exposure is possible, the clothing is required to be protected from acid and arc rated to the hazard according to ASTM F 1891 or equivalent and evaluated by ASTM F 1296 for acid protection.

<sup>b</sup>In clean rooms or other electrical installations, that do not permit leather protectors for arc flash exposure, ASTM F 496 is required to be followed for use of rubber insulating gloves without leather protectors.

Typical Protective Clothing Systems			
PPE Category	Clothing Description (Number of clothing layers is given in parentheses)	Total Weight oz./yd <sup>2</sup>	Minimum Arc Thermal Performance Exposure Value (ATPV)* or Breakopen Threshold Energy (E <sub>bt</sub> )* Rating of PPE cal/cm <sup>2</sup>
1	FR Shirt and FR Pants (1)	4.5 - 8	4
2	Cotton Underwear plus FR Shirt and FR Pants (2)	9 - 12	8
3	Cotton Underwear plus FR Shirt and FR Pants plus FR Coverall (3)	16 - 20	25
4	Cotton Underwear plus FR Shirt and FR Pants plus Double Layer Switching Coat and Pants (4)	24 - 30	40

\* ATPV is defined in the ASTM PS58 standard arc test method for arc-rated fabrics as the incident energy that would just cause the onset of a second degree burn (1.2 cal/cm<sup>2</sup>) E<sub>bt</sub> is reported according to ASTM PS58 and is defined as the highest incident energy which did not cause arc-rated fabric breakopen and did not exceed the second degree burn criteria. E<sub>bt</sub> is reported when ATPV cannot be measured due to FR fabric breakopen.

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## 1. Table 130.5(G) Selection of Arc-Rated Clothing and Other PPE When the Incident Energy Analysis Method Is Used

### Incident energy exposures equal to 1.2 cal/cm<sup>2</sup> up to 12 cal/cm<sup>2</sup>

Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy (A) Long-sleeve shirt and pants or coverall or arc flash suit (SR) Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR) (B) Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN) Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) (C) Hard hat Safety glasses or safety goggles (SR) Hearing protection and Leather footwear

**Incident energy exposures greater than 12 cal/cm<sup>2</sup>**

Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy <sup>(A)</sup> Long-sleeve shirt and pants or coverall or arc flash suit <sup>(SR)</sup> Arc-rated arc flash suit hood Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) <sup>(AN)</sup> Arc-rated gloves or rubber insulating gloves with leather protectors <sup>(SR)</sup> <sup>(C)</sup> Hard hat Safety glasses or safety goggles <sup>(SR)</sup> Hearing protection and Leather footwear

**SR:** Selection of one in group is required.

**AN:** As needed.

**(A)** Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.

**(B)** Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.

**(C)** Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection

## Appendix D - Sample Calculation of Arc Flash 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 which are 600 volts and below, the arc flash boundary shall be 4.0 feet, based on the product of clearing times of 0.1 seconds and the available fault currents of 50 kA or any combination not to exceed 300 kA cycles (5,000 ampere seconds).

The arc flash boundary shall alternatively be permitted to be calculated as shown below.

At voltage levels above 600 volts, the arc flash boundary is the distance at which the incident energy level equals  $1.2 \text{ cal/cm}^2$ .

### A. Sample Calculation - Arc Flash 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: Reference to the paper that contains these formulas is located in Appendix C

Calculate the short-circuit current:

$$\begin{aligned} I_{sc} &= \{[\text{MVA Base} \times 10^6] / [1.732 \times V]\} \times \{100 / \%Z\} \\ &= \{[10 \times 10^6] / [1.732 \times 4,160]\} \times \{100 / 5.5\} \\ &= 25,000 \end{aligned}$$

Calculate the power in the arc:

$$\begin{aligned} P &= (\text{Maximum Bolted Fault in MVA}_{bf}) \times 0.707^2 \\ P &= 1.732 \times 4,160 \times 25,000 \times 10^{-6} \times .707^2 \\ P &= 90 \text{ MW} \end{aligned}$$

**Calculate the curable burn distance  $D_c$**

$$D_c = \{(2.65 \times MVA_{bf})(t)\}^{1/2}$$

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

$$= 6.8 \text{ or } 7 \text{ feet}$$

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

$$D_c = \{(53)(MVA)(t)\}^{1/2}$$

$$D_c = [53 \times 10 \times .1]^{1/2}$$

$$= 7.28 \text{ feet}$$

## B. 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  $E_{ma}$**

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

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

$$E_{ma} = (5271)(24)^{-1.9593} (0.1)[0.0016(25)^2 - 0.0076(25) + 0.8938] = 1.77 \text{ cal/cm}^2$$

Note: This would require a Category 0 clothing system

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

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

Note: This would require a Category 1 clothing system

### C. 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  $E_{mb}$**

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

For  $I_{sc} = 25 \text{ kA}$ ,  $t_A = 0.1 \text{ seconds}$ ,  $D_B = 18 \text{ inches}$

$$E_{mb} = (1038.7)(24)^{-1.4738} (0.1)[0.0093(25)^2 - 0.3453(25) + 5.9675] = 4.62 \text{ cal/cm}^2$$

Note: This would require a Category 2 clothing system

For  $I_{sc} = 50 \text{ kA}$ ,  $t_A = 0.1 \text{ seconds}$ ,  $D_B = 18 \text{ inches}$

$$E_{mb} = (1038.7)(24)^{-1.4738} (0.1)[0.0093(50)^2 - 0.3453(50) + 5.9675] = 17.54 \text{ cal/cm}^2$$

Note: This would require a Category 3 clothing system

# Appendix E – 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 (creates a greater hazard to deenergize of is Infeasible):  
\_\_\_\_\_  
\_\_\_\_\_

Requester/Title \_\_\_\_\_

Date \_\_\_\_\_

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

- |  |   |
|--|---|
| 1) Detailed job description procedure to be used in performing the above described work:<br>_____<br>_____   | Check when Complete<br><input type="checkbox"/> |
| 2) Description of the Safe Work Practices to be employed: _____<br>_____   | <input type="checkbox"/>                        |
| 3) Results of the Shock Hazard Analysis: _____<br>_____  | <input type="checkbox"/>                        |
| 4) Determination of Shock Protection Boundaries: _____<br>_____  | <input type="checkbox"/>                        |
| 5) Results of the Flash Hazard Analysis: _____<br>_____  | <input type="checkbox"/>                        |
| 6) Determination of the Arc Flash Boundary: _____<br>_____   | <input type="checkbox"/>                        |
| 7) Necessary personal protective equipment to safely perform the assigned task: _____<br>_____   | <input type="checkbox"/>                        |
| 8) Means employed to restrict the access of unqualified persons from the work area: _____<br>_____   | <input type="checkbox"/>                        |
| 9) Evidence of completion of a Job Briefing including discussion of any job-specific hazards:<br>_____   | <input type="checkbox"/>                        |
| 10) Do you agree the above described work can be done safely?<br><input type="checkbox"/> Yes <input type="checkbox"/> No (If no, return to requester) |   |

Electrically Qualified Person(s) \_\_\_\_\_

Date \_\_\_\_\_

Electrically Qualified Person(s) \_\_\_\_\_

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

Note: Once the work is complete, forward this form to the site Safety Department for review and retention.

## Appendix F - Job Briefing Checklist

<b>Identify</b>	
<input type="checkbox"/> What are the hazards?	<input type="checkbox"/> Potential for arc flash
<input type="checkbox"/> What voltage levels are involved?	<input type="checkbox"/> Unusual work conditions
<input type="checkbox"/> What skills are required?	<input type="checkbox"/> Is this a multiple-person job?
<input type="checkbox"/> "Foreign" voltage source present?	
<b>Ask</b>	
<input type="checkbox"/> Can the equipment be de-energized?	<input type="checkbox"/> Is a "standby person" required?
<input type="checkbox"/> Are there possible backfeeds of the circuits to be worked on?	
<b>Check</b>	
<input type="checkbox"/> Job plans	<input type="checkbox"/> Safety procedures
<input type="checkbox"/> One lines and vendor prints	<input type="checkbox"/> Vendor information
<input type="checkbox"/> Status board	<input type="checkbox"/> For up-to-date information on plant and vendor resources
<input type="checkbox"/> Individuals familiar with facility?	
<b>Know</b>	
<input type="checkbox"/> What is the job?	
<input type="checkbox"/> Who is in charge?	
<input type="checkbox"/> Who else needs to know? ... Communicate!	
<b>Think</b>	
<input type="checkbox"/> About the extra event ... What if?	<input type="checkbox"/> Use the right tools and equipment, including PPE
<input type="checkbox"/> Lock - Tag – Test – Try	<input type="checkbox"/> Install barriers and barricades
<input type="checkbox"/> Test for voltage – FIRST	<input type="checkbox"/> What else ...?
<input type="checkbox"/> Install and remove grounds	
<b>Prepare for an emergency</b>	
<input type="checkbox"/> Standby person CPR trained?	<input type="checkbox"/> What is the exact work location?
<input type="checkbox"/> Telephone location?	<input type="checkbox"/> How is the equipment shut off in an emergency?

<input type="checkbox"/>	Fire alarm locations?	<input type="checkbox"/>	Where is the emergency equipment?
<input type="checkbox"/>	Confined space rescue available if required?	<input type="checkbox"/>	Is the required emergency equipment available?
<input type="checkbox"/>	Emergency phone numbers?	<input type="checkbox"/>	Radio communications available?
<input type="checkbox"/>	Extinguisher?	<input type="checkbox"/>	

## Appendix G

### A. Communication Facilities

1. The employer **shall** ensure that no employee shall look into an open waveguide or antenna that is connected to an energized microwave source.

In addition, if the electromagnetic radiation level exceeds the radiation protection guide noted in 29 CFR 1910.97, the warning symbol described therein **must** be posted at the affected area. The lower half of the symbol **shall** have the following message or its equivalent: “Radiation in this area may exceed hazardous limitations and special precautions are required. Obtain specific instruction before entering.”

When employees **must** work in an area that is posted as above, the employer **shall** ensure that the employee’s exposure is not greater than that permitted by the protection guide. Such measures may include administrative and engineering controls and personal protective equipment.

2. Power-line carrier work, including work on equipment that is used for coupling carrier current to power line conductors, **shall** be in accordance with requirements detailed for working on energized lines.

### B. Special Conditions

1. Working on capacitors requires the following measures:
  - a. The capacitors **shall** be disconnected from energized sources and a five minute wait will be required before the capacitors **shall** be short circuited and any work on the capacitor begins.
  - b. Before any capacitor units are handled, they **must** be short circuited between their terminals and the rack. If the rack is ungrounded, it **shall** be bonded to the ground.
  - c. All lines to which capacitors are connected **shall** be considered energized until the capacitors are short circuited.
2. The secondary of a current transformer **shall not** be opened while the transformer is energized. If the primary of the current transformer cannot be de-energized to permit work on its secondary devices, the primary circuit **must** be bridged.

3. If the open circuit voltage on series streetlighting exceeds 600 volts, the circuit **shall** be worked as an overhead line or an underground facility. A series loop can be opened only after the transformer has been de-energized and isolated from the source of supply.
4. If natural lighting is insufficient to illuminate the work site, artificial illumination **shall** be provided.
5. Employees who are subjected to potential drowning hazards **shall** wear U.S. Coast guard approved personal flotation devices.

Personal flotation devices **shall** be maintained in safe condition and **shall** be inspected on a regular basis. The inspection **shall** check for visible rot, mildew, water saturation, or any other condition that could render it unsuitable for use.

Crossing of streams and other bodies of water is permissible only if a safe means of passage is provided.

6. Protection for employees from vehicular and pedestrian traffic **shall** be provided by signs, flags, and other traffic control devices.  
The traffic control signs and devices shall meet the requirements of 1926.200(g)(2). If additional protection is needed, barricades **shall** be used. Warning lights **shall** be used at night.  
Excavated areas **shall** be protected with barricades.
7. When there is a possibility of feedback from any source, the lines or equipment **must** be worked as if they were energized; or they **must** be isolated, tested, locked out/tagged out and grounded so they can be worked on as de-energized.
8. Laser equipment **shall** be installed, adjusted, and operated as noted in 29CFR1926.54.
9. Hydraulic fluids used as insulation for different sections of equipment **shall** provide the insulation for the voltage involved.

## C. Testing and Test Facilities

This section applies to testing involving interim measurements of high voltage and/or high power in laboratories, shops, field, or substations. The following does not apply to testing involving continuous measurements, as in routine metering, relaying, and normal line work.

The employer **shall** establish and enforce additional work practices for worker protection at all test areas, temporary and permanent. Such measures **shall** provide as a minimum: test area guarding, grounding, and safe use of measuring and control circuits. A periodic safety check of field test areas **shall** also be included. Also required is the training of employees in their initial assignments, with continuing periodic reviews and updates.

Specifics on work practices in test areas are as follows:

a. Guarding of Test Areas

1. Permanent test areas **shall** be guarded by walls, fences, or barriers to prohibit entry by unauthorized employees.
2. Field testing or temporary test sites, **shall** be guarded by distinctively colored safety tape at waist height and also by supporting safety signs. An alternative to this method would be the stationing of one or more test observers who could monitor the entire area. When no longer needed, these barriers **shall** be removed.
3. In order to prevent accidental employee contact with energized parts, guarding **shall** be provided to control access to test equipment and any apparatus under test that could become energized by direct or inductive coupling.

b. Grounding Practices

1. The employer **shall** establish and implement safe grounding practices:
  - a. All conductive parts accessible to a test operator **shall** be grounded **or shall** be isolated from the operator by guarding.
  - b. If left ungrounded, the terminals of the test equipment and apparatus under test **shall** be treated as energized unless determined by test to be isolated.
2. Visible grounds **shall** be applied automatically or manually with properly insulated tools after the circuit is isolated and before any work begins. Common ground connections **shall** be solidly connected to the test equipment and the apparatus under test.

3. During high-power tests, an isolated ground-return conductor system **shall** be provided. This will prohibit a voltage rise in the ground grid system and/or earth. However, an isolated ground-return conductor is not required if the employer demonstrates the following two conditions:

The distance is too great from the energy source and the test site,

**AND**

Employees are protected from the hazards of touch and step potential that could develop during tests.

4. During some tests, the grounding through the power cord may present a hazard to the test operator or may prevent satisfactory test measurements. In these cases, an equivalent safety ground **shall** be provided and this information **shall** be given to all concerned.
  5. When the test area is entered following de-energization, an intentional ground **shall** be placed on the high voltage terminals and any other exposed terminals. High-capacitance equipment **shall** be discharged through a rated resistor. After discharge, a ground **shall** be applied.
  6. The chassis of test vans or trailers **shall** be grounded. The hazard of touch potential with respect to the chassis **shall** be guarded against by bonding, insulation, or isolation.
- c. Control and Measuring Circuits
1. Control wiring, meter connections, test leads, and cables may not be run from a test area unless they are contained in a grounded metallic sheath and terminated in a grounded metallic enclosure, or unless an equivalent safety measure has been applied.
  2. Meters and other instruments with accessible terminals **shall** be isolated from test personnel to protect against inadvertent energization. If this isolation is provided by locating equipment in metal compartments with viewing windows, the compartment cover **shall** be equipped with interlocks to interrupt the power supply if the cover is opened.

3. Routing and connections of temporary wiring **shall** be protected from damage, accidental interruptions, and other hazards to the maximum extent possible, signal, control, ground, and power cables **shall** be kept separate.
  4. While employees are present in the test area during testing, a test observer who is capable of performing immediate de-energization of test circuits for safety purposes **shall** be present.
- d. Safety Checks
1. Safety practices at temporary and field areas **shall** provide for a routine check for safety at the beginning of each series of tests.
  2. Using routine safety checks, the test operator in charge will verify, at a minimum, the following:
    - a. Guards and barriers are in workable condition and properly placed to isolate all hazardous areas.
    - b. The system test status signal, if used, is in operable condition.
    - c. Test power disconnects are clearly marked and readily available in case of an emergency situation.
    - d. Ground connections are clearly identified.
    - e. Required personal protective equipment is provided and used.
    - f. All signal, ground, and power cables are properly separated.

## Appendix H – Fall Protection

### A. Fall Protection

Fall protection/fall arrest equipment uses **shall** meet the following requirements:

- a. Personal fall arrest equipment **shall** meet the requirements of Subpart E of Part 1926.
- b. Body belts and safety snaps for work positioning **shall** meet the requirements of 1926.959.
- c. Body belts, safety snaps, lanyards, lifelines, and body harnesses **shall** be inspected before use each day. Defective equipment **shall not** be used.
- d. Lifelines **shall** be protected against being cut or abraded.
- e. Fall-arrest equipment, work-positioning equipment, or travel-restrictive equipment **shall** be used by employees when working 4 feet (1.2 M) or more above ground on poles, towers, or other structures if other fall protection has not been provided. Qualified employees are not required to use fall protection while climbing or changing locations on poles, unless there are conditions such as, but not limited to, ice, high winds, presence of contaminants on poles, or no provisions for holding on with hands.
- f. Personal fall-arrest systems **shall not** produce an arresting force on an employee of more than 900 pounds (4 KN) if used with a body belt.
- g. Personal fall-arrest systems **shall not** produce an arresting force on an employee of more than 1800 pounds (8 KN) if used with a body harness.
- h. Personal fall-arrest systems shall be rigged to limit an employee's free fall to no more than 6 feet (1.8m) or to a distance equal to the employee's height, whichever is less.

- i. Only one employee may be attached to vertical life-lines or droplines.
- j. Snaphooks **shall not** be connected to loops made in webbing lanyards.
- k. Snaphooks **shall not** be connected to each other.

## Appendix I - Electrical Operations

### A. General

1. The Electrical Utility Department of Facilities Management is responsible for the operation of the campus electrical distribution systems between the point of NSP supply and the service point of each building, as well as all electrical distribution and utilization equipment within University buildings which operates in excess of 600 volts A.C. in a safe, reliable, and economic manner.
2. **SAFETY IS FUNDAMENTAL TO THIS OPERATION AND IS THE HIGHEST PRIORITY OF THE ELECTRICAL UTILITY DEPARTMENT.** Reliability and economy shall always be considered secondary to the safety of University personnel and the public in the planning, coordination, and carrying-out of all work performed on the electrical communication among all concerned is essential to maintain this standard.

### B. Switching Procedures

**NOTE: The following requirements are not intended to prevent a qualified high-voltage crew electrician from operating, in an emergency, switches to de-energize equipment when an immediate hazard to personnel, or likelihood of equipment failure exists.**

1. No switching shall be performed without a written approved switching procedure.
2. Switching procedures shall identify all locations and equipment to be switched in specific order and shall identify all hold card and ground requirements.
3. For all switching, the High-Voltage crew subforeman shall designate a qualified electrician in each crew as responsible for following and completing the switching procedure.
4. Switching procedures shall be followed in their specific order, the time of each action recorded, and the signature of the designated high-voltage crew electrician provided at the completion of the procedure. All completed procedures shall be returned to the Electric Utility Manager.
5. If changes to the procedure are required during switching, they shall be approved by radio by the high-voltage crew subforeman

or the Operations Engineer and noted on the switching procedures.

6. Copies of standard approved ON, OFF, ON/OFF, and EMERGENCY OFF procedures for each feeder shall be maintained by the high-voltage crew subforeman readily available for emergency use.

Deviation from the standard procedures in an emergency require the approval of the Operations Engineer, the Principal Plant Engineer, or the Electric Utility General Foreman. the circuit **shall** be worked as an overhead line or an underground facility. A series loop can be opened only after the transformer has been de-energized and isolated from the source of supply.

### **C. Request for Outage**

1. Planned outage of equipment that will interrupt service to customers shall be obtained through the Procedures for Notification of Interruption of Utilities and will be scheduled by Electric Utility Department.
2. Requests for outages to perform maintenance and operations work shall be made by the electrical subforeman to the Operations Engineer.
3. Requests by contractors for outages to perform construction work must be submitted by the University Project Manager following the procedure identified in A.
4. All outages requiring primary switching shall require a switching procedure.

### **D. Clearance for Work**

1. Clearance for work and the safety of personnel working on circuits or equipment which has been de-energized for that purpose shall be the responsibility of the qualified electrician in charge of the work. This may or may not be the same person responsible for the switching that provides clearance.
2. Before clearance for work is given or accepted, the qualified electrician in charge of the work shall review with the designated high voltage crew electrician the switching procedure, all sources of voltage or backfeed, the location of all hold cards, and the location of all protective grounds. If the work is being done by

University Personnel, the qualified electrician shall witness the testing for voltage and application of protective grounds.

3. If clearance for work is given to an outside contractor, the contractor's person in charge of the work shall review the items in b. with the designated high-voltage crew electrician. The contractor crew shall be responsible to test for voltage and apply quantity and location of grounds shall be recorded on the U of M switching procedure.
4. In general, clearance for work requires:
  - a. De-energization, testing for dead, visible air clearance, personal lock/tag and hold cards and protective grounds on all sources of voltage in excess of 600 volts A. C.
  - b. De-energization, testing for dead, visible air clearance, personal lock/tag and hold cards on all sources of voltage 600 volts A.C. or less. If visible break is not available (e.g.; molded-case circuit breaker, or network protector), protective grounds must be used.

Note: Lock boxes may be used to apply personal lock/tag devices.
5. Under no circumstances shall clearance for work be granted or released on a pre- determined time basis.
6. When the work is completed, and all persons are clear, the person in charge of the work and who received the clearance for work, shall report in writing on the U of M switching procedure to the appropriate Switching Authority that he/she is releasing his/her clearance for work. All personal lock/tags shall be removed before releasing the clearance for work.
7. If a person in charge of work is not available to release his/her hold cards, his/her immediate supervisor may release them after carefully assuring that all personal lock/tags have been removed and workers are cleared from the work site and it is safe to return the equipment to service.
8. Clearance for work may be temporarily withheld, for testing purposes and emergency availability, by contacting the Switching Authority. Before any switches, MODS, pot fuses, etc, may be operated, all persons working on the equipment must be notified and cleared from the equipment, all personal locks and tags and all Hold Cards must be removed. Before work is resumed, clearance for work must be again obtained from the Switching Authority.

9. Station auxiliary transformers, potential transformers, potential devices and coupling capacitors are possible backfeed sources and they shall be isolated from the electrical system and placed in the group position, when possible, to provide clearance for work. When working directly on this equipment, it shall be grounded to provide clearance for work.

## Appendix J - Safety Tags

### A. Safety Tags (Lockouts, Personal Danger Tag, Hold, Secure, Unsafe, Grounding Point Cards, etc.)

1. Personal Danger Tag - Each person **shall** install his/her personal lock/tag before start of work and remove their personal lock/tag when they finish work.

#### Removal of Personal Danger Tags

The Personal Danger Tag rules and procedures state that Personal Danger Tags **shall** only be removed from a device by the tag owner/originator or person nominated on the tag.

However, when person(s) authorized to remove the tag are unavailable and operation of the equipment is necessary, the following procedure **shall** be implemented.

- a. The appropriate supervisor/facilitator must make every reasonable effort to locate the authorized person(s) to have the tag(s) removed;
- b. When contacted, the person who has left their tag on the equipment must return to the plant and remove the tag as soon as possible. Persons returning to site to remove a tag must inform the supervisor/facilitator who requested their return when they have removed the tag;
- c. Where the person has been personally contacted but is unable to return to site to remove their Personal Danger Tag, the following procedure shall apply;
  1. Ask the person why they attached the tag.
  2. Have the person from the appropriate discipline assess the equipment and ensure that the equipment operation will not pose a hazard to people or equipment.
  3. The person assessing the equipment and the supervisor/facilitator responsible for the equipment shall ensure that the area protected by the danger tag is clear of people.
  4. The supervisor/facilitator may then remove the Personal Danger Tag in the presence of a witness, using the removal procedure for that tag.

- d. Where the person cannot be personally contacted, the following procedure **shall** apply:
    1. Determine as far as possible why the tag was attached.
    2. Have a person from each discipline involved (Electrical, Mechanical, Operations) assess the equipment and ensure that the equipment operation will not pose a hazard to people or equipment.
    3. The people assessing the equipment and the supervisor/facilitator responsible for the equipment shall ensure that the area protected by the Personal Danger Tag is clear of people.
    4. The supervisor/facilitator may then, in the presence of a witness, remove the tag using the removal procedure for that tag.
    5. Appropriate steps **shall** be taken to:
      - a. notify the person who has had their tag removed as soon as possible, that their tag has been removed.
      - b. guard against the return of the tag owner to the original work location.
  - e. The supervisor/ facilitator **shall** then initiate an incident report, which shall include all steps taken in the tag removal process outlined above.
2. While Personal Danger Tags, Hold, Secure, Unsafe and/or Grounding Point Tags are attached, the position of the switch or valve **shall** not be changed. A properly filled out and attached Hold, Secure, Unsafe and/or Grounding Point Tags **shall** not be removed unless authorized by the person authorizing the attachment. This person must also authorize removal. However, in certain situations where it is urgent that equipment be returned to service and every reasonable effort to contact and receive authorization from person holding equipment has failed, the person's supervisor may, after determining that it's safe to do so, authorize removal of Hold, Secure, Unsafe and/or Grounding Point Tags. Removal of this tag must be documented by the supervisor.
  3. Safety Tags shall be properly and completely filled out and, if required after removal, sent to the authorizing source for record maintenance.

4. Lockouts: In the de-energizing of lines and equipment, switches and disconnectors shall be rendered inoperable, i.e. locked in a de-energized position, where design permits.

## **B. Safety Tag Procedures**

1. This section applies to the control of all equipment. If more stringent governmental requirements are applicable, they shall be incorporated with Division/Department procedures.

Training: Technical, job specific training shall be the responsibility of each operating unit. Each individual involved in the use of safety tags including request for, writing of, recording of, attachment, verification, removal or any other function involving safety tags shall be thoroughly trained and knowledgeable of the systems or components with which safety tags are used. Retraining shall be at the discretion of each responsible operating unit and should be conducted at annual intervals. In considering responsibilities of the supervisor, authorized person, competent person and qualified person, the following items shall be reviewed:

- a. Supervisor or authorized person shall be:
  1. Thoroughly acquainted with the requirement of an isolation or restoration procedure before the isolation or restoration process starts.
  2. Assuring that the qualified person understands the outage requirements and competent person understands the switching requirements and not proceed until such understanding exists.
  3. Repeating all telephone and radio messages involving switching orders or other important information from any source and recording time and date.
  4. Verifying the correct Safety Tag is used and that a safety tag is attached for each person requesting same or that multiple requests are properly logged for attachment of a single safety tag.
  5. Maintaining the hold and secure card records.
  6. Giving final clearance on holding or securing of equipment and releasing same.

7. Insuring that a competent individual has independently verified the isolation and restoration of equipment when required.
  8. Shall be responsible for issuing and releasing temporary releases.
- b. Qualified persons shall be responsible for:
1. Being alert to potential hazards to employees in addition to those identified on the work request or work order.
  2. Repeating all telephone and radio messages involving switching orders.
  3. Thoroughly understanding instruction and performance of operational tasks.
  4. Verifying that equipment is in correct configuration prior to tagging.
  5. Filling out, installing, and removing safety tags.
- c. The Qualified or competent person in charge of the actual work shall be responsible for:
1. Requesting hold or secure tags be applied.
  2. Assuring that the requirements governing equipment control have been properly implemented to ensure safe working conditions.
  3. Reporting completion of work and releasing equipment back to Operations.
2. Safety Tags: Personal Danger Tag, Hold, Secure, Unsafe, and Grounding Point

The Electrical Utility Department shall use five visually distinct types of safety tags to alert employees to the requirement of non-operation of equipment such as switches, breakers, valves, controls, or to alert employees not to use unsafe tools such as ladders or hand tools.

- a. Personal Danger Tag - Each person **shall** install his/her personal lock/tag before start of work and remove their personal lock/tag when they finish work.

- b. Hold cards shall be approximately 3" x 7" printed in red, black and white with the words: HOLD; DANGER; DO NOT REMOVE THIS TAG UNLESS AUTHORIZED and spaces to record the date, time, location, purpose, and name of the individual.

Hold cards are intended to be used only for personal protection. All switches, breakers, cutouts, valves etc., whose operation represents a potential hazard to personnel working on a line or equipment shall have a hold card placed on them. Hold cards shall not be used for operational reasons or for protection of equipment.

- c. Secure cards shall be approximately 3" x 7" and printed in black on yellow with the words: SECURE; CAUTION; DO NOT REMOVE THIS TAG UNLESS AUTHORIZED and spaces to record the date, time, location, purpose and name of the individual.

Secure cards are intended to be used to identify equipment that is not to be operated because of system or equipment considerations. An example is a tie switch between two voltage sources that are not in-phase. Secure cards are not to be used for personal protection. Secure cards may be removed on the authorization of the person responsible for the system or equipment involved.

- d. Unsafe cards shall be approximately 3"x 5" printed in black, white and red with the words: UNSAFE, DO NOT USE UNTIL REPAIRED and spaces to record the date, time, reason and name of the individual.

Unsafe cards shall be used to alert employees to tools or equipment that are not safe to operate due to breakage, insulation failure, or other problems. Unsafe cards shall not be used as substitutes for hold cards. Unsafe cards may be removed by a qualified individual after making the required repair and testing the equipment for safety.

- e. Grounding Point cards shall be 3" x 7" and green and white. Grounding Point cards shall be used to identify equipment where temporary personnel safety grounds are installed. Equipment where personnel safety grounds are installed shall be noted on switching procedures by the Hold card electrician.

- f. Hold Card Use: NOTE: THERE IS NO MORE IMPORTANT SAFETY DEVICE THAN A PROPERLY FILLED OUT AND ATTACHED PERSONAL DANGER

TAG AND/OR "HOLD" CARD. IT MUST BE UNDERSTOOD AND RESPECTED FOR WHAT IT REPRESENTS--A LIFE-SAVING PROCEDURE. IT SHALL BE USED ONLY FOR THE PURPOSE INTENDED.

Hold card use shall include the following concerns:

1. Method of installation
  2. When to use
  3. Limitation of use
  4. Limitation of device movement with Hold card attached
  5. Limitation on re-use
  6. Limitation on persons working under a Hold card.
  7. Instructions on filling out the Hold card
  8. Authorizing person
- g. Secure Card Use: Secure card use shall include the following concerns:
1. Method of installation
  2. When to use
  3. Limitation of use
  4. Limitation of device movement with Secure Card attached
  5. Limitation of re-use
  6. Instruction in filling out the Secure Card
  7. Authorizing person
3. Hold and Secure Card Installation and Removal for Equipment isolation.
- a. The following items shall be considered in the procedure of Hold and Secure Card installation:
    1. Card installed for person doing the work or immediate supervisor

2. Isolation under proper authority
  3. Verification that system can be properly isolated
  4. Identification of qualified or competent persons to install cards
  5. Verification that cards have been properly installed
  6. Energy potential isolation
  7. Safeguards against accidental re-energizing
  8. Proper telephone, radio or verbal communication and understanding
  9. Meter indications of isolation
  10. Limitations on holding a system
  11. Disconnect loading and card positioning on locks
  12. Secure information card attachment to switchboard remote control devices
  13. Hold card limitation on switchboard remote control device attachment
- b. The following items shall be considered in the procedure of Hold and Secure card removal:
1. Only the person for whom a Hold or Secure Card was installed shall release it or, in unusual circumstances, the immediate or peer supervisor.
  2. Removal of cards ordered by supervisor or authorized person.
  3. Ascertaining that equipment is clear and ready for re-energizing by competent or qualified person.
  4. Removal of cards performed by qualified or competent person.
  5. Methods to assure all cards are accounted for in removal and no additional cards removed.
  6. Steps in removing of card and re-energizing.

7. Maintenance of clear area while energizing for personnel protection
8. Completion of card by competent or qualified person.
9. Depositing of cards with Supervisor of authorized person.

#### 4. Temporary Release

When a system requires to be temporarily repositioned for testing, cleaning, flushing or other purposes, the following outline shall be considered:

- a. A temporary release request filed with the Supervisor or authorized person.
- b. Clearance for repositioning obtained from all signers of the Hold Card in question.
- c. The individual authorized to remove the Hold Card in question, after removing the Hold Card, reports to the supervisor or authorized person who:
  1. Notes that on the log and;
  2. Maintains the released Hold Card with the log and;
  3. Notes and initials upon removal of the temporary release condition.

#### 5. Hold and Secure Card Records

The following items shall be considered in maintaining records of Hold or Secure cards:

- a. A record either on a log, work order or dispatcher log of:
  1. Card number if used
  2. Name and title of person for whom card is attached
  3. Name or initials of supervisor or authorized person ordering installation of the card
  4. Request for outage or work number if applicable
  5. Name or initials of Supervisor or authorized person who orders removal of the card.
  6. Maintenance of this record at a designated location.



### C. Example of Safety Tags - Personal Danger Tag, Hold, Secure, and Grounding Point Cards



## Appendix K - Work Area Protection

### A. Introduction

Work area protection is the adequate safeguarding or protecting of pedestrians, motorists, workers and equipment by the use of adequate barriers, warning signs, lights, flags, high visibility vests, traffic cones, high-level standards, barricade rope or flagpersons on approaches and in the vicinity of work areas, excavations, open manholes or parked equipment.

1. Work area protection is accomplished by the use of good informative and protective devices keeping in mind that a safe installation requires the use of these devices in relation to the location of the employees and the equipment involved. The use of these devices must be coupled with proper planning, design, installation, inspection, maintenance and the use of good common sense and will greatly minimize the possibility of accidents. It is of the utmost importance that the work area be properly identified and that warning devices say what they mean, to convey the message to the employees well in advance of arrival at the work area.
2. The employee must be warned in advance, then regulated and guided safely through or around the work area. Proper work area protection shall be planned to insure the safety and protection of the public and the equipment.
3. High visibility vests or their equivalent shall be worn by employees whenever working in or around vehicular traffic areas. If work is to be done at night, reflectorized material shall be worn.

### B. Equipment

1. Only those signs, standards, barricades, flags and cones that conform to federal, state or local codes shall be used.
2. All state and local traffic codes shall be followed when providing work area protection.
3. During night operations or in periods of reduced visibility, special precautions shall be taken. Adequate warning equipment, which may include flashing lights, flares or area illumination, shall be used.

4. Warning devices and equipment shall be removed as soon as the hazard is eliminated.
5. Warning devices and equipment not in use shall be stored in a proper manner or shall be removed from the work area.

### **C. Flagperson**

1. Flagpersons or other appropriate traffic controls shall be used whenever there is any doubt that effective protection can be provided by signs, signals and barricades and where state or local standards dictate their use.
2. Flagpersons shall wear a blaze orange warning vest or other high visibility garment. Warning garments worn at night shall be of a reflectorized material.
3. Flagpersons using hand signaling equipment shall insure that signals provide sufficient warning to protect themselves and the work site.
  - a. Signal flags shall be used only in an emergency and shall be red and at least 24 inches square.
  - b. Sign paddles (stop and slow) shall be on a 6-foot staff.
  - c. In periods of darkness or reduced visibility red lights shall be used. Flashlights may be used in emergencies.
4. Flagpersons shall place themselves in a protected position to reduce possibility of injury from traffic.
5. Flagpersons shall insure they can fully observe the operation and shall guide vehicular traffic in such a manner as to minimize the possibility of accidents or injury.
6. When flagpersons are used at both ends of a job site, reliable communications or prearranged signals shall be used to insure proper traffic flow.
7. Flagpersons shall face traffic when giving signals.
8. Flagpersons shall give positive, direct signals that leave no doubt as to their meaning.

## Appendix L - Substation Project Installation Safety Assessment Checklist

Project Title: \_\_\_\_\_  
 Auditor: \_\_\_\_\_  
 Contractor: \_\_\_\_\_  
 Project Progression: \_\_\_\_\_

Date: \_\_\_\_\_  
 Time: \_\_\_\_\_  
 Supervisor: \_\_\_\_\_

Item	Yes	No	N/A	Comments
1. Employees wearing proper PPE as required for job being performed (eye protection, hard hat, boots,etc)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
2. All wearing protective clothing where necessary?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
3. All completed electrical safe work practices safety orientation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
4. All Hot Work/Confined space Entry/ Digging permits posted and conditions followed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
5. Aerial device/crane communication procedures followed, operators/crew trained?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
6. Electrical equipment in good repair, grounded, utilizing GFCI?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
7. Lockout & tagout, procedures followed, training completed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
8. Excavations/Trenches shored, sloped, set-up properly (OSHA 1926.650-652)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
9. Training of electrical safe work practices is provided.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
10. Are safe work practice rules readily available to all personnel?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
11. Enforcement of electrical safe work practices is consistent.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
12. All qualified and authorized personnel understand that <i>“Electrical equipment and lines shall be considered energized until isolated, tested or otherwise determined to be de-energized, and grounded.”</i> as stated in electrical safety standard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
13. All steps outlined in electrical safety standards to establish a zero-potential work area are followed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
14. Grounds are installed as per electrical safety standard and applied in the proper manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
15. Documented Plans exist for all repetitive high voltage work and all switching is done from written switching orders. Clearance and/or lockout/tagout procedures are adequate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
16. Pre-work briefings are held to discuss Job Plans (switching orders, clearance procedures, lock/tag requirements, PPE requirements, job hazards).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

	Item	Yes	No	N/A	Comments
17.	Documentation shows that equipment, live line tools, and gloves are tested with appropriate frequency, maintained, and stored correctly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
18.	Live line tools are used for all high voltage work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
19.	Safety awareness/behavior meets expectations?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
20.	Safe approach distances are understood and adhered to by authorized, and qualified personnel.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
21.	All mobile equipment operators understand 10-foot rule.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
22.	Critical safety components of mechanical elevation and rotating equipment are inspected before use on each shift using the manufacturers recommended checklist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
23.	Electrical hazards are taken into consideration when mobile equipment is in transit. Escorts are used when required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
24.	Safe work zones are established.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
25.	Mobile equipment that could potentially enter the 10 foot restricted zone is properly grounded and or barricaded.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
26.	Materials, equipment, and temporary structures are not stored on right-of-ways under non-insulated high voltage lines closer than 10 feet horizontal.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
27.	Unnecessary materials and equipment are not stored in substation yard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
28.	Guards are provided around live parts where electrical safety hazards may exist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
29.	A fall prevention survey specific to high-voltage electrical has been completed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
30.	Fall arrest equipment is used when appropriate and inspected before each use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
31.	Cranes/Heavy Equipment/Vehicles inspected, safe, set-up properly?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
32.	Rigging correct, and in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
33.	Roads, walkways properly blocked and flagged where necessary? Fire accesses clear?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
34.	Scaffolding properly installed/inspected/tagged?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
35.	Ladders used Properly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
36.	Tools used properly? In good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
37.	Proper lifting methods/material handling?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
38.	Retaining pins on air hose/tool connections?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
39.	Welding/cutting equipment used properly and in good repair?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
40.	Compressed gas cylinder secured upright and in proper location?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
41.	Good housekeeping, environmental conditions safe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

42. Hazardous corners, protrusions, pinch points guarded?    \_\_\_\_\_
43. Special warning signage posted as necessary?    \_\_\_\_\_

## Appendix M - Substation Inspection Checklist

Plant \_\_\_\_\_ Substation \_\_\_\_\_ Inspection Date \_\_\_\_\_

Inspector \_\_\_\_\_

Item	Yes	No	N/A	Comments
1. Signage - Substation Identification, Entry Requirements, Electrical Hazard Warning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
2. Gates Locked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
3. Fence Secure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
4. Debris or unauthorized Material In Substation Lot	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
5. Vegetation in Substation Lot	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
6. Fence, Gate, Other Metal Surfaces Bonded and Grounded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
7. Guarding and hazard warning – Low Profile Equipment, Dimensional Clearances, Potential Safety Items	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
8. Equipment Identification/labels - Switches, Transformers, Breakers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
9. Operation Locks on Switches to Prevent Unintentional Operation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
10. Bushings and Insulators in Good Condition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
11. Indications of Burning, Arcing or Heat Buildup In Electrical Joints	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
12. Evidence of Oil Leaks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
13. Substation Lighting, Emergency Lighting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

<b>NAME OF EQUIPMENT</b>				
<b>TRANSFORMER</b>				
Name on transformer				
Top Oil Temperature				
Oil Level				
Tank Pressure, psi				
Fan operation				
Pump operation				
Oil leaks?				
Abnormal noises?				
Condition of :				
Paint				
Bushings				
Terminals, bushing studs, other electrical connections – evidence of corrosion or heating?				
Radiators				
<b>CIRCUIT BREAKER</b>				
Name on circuit breaker				
Oil leaks?				
Condition of :				
Paint				
Bushings				
Terminals, bushing studs, other electrical connections – evidence of corrosion or heating?				
<b>SWITCHES</b>				
Name on switch				
Switch operating handle and operating pipe bonded to ground?				
Switching ground mat available and bonded to ground?				
Switch fully closed or open?				
Evidence of corrosion or heating?				
<b>STATION BATTERIES</b>				
Condition of batteries and terminals				
Volts				
Battery Station Ventilation				

<b>BATTERY CHARGER</b>				
Volts				
Condition of eyewash station				





## Appendix N - Electrical Control Room Inspection Checklist

Plant \_\_\_\_\_ Electrical Control Room \_\_\_\_\_ Inspection Date \_\_\_\_\_

Inspector \_\_\_\_\_

Item	Yes	No	N/A	Comments
1. Signage – Identification of Control Room or Area, Entry Requirements, Electrical Hazard Warning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
2. Entry Doors Locked, Control of Unauthorized Personnel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
3. Storage of Material in Electrical Control Room	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
4. Items Stored in front of Switchgear or MCCs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
5. Debris In Electrical Control Room (Housekeeping items)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
6. Single Line Diagram of Power System, Switchgear, and MCCs Posted in Area, Drawing up to date	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
7. Equipment Identification (labels) – Switchgear, Transformers, Switches, Breakers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
8. Metal Surfaces of Transformers, Switchgear, or MCCs Bonded and Grounded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
9. Switchgear or MCC Doors Open, Covers Missing on Electrical Equipment Enclosures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
10. Guarding and Hazard Warning – Live parts, Low Profile Equipment, Dimensional Clearances, Potential Safety Items	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
11. Evidence of Abnormalities in Electrical Equipment, Indications of Burning, Arcing or Heat Buildup, Physical Damage, Abnormal noises	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
12. STATION BATTERIES - Condition of Batteries and Terminals, Volts, Battery Station Ventilation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
13. BATTERY CHARGER – Volts, Condition of Eyewash Station	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
14. Electrical Control Room lighting, Emergency Lighting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

General Comments:



## Appendix O - Test Procedure for Daily Inspection of Rubber Gloves

Insulating rubber gloves shall be inspected and air tested 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.



Insulating gloves suspected of being defective shall be removed from service immediately and returned for testing.

## Appendix P - Grounding Cable and Jumper Ratings

### Grounding Cable and Jumper Ratings

Calculated Short Circuit Properties <sup>A</sup>								
Grounding Cable Size, AWG		Withstand Rating Symmetrical kA RMS 60 Hz		Ultimate Capacity <sup>B</sup> Symmetrical kA RMS 60 Hz				Continuous Current Rating, A RMS 60 Hz
Copper	Aluminum <sup>C</sup>	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	1/0	14.5	10	29	18	13	9	200
1/0	3/0	21	15	47	30	21	14	250
2/0	4/0	27	20	59	37	26	18	300
3/0	250 MCM	36	25	74	47	33	23	350
4/0	300 MCM	43	30	94	60	42	29	400
250 MCM	350 MCM	54	39	120	70	49	35	450
350 MCM	500 MCM	74	54	150	98	69	49	550

<sup>A</sup> Withstand and ultimate short circuit properties are based on performance with surges not exceeding 20% asymmetry factor.

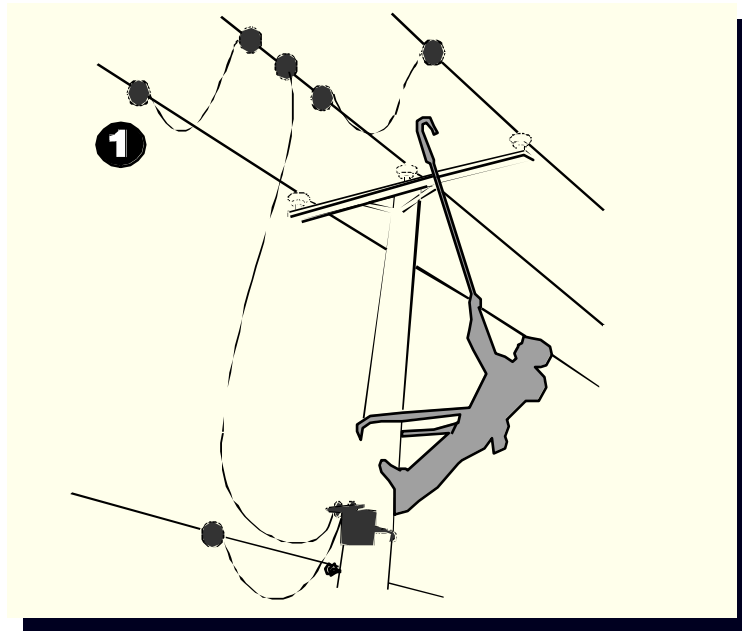
<sup>B</sup> Ultimate capacity represents a calculated symmetrical current which the cable or jumper is capable of conducting for the specified time.

These currents are based upon the fusing (melting) current-time values for copper, derived from I. M. Onderdonk's equation with an ambient temperature of 40°C.

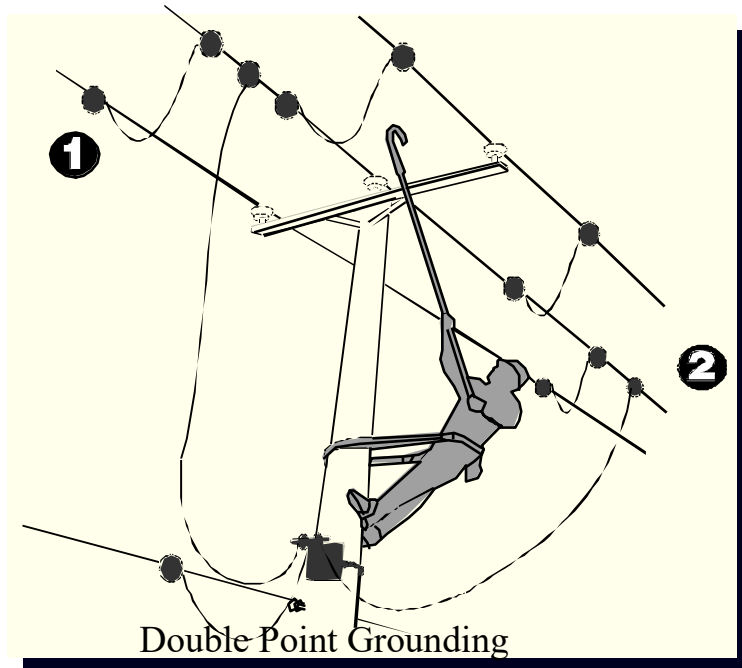
<sup>C</sup> Aluminum cables must be two AWG sizes larger than copper for equal current ratings.  
(Ref ASTM-F855)

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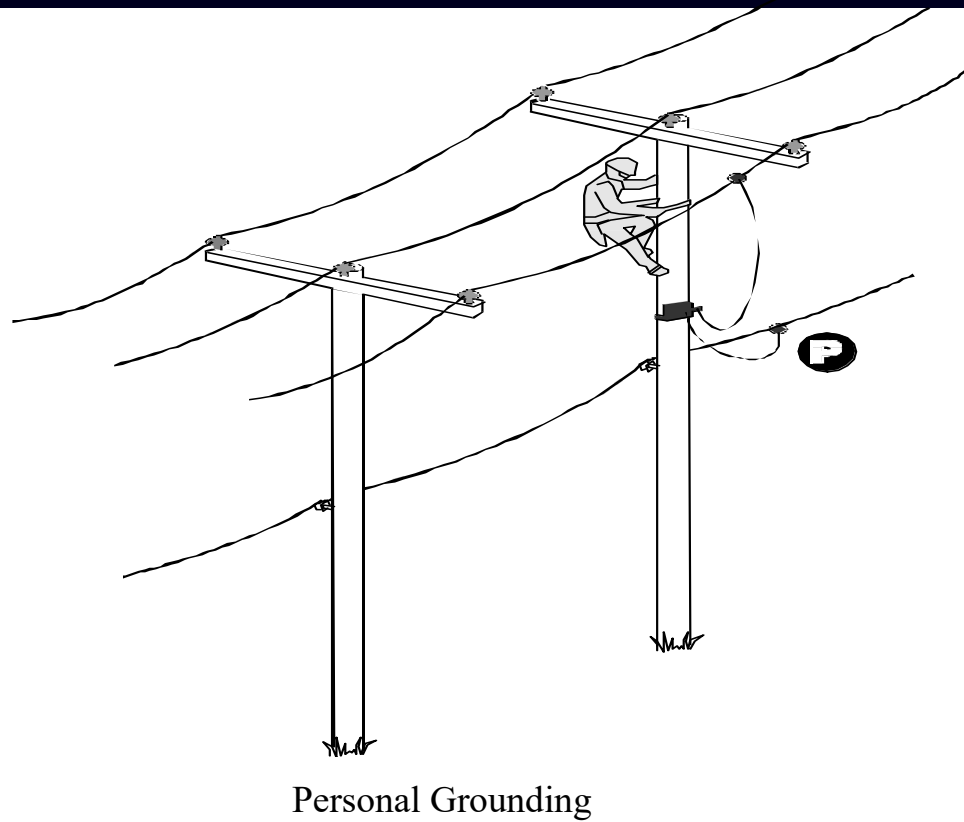
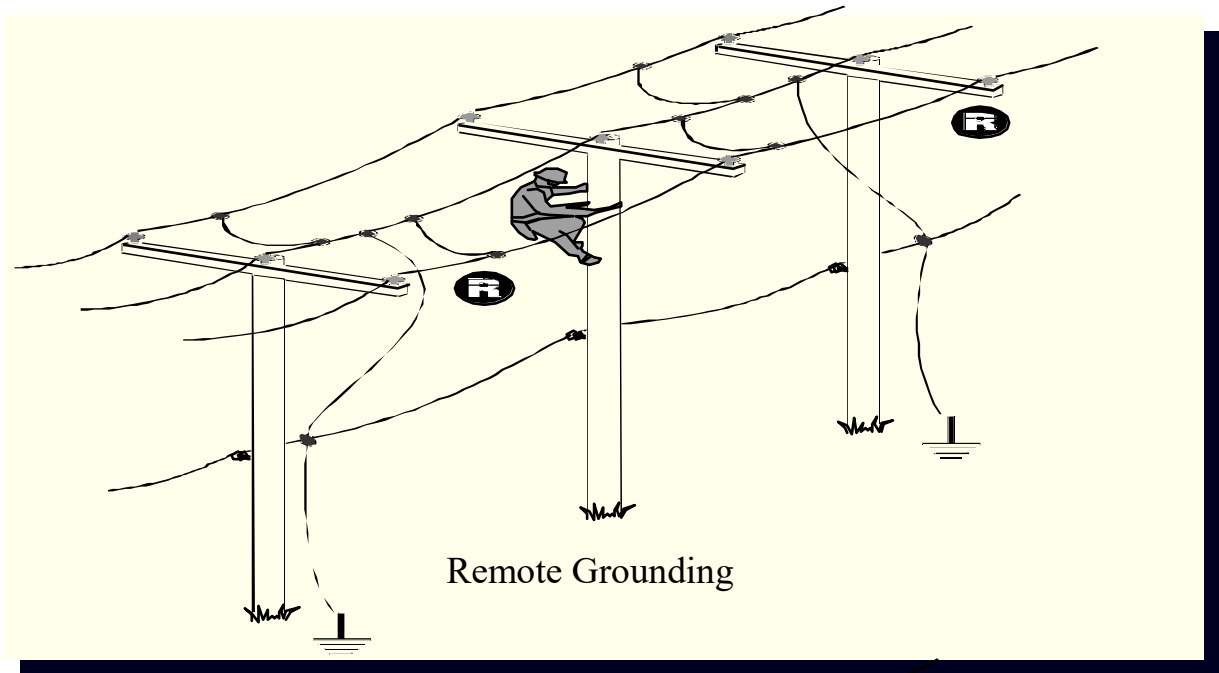
## Appendix Q - Equipotential Grounding Techniques



Single Point Grounding



Double Point Grounding



## Appendix R - Principles of Electrical Safety

You must understand, accept and practice all of the following safety principles:

### **Maintain Distance**

An effective way to maintain safety is to keep a safe distance from live parts.

### **Test Before Touch**

Consider every electrical conductor or circuit part energized until proven otherwise.

### **De-energize if Possible**

De-energize all equipment before you work "on" or "near" exposed electrical conductors or circuit parts.

### **Recognize potential hazard**

Installing barriers, barricades, and de-energizing (switching) are potentially hazardous tasks.

### **Plan Every Job**

Plan every job carefully, regardless of size.

### **Anticipate Unexpected Events**

Before beginning work, ask "What if..?" and decide what you will do if something goes wrong.

### **Use the Right Tool for the Job**

Identify the tools required and do not perform the task until you have the correct tool.

### **Use Procedures as Tools**

Establish and adhere to procedures to accomplish a job safely.

## **Isolate the Equipment**

Lock, Tag, Try and Test.

## **Identify the Hazard**

Identify and address each hazard.

## **Minimize the Hazard**

Use insulating barriers, safety grounds, and safe work practices.

## **Protect the Person**

Avoid exposure to electrical hazards wherever possible. Use appropriate personal protective equipment (PPE) for each potential hazard.

## **Assess People's Abilities**

Evaluate each person's qualifications, capabilities, and physical and mental state at the time a potentially hazardous task is to be done.

## **Audit These Principles**

Audit the principles frequently to verify that they reflect current practices.



(Sign)

- **List Each Person Covered by the SPPC.** Ensure that each crew member associated with the particular job/task for which the card is being completed initials or prints their name after familiarizing with the SPPC information.
- **At Risk Employees.** Answer and record the following:

- ✓ Are you or any member of the crew identified as an “At Risk Employee”? If “yes”, record name.

Note: An “At Risk” employee lacks necessary experience or involves a task that is defined as high risk by the supervisor.

- ✓ Who is assigned as the experienced partner? (List their names)

◆ **Section #2**

- **List Tasks.** List all significant job tasks, the activities that will cover the total job scope. If using the job work order to list the tasks, the work order must accompany the SPPC when turned in.
- **Tools/Equipment Required For Tasks.** List all tools/equipment required for completion of the tasks. Indicate whether prior training is required to operate tool/equipment.

◆ **Section #3**

- **Identify Potential Hazards.** Check items accordingly as to the hazards associated with this particular job.
- **List Additional Hazards.** List all the hazards that have been identified for each task. Are there more? Be specific.

◆ **Section #4**

- **Identify Hazard Elimination.** Check items accordingly as to how those hazards identified will be eliminated or controlled.
- **Eliminate or Control Hazards.** Review each hazards identified, and record what control or elimination measures will be taken. Are there others?

◆ **Section #5**

- **Job Preparation/Permits.** Answer and record the following:
  - ✓ Is the job scope understood? If “NO”, stop and review job with your supervisor.
  - ✓ Is all required safety equipment at the job site? If “NO”, stop and review with supervisor.
  - ✓ Have the required permits been issued? Are any other permits required? If so, stop and review with supervisor.
  - ✓ Has an oxygen/flammability check been performed? (i.e. GX-94 or GX-86 for permit required confined space entry) A “NO” answer would indicate a test was required and not completed. Stop and find out why not.
  - ✓ Underground digging? Call Gopher One hotline.
  - ✓ Is a confined space procedure required? If “YES”, have you reviewed the procedure? Does it include a rescue plan?

- ✓ Have the appropriate rescue team people been notified or emergency number been reviewed? If “NO”, stop and review with your supervisor immediately.
- ✓ Are the required valves, switches, and disconnects restrained and tagged? If “NO”, stop and discuss/review with supervisor.
- ✓ Have all workers or affected trades been communicated with as to the work about to begin in the area? If “NO”, review with supervisor and make sure item is completed.
- ✓ Are the proper tools for the job being used? If “NO”, stop and take the time to review.
- ✓ Have the MSDS’s for any hazardous substance that may be present been reviewed? If “NO”, review with supervisor and make sure item is completed.
- ✓ If the job involves rigging, has a rigging plan been completed? If “NO”, stop and review with supervisor.
- ✓ Has the proper signage been posted (i.e. Caution tape, Danger, Warning signs)?
- ✓ Has the forklift or skidsteer gone through it’s daily inspection? Complete daily inspection form and file.
- ✓ For all work that involves a flash hazard potential, was a flash hazard analysis conducted for access to the electrical vault?

***YOU MUST SELECT A or B!***

A. Risk categories 1& 2 requires 8 cal/cm<sup>2</sup> ATPV:

(Every Day Use)

- 8 cal/cm<sup>2</sup> polycarbonate faceshield/hardhat
- FR rated coveralls 8 cal/cm<sup>2</sup>
- Leather gloves/boots

B. Risk categories 3& 4 requires 25 cal/cm<sup>2</sup> ATPV :

(Electrical Switching Clothing Use)

- 25 cal/cm<sup>2</sup> polycarbonate faceshield/hardhat
- FR rated coveralls and flash suit combination meeting 25 cal/cm<sup>2</sup> ATPV
- Leather gloves/boots

- ✓ Has each employee in the crew completed the safety orientation? This includes both FM and site safety orientation. If “NO”, do not continue

◆ ***Section #6***

- **End of shift review.** The operations supervisor is to complete this section after completion of the task and/or at the end of the shift. Check items accordingly:
  - ✓ Has the area been cleaned up?
  - ✓ Have the Locks and Tags been removed, released and signed off by all individuals?
  - ✓ Have all permits been signed and returned to the appropriate people?
  - ✓ Has the status of the job been communicated to the customer or the next shift or trade?
  - ✓ Has the system been checked and the area clear for start up?
- **Return cards to your supervisor.** Return cards to safety department on a weekly basis for proper filing.

**1 SAFETY PRE-TASK PLAN CARD**

Job Activity: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

Emergency Phone No.: \_\_\_\_\_

Job No.: \_\_\_\_\_

Job Location: \_\_\_\_\_

Customer Name and Phone #: \_\_\_\_\_

Completed By: \_\_\_\_\_  
(Please Print & Sign Name)

List each person covered by this SPPC:  
(Please Print Name and Initial)

_____	Initial Here
_____	_____
_____	_____
_____	_____

**1.1.1.1.1.1 AT RISK EMPLOYEES**

New to: Work Site  Facility  Job

Employee	Experienced Partner
_____	_____
_____	_____

**2 LIST TASKS**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**TOOLS/EQUIPMENT REQUIRED FOR TASKS:**

Check those that apply

PAPR or Voluntary Dust mask

Powder-Actuated Tools

Suspended Personnel Platforms/

Aerial Lifts/JLG

Asbestos Survey

Forklift

Skidsteer

GFCI

GX-86 or Gx-94

Flash Hazard Protection

**3 IDENTIFY POTENTIAL HAZARD ( )**

<input type="checkbox"/> Chemical Burn	<input type="checkbox"/> Trips/Slips/Falls
<input type="checkbox"/> Thermal Burn	<input type="checkbox"/> Fire
<input type="checkbox"/> Particles/liquid In Eye	<input type="checkbox"/> Spills
<input type="checkbox"/> Overexertion	<input type="checkbox"/> Abrasion/Cuts
<input type="checkbox"/> Elevated Load	<input type="checkbox"/> Cave-In
<input type="checkbox"/> Falls Over 6'	<input type="checkbox"/> Loud Noises
<input type="checkbox"/> Overhead Work	<input type="checkbox"/> Heat/Cold Exposure
<input type="checkbox"/> Sprains/Strains	<input type="checkbox"/> Electric Shock
<input type="checkbox"/> Dropping Material/	<input type="checkbox"/> Pinch Points
<input type="checkbox"/> Tools to lower level	<input type="checkbox"/> Lead/Asbestos
<input type="checkbox"/> Installing Hazardous Substance	<input type="checkbox"/> Moving Machinery
	<input type="checkbox"/> Low Visibility (lighting)
<input type="checkbox"/> Live Utilities (above/below ground)	<input type="checkbox"/> Electrical (temporary power)
<input type="checkbox"/> Vapors (glues, paint, solvents)	<input type="checkbox"/> Fumes (welding)
<input type="checkbox"/> Flash hazard	

**LIST ADDITIONAL HAZARDS:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**4 IDENTIFY HAZARD ELIMINATION (□)**

\_\_\_ "0" Electrical gloves (up to 1,000V)    \_\_\_ Safety Harness/ Tie Off (up to 20,000V)  
 \_\_\_ Class 2 electrical gloves (up to 20,000V)

\_\_\_ Hot Stick

\_\_\_ Flash Hazard Analysis (see Section 5 #13)

\_\_\_ Inspect tools

\_\_\_ Rigging Equipment (chain falls, slings)

\_\_\_ Gloves-chemical, leather, cut resistant

\_\_\_ Hearing Protection (muffs, plugs)

\_\_\_ Tyvek suit

\_\_\_ Voluntary Nuisance (Dust Mask, Face Shield, Get Proper Tools, Goggles, Safety Glasses, Hard Hat, Keep Area Picked Up and Clean, Hoses, Fire Watch, Fire Extinguisher, Contain Sparks, Review Potential for Spill, Containment Needed?, Don't Do It - Get The Experts (Outside Contractor, FM Safety, DEHS), Lines Drained and Purged, Close Drains & Vents, Temporary Lighting)

\_\_\_ Ladders tied off

\_\_\_ Guardrails (42" toprail midrail=1/2 of toprail)

\_\_\_ Check for Low Clearance- "Headknockers"

\_\_\_ Get Help (See SOP, 2 person job, carts)

\_\_\_ Re-Check Line I.D. (demolition)

\_\_\_ Erect Barricades

\_\_\_ GFCI in Place

\_\_\_ Be in Proper Position

\_\_\_ Proper Sloping, Shoring

\_\_\_ Toe Boards (4" high)

\_\_\_ Scaffold, Manlift, Ladder

\_\_\_ Lockout/Tagout/Test/Tryout

**1.1.1.1.2** \_\_\_ *Confined Space Entry Equipment (gas meter, ventilator, fall protection)*

**1.1.1.1.3** *ELIMINATE OR CONTROL HAZARDS:*

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**5 JOB PREPARATION/PERMITS**

Yes No N/A

1 Job Scope Understood?..... □ □ □

2 Proper Safety Equip. on Job Site?.... □ □ □

3 Permit Issued? What Type?

Hot Work □ □ □

Confined Space □ □ □

4 Call Gopher One Hotline for digging?.... □ □ □

5 Oxygen/Combustible/CO/H2S checked?..... □ □ □

6 Confined Space/Enclosed Procedure/ Rescue Plan reviewed? ..... □ □ □

7 All valves, disconnects, or circuit breakers in proper position, tagged & locked? (No. of Locks \_\_\_\_\_)..... □ □ □

8 Communicated work with others in area? ..... □ □ □

9 Proper tools for job? ..... □ □ □

10 Reviewed the MSDS of any Hazardous substance that might be present?..... □ □ □

11 Proper signage in place..... □ □ □

12 Daily Inspection of Forklift or Skidsteer?..... □ □ □

13 Flash Hazard Analysis for vault/equipment access..... □ □ □

**YOU MUST SELECT A or B!**

A. Risk categories 1&2 requires 8 cal/cm2 ATPV: □ □ □  
 (Every Day Use)  
 - 8 cal/cm2 polycarbonate faceshield/hardhat  
 - FR rated coveralls 8 cal/cm2  
 - Leather gloves/boots

B. Risk categories 3&4 requires 25 cal/cm2 ATPV: □ □ □  
 (Electrical Switching Clothing Use)  
 - 25 cal/cm2 polycarbonate faceshield/hardhat  
 - FR rated coveralls and flash suit combination meeting 25 cal/cm2 ATPV  
 - Leather gloves/boots

14 Safety Orientation Complete?..... □ □ □

**6 END OF SHIFT REVIEW**

(BY Supervisor) Initials \_\_\_\_\_

	Yes	No	N/A
1. Work area cleaned up?.....	□	□	□
2. All tags, locks, removed, released and signed off?.....	□	□	□
3. Permit signed and turned in?....	□	□	□
4. Job status communicated to Customer/next shift or trades?...	□	□	□
5. System checked and area Clear for start up?.....	□	□	□

Additional Comments:

\_\_\_\_\_


\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(When complete return to your supervisor.)



# Appendix T – Digitized Energy Management Safety Pre-Task Plan Form

### Energy Management Safety Pre-task Plan Form

#### 1. Job Information

Date: \_\_\_\_\_

In case of an emergency, I will call: \_\_\_\_\_

Job Location:

- Electrical Room
- Manhole
- Street/Outside
- Vault
- Generator
- Mechanical Room
- Tunnel
- Other: \_\_\_\_\_

Crew:

- CHILLWATER
- EMELEC
- STEAM
- Other: \_\_\_\_\_
- ELECTRIC
- EMTECH
- WATER

Additional Persons covered by this SPPF:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Are there New Employees paired with an Experienced Partner (new to job, work site, UMN)?

- YES
- NO

Does the job require an AED?

- YES
- NO

#### 2. Tasks

General Job Description:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

List Job Tasks:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Safe Work Practices and Procedures:

- Aerial Lift Equipment Operating Procedures
- Confined Space Entry Procedure
- Electrical Switching Procedure
- Energized Electrical Work Permit
- Excavation/Digging Practices/Current Utility Locations
- Fall Protection Practices
- Forklift, Skidsteer, Boom/Truck Operating Procedures
- Hot Works/Fire Protection Impairment
- LOTO
- Rigging and Heavy Lift Procedures/Practices

Other safe work practices:

\_\_\_\_\_  
\_\_\_\_\_

#### 3. Identify Potential Hazards

- Burns, chemical, or thermal
- Dust, debris
- Spills, splashing

- Abrasions/Cuts
- Dropped or Falling objects
- Elevated Load/Rigging
- Falls Over 6'
- Head knockers
- Ladder work
- Overexertion
- Pinch points
- Sprains/strains
- Trips, Slips, Falls

- Confined Space
- Hazardous atmosphere: Vapors (glues, paint, solvents); O<sub>2</sub>, CO, H<sub>2</sub>S, LFL; Fumes (welding)
- Trench work Cave-In

- Biohazards
- Compressed gas cylinders
- Hazardous materials – Lead, Asbestos, Mercury

- Arc Flash
- Electrical (temporary power)
- Electric Shock
- Live and stored energy sources
- Live Utilities (above/below ground)

- Fire, Explosions
- Heat/Cold Exposure
- Loud Noises
- Low visibility (lighting)

- Moving machinery
- Pedestrians in work zone
- Traffic in work zone

List Additional Hazards/ID Unanticipated Hazards:

\_\_\_\_\_  
\_\_\_\_\_

**4. Identify Hazard Elimination**

- Adequate Lighting (supplemental as needed)
- Consult supervisors and experts as needed
- Correct tools for the job, inspect tools
- Housekeeping, before, during and after
- Know your limits, get help
- Material handling: vehicles, carts, two wheelers
- Review chemical labels & SPS
- Rigging Equipment (chain falls, slings)
- Ventilation, air quality and cooling
  
- Confined space entry procedures & equipment
- Lockout-Tagout and Verify
- Spill control – absorbent material, containment
- Trenching sloping, shoring, egress
- Verify valve lineups
- Work zone control: cones, barricades, tape, signs
  
- Arc Flash Hazard Analysis (see Sec. 5)
- Arc suppression blanket
- GFCI in place and clean
- Hot stick
  
- Compressed gas cylinders secured
- Fire control: fire watch, contain sparks, access to fire extinguisher & hoses
- Welding screens
  
- Aerial lift
- Fall protection:
  - Guard rails (42"± 3" top rail + midrail)
  - Tie off/Anchorage/Rescue plan
- Ladders in good repair, stable and tied off
- Materials/tools secured
- Scaffold, built & inspected by competent person

**5. PPE Required for Tasks, based on hazards:**

- |   |
|---|
| <input type="checkbox"/> Hard hat   |
| <input type="checkbox"/> Welding helmet   |
| <input type="checkbox"/> Electrical Gloves ('0' to 1000 V, Class 2 up to 17,000 V)/Fall protection PPE                |
| <input type="checkbox"/> Eye protection: Safety glasses, goggles, face shield/Hearing protection (muffs, plugs)       |
| <input type="checkbox"/> Gloves, chemical, leather, cut resistant/Protective clothes: Electrical Arc, chemical resist |
| <input type="checkbox"/> Fall protection PPE  |
| <input type="checkbox"/> Hearing protection (muffs, plugs)  |
| <input type="checkbox"/> Protective clothes: Electrical Arc, chemical resist  |
| <input type="checkbox"/> Respiratory protection Voluntary nuisance dust mask; PAPR (soft, hard, welding hood)         |

Specific PPE for Electricians

- |  |
|--|
| <input type="checkbox"/> Risk Cat.1+2 requires 8 cal/cm2 ATPV: Every day use <ul style="list-style-type: none"> <li>• 8 cal/cm2 polycarbonate faceshield/hardhat</li> <li>• FR rated coveralls 8 cal/cm2,</li> <li>• Leather gloves/boots</li> </ul>   |
| <input type="checkbox"/> Risk Cat.3+4 requires 40 cal/cm2 ATPV: Electrical switching clothing use <ul style="list-style-type: none"> <li>• Flash suit hood meeting 40 cal/cm2 ATPV</li> <li>• FR rated coveralls and flash suit combination,</li> <li>• Meeting 40cal/cm2 ATPV,</li> <li>• Leather gloves/boots</li> </ul> |

**6. On-Site Job Review**

- |  |
|--|
| <input type="checkbox"/> Review Work Assignment, Location, Existing Conditions |
| <input type="checkbox"/> Review the Safety Procedures and Practices that Apply |
| <input type="checkbox"/> Review the Identified Hazards                         |
| <input type="checkbox"/> Review actions to Mitigate the Hazards                |

Are there other hazards not identified?

- YES       NO

What additional actions are needed to mitigate the hazards?

\_\_\_\_\_

\_\_\_\_\_

**7. End of Shift/Work Task Review**

Were the existing conditions as expected?

- YES       NO

If not, what was different?

\_\_\_\_\_

\_\_\_\_\_

Were there any hazards not identified?

- YES       NO

If so, what were they?

\_\_\_\_\_

\_\_\_\_\_

Were the actions to mitigate the hazard adequate?

- YES       NO

If not, what was changed?

\_\_\_\_\_

\_\_\_\_\_

What additional feedback would you offer to make the work task safer next time?

\_\_\_\_\_

\_\_\_\_\_

## Appendix U – Policy for Qualified District/Energy/U-Construction Electricians for Vault Access

1. Vault access for Qualified District/Energy/U-Construction Electricians requires a written request from the employee’s supervisor. All requests will be evaluated by Electric Utilities before access is granted.
2. Vault entry requires a minimum of two qualified and licensed electricians.
3. Operation of Primary Voltage Switches (13.8 kV), Secondary Mains and Secondary Ties will be by qualified Electric Utilities employees only regardless of whether the equipment is located in a vault or not.
4. All electrical installations within a vault will be made by Electric Utility (EU) electricians. The scope of work for Qualified District/Energy Electricians will be limited to fire alarm testing and resetting branch circuits. Fire alarm testing will require only one qualified electrician for escort.
5. EU will provide a continuous escort for contractors performing work in a vault unless EU can mitigate the hazards with the use of barricades, LOTO, etc... in which case a contractor may be granted vault access.
6. Vaults are not to be used as break rooms or for storage of any kind.
7. Entry to a vault requires pre task planning and an SPPC card that will be submitted to the Safety Department.
8. A minimum of Safety glasses, leather ER (Electric Rated) safety shoes and hazard risk category 2 arc-rated clothing are required for vault entry by all personnel whether performing work or just being

escorted. Additional PPE may be required for the task being performed by personnel within the arc flash boundary.

- 9. District/Energy Electricians will only provide an escort into a vault for personnel required to assist with fire alarm testing. The District/Energy Electricians allowed to act as escorts shall have received electrical safety awareness training by the FM Safety Department. All other escorts must be members of the Electric Utilities Department.
- 10. All vaults shall be secured and locked at all times. Doors shall not be temporarily held open.
- 11. A vault access card shall only be used by the person it is issued to.

I certify that I understand the above policy and I agree to comply with the requirements of the policy. Infractions will result in loss of vault access until I am re-certified according to OSHA 1910.269 standards by the Safety Department and Electric Utilities. Additional discipline may be vetted up to and including termination. I understand that my qualification status will be reviewed by the Safety Department and Electric Utilities annually and I may need to have additional and /or refresher training.

\_\_\_\_\_ Title \_\_\_\_\_ Date \_\_\_\_\_  
 Print Name with Signature

Witnessed for the University of Minnesota Electric Utilities by:

\_\_\_\_\_ Title \_\_\_\_\_ Date \_\_\_\_\_  
 Signature

**Appendix V – Checklist and Certification**

Name of employee \_\_\_\_\_ ID Number \_\_\_\_\_  
 Signature of employee \_\_\_\_\_ Date: \_\_\_\_\_

Job Title \_\_\_\_\_ Qualified Employee \_\_\_\_\_  
 Authorized Employee \_\_\_\_\_

The inspector must place a check mark in the appropriate column on the right to reflect observations made and/or discussion occurring with the employee during this inspection.

Topic to be reviewed	Yes	No	N/A
1) Understanding of the "Basic Rule": It isn't deenergized until it has been isolated, tested for the absence of voltage, locked and/or tagged, and grounded if grounding is required			
2) Understanding it isn't deenergized until it has been Locked, Tagged, and Verified			

3) Skills and techniques necessary to distinguish between live parts and other parts of electrical equipment			
a) Understands how to read Schematics & Single Line Drawings			
b) Can Identify equipment, conductors and bus work (review pictures of equipment if they exist)			
c) Is able to understand the correct disconnect device for the equipment to be worked on (label on disconnect device)			
d) Can identify guarding on equipment, conductors, and bus work			
4) Skills and techniques necessary to determine the nominal voltage of equipment and exposed live parts			
a) Understands the correct use of testing equipment (know correct area to test for voltage and the rating of the test equipment to use)			
b) Understands when to use Insulated tools			
c) Able to verify and understand the drawings of what you are going to interact with			
5) Minimum approach distance corresponding to the voltage to which the employee will be exposed			
a) Understands approach distances to exposed energized parts			
b) Understands the requirements for escorting of non-qualified/authorized personnel and contractors			
c) Understands requirements of right of ways under power lines			
d) Storage of material in right of ways of power lines?			
e) Understands proper storage of material near electrical equipment and in electrical rooms			
6) Arc Flash Boundary and PPE			
a) Understands the minimum PPE requirements and safeguards to protect for the hazard(s) that may exist while interacting with electrical equipment and performing tasks			
b) Has the knowledge required to inspect all PPE			
c) Understands how to read and follow arc-flash labels on equipment			

7) Job Safety Planning and Job Briefing (JSA)(JHA) Requirements			
a) Create a documented Job Safety Plan(see requirements in NFPA 70E-2018)			
b) Thoroughly understand the job			
c) Thoroughly understand his/her role and everyone else's role in the job			
d) Aware of all the hazards that may be encountered			
e) Provide a shock and arc flash risk assessment for the job			
f) Knowledgeable about all safety rules and required personal protective equipment			
e) Think about unexpected events occurring			
8) Work Zones/Barricades/Alerting Techniques			
a) Has the knowledge to set-up area protection when required			
b) Understands who and when one can enter the barricaded area			
c) Understands the reason for the control of work areas and how to implement the control of the area			
d) Understands why one needs to protect from "Look-Alike" Equipment			
9) Grounding (If required to install temporary safety grounds)			
a) Demonstrated how to install and remove temporary safety grounds			
b) Demonstrated understanding of the required rating of temporary safety grounds (ASTM F855)			
10) Equipment grounding			
a) Understands the importance of equipment grounding			
b) Understands perimeter fence grounding			
11) Switching procedures, Lockout/Tagout Rules, De-energizing lines and equipment for employee protection			
a) Understands the required PPE and proper body position when performing switching procedures			
b) Understands the importance of ensuring you are operating the correct disconnect device through the use of P&IDs or equipment labels			

c) Understands and can explain the University of Minnesota Lockout/Tagout policy			
12) Understands the requirements for performing energized work			
a) First choice deenergize before start of work. Create an electrically safe work condition or lock/tag/verify			
b) Understands energized work can only be performed if it creates a greater hazard to deenergize or it is infeasible to deenergize. Any energized work requires a written <u>Energized Electrical Work Permit signed by management</u>			
c) Understands the exceptions to an EEWP – Diagnostic testing and trouble shooting			

Certification

I certify that I have conducted the Inspection checklist above. I am a qualified employee. During the inspection, I identified and corrected any deviations that occurred. I provided retraining immediately as to any such deviation and as to any evident inadequacies in the employee's knowledge or use of the electrical safe work practices. I also provided the opportunity for questions to be asked and answered during such retraining and that the subject employee demonstrated proficiency in the electrical safe work practices.

Inspector \_\_\_\_\_

Date: \_\_\_\_\_