Electrical Safety Program for Facilities

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1. GLOSSARY

Affected worker - a worker who is not directly involved in the work requiring the hazardous energy control, but who is (or may be) located in the work area.

Ampacity - the current, in amperes (amp), that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Amperage (amp) - strength of an electrical current, measured in amperes.

Arc-blast - explosive release of molten material from equipment caused by high-amperage arcs.

Arcing - luminous electrical discharge (bright, electrical sparking) through the air that occurs when high voltages exist across a gap between conductors.

Arc flash hazard - a dangerous condition associated with the possible release of energy caused by an electric arc.

Arc flash hazard analysis - a study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash protection boundary, and the appropriate levels of personal protective equipment.

Arc flash suit - a complete flame-resistant clothing and equipment system that covers the entire body except for the hands and feet. It includes pants, a jacket, and a bee-keeper-type hood fitted with a face-shield.

Authorized worker - a worker who is qualified because of knowledge, training, and experience and has been assigned to perform lockout.

Bonding (bonded) - a low-impedance path that is obtained by permanently joining all non-current-carrying metal parts to ensure electrical continuity and has the capacity to conduct safely any current likely to be imposed on it.

Bonding conductor - a conductor that connects the non-current-carrying parts of electrical equipment, raceways, or enclosures to the service equipment or system grounding conductor.

Boundary, arc flash protection - 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.

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, 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.

Capable of being locked out - an energy-isolating device is considered capable of being locked out if it meets one of the following requirements:

- It is designed with a hasp to which a lock can be attached.
- It is designed with any other integral part through which a lock can be affixed.
- It has a locking mechanism built into it; or
- It can be locked without dismantling, rebuilding, or replacing the energy isolating device or

permanently altering its energy control capability.

Circuit - complete path for the flow of current.

Circuit breaker - a device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its ratings.

Conductive - suitable for carrying an electric current.

Conductor - a wire, cable, or other form of metal installed for the purpose of conveying electric current from one piece of electrical equipment to another or to ground.

Conductor, bare - a conductor having no covering or electrical insulation.

Current - movement of electrical charge.

De-energize - shutting off the energy sources to circuits and equipment and depleting any stored energy.

Double-insulated - equipment with two insulation barriers and no exposed metal parts.

Energized (live, "hot") - machines and equipment are energized when (1) they are connected to an energy source or (2) they contain residual or stored energy.

Energy-isolating device - a mechanical device (e.g., a disconnect switch, line valve, block, blank off plate) that physically prevents the transmission or release of an energy source to machinery or equipment. An example is a manually operated switch by which the conductors of the circuit can be disconnected from all ungrounded supply conductors. These include, but are not limited to, manually operated electrical circuit breakers, disconnect switches, line valves, and blocks.

Energy source - any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Fixed wiring - permanent wiring installed in homes and other buildings.

Flexible wiring - cables with insulated and stranded wire that bends easily.

Fuse - an overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it.

Note: *A fuse comprises all the parts that form a unit capable of performing the prescribed functions. In some cases, it can be the complete device necessary for connecting it to an electrical circuit.*

Ground - physical electrical connection to the earth.

Ground fault - loss of current from a circuit to a ground connection.

Ground potential

Guarded - covered, shielded, fenced, enclosed, or otherwise protected by 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.

Insulation - material that does not conduct electricity easily.

Leakage current - current that does not return through the intended path, but instead "leaks" to ground.

Lockout - this is a device that uses a positive means (such as a lock) to hold an energy-isolation device in a safe position and prevents the energizing of a machine or a piece of equipment. When properly installed, a blank flange or bolted slip blind are considered equivalent to lockout devices. This includes devices such as accessories to go over valves and other isolation devices. Each lockout device must always be accompanied by a tagout device. All lockout devices, must:

- be unique, distinctive, easily recognizable, and clearly visible.
- be the only devices used for controlling potentially hazardous energy.
- not be used for any other purpose.
- be capable of withstanding the environment to which they are exposed.
- be substantial enough to prevent operation of the energy isolating device without the use of excessive force.
- application of lockout device shall not itself create a hazard to either authorized or affected individuals.

Locks, by themselves, do not de-energize equipment. They are attached only after the machinery has been isolated from its energy sources. For more information about Lockout Tagout (LOTO), please refer to the UofT Lockout/Tagout Standard and UofT Lockout/Tagout: General Procedure.

Milliampere (milliamp or mA) - 1/1,000 of an ampere.

Neutral – the conductor (when one exists) of a polyphase circuit or single-phase, 3-wire circuit that is intended to have a voltage such that the voltage differences between it and each of the other conductors are approximately equal in magnitude and are equally spaced in phase.

Ohm (Ω) - unit of measurement for electrical resistance.

Overcurrent protection device - device that prevents over current in a circuit.

Overload - too much current in a circuit.

Power - amount of energy used each second, measured in watts (W).

PPE - personal protective equipment (e.g., eye protection, hard hat, special clothing, etc.).

Qualified (Electrical) Worker – a qualified person trained and knowledgeable of construction and operation of equipment or a specific work method and is trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.

- Qualified electrical workers shall be familiar with the proper use of the special precautionary techniques, personal protective equipment (PPE), including PPE for arc-flash protection, insulating and shielding materials, and insulated tools and test equipment.
    - **Note:** Whether a person is considered to be a “qualified” person will depend upon various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered “qualified” with regard to certain equipment in the workplace, but “unqualified” as to other equipment.
- A worker who is undergoing on-the-job training and who, during such training, has performed duties safely at their level of training and who is under the direct supervision of a qualified person shall be considered to be qualified for the performance of those duties.
- Only a Qualified Electrical Worker is allowed to work on or around exposed energized circuits

or equipment.
- Qualified electrical workers **shall not** be assigned to work alone on electrical tasks, except for replacing fuses, operating switches, or other operations that do not require the employee to contact energized high voltage conductors or energized parts of equipment, while clearing trouble/alarms, or emergencies involving hazard to life or property.

Resistance - a material's ability to decrease or stop electrical current.

Shocking current - electrical current that passes through a part of the body.

Short - low-resistance path between a live wire and the ground, or between wires at different voltages (called a fault if the current is unintended).

Tag out - tagout means to attach tags or signs to the locks with written information about the nature of the lockout. For more information about Lockout Tagout (LOTO), please refer to the UofT Lockout/Tagout Standard and UofT Lockout/Tagout: General Procedure.

Tag out device - this is a tag or sign, which must be attached to the lockout device, that is used to communicate vital information about the lockout, including the identity of the Authorized Worker who applied the device, the reason for locking out, and the date and time. It also warns workers not to operate that equipment. The tag must be substantial enough to withstand the environment, be secured to prevent inadvertent or accidental removal, and it must remain legible for the duration of the job. It must be made of non-conducting material and be placed in a conspicuous location.

Trip - automatic opening (turning off) of a circuit by a ground-fault circuit interrupter (GFCI) or circuit breaker.

Voltage - a measure of electrical force, measured in volts (V).

Voltage ratings – in accordance with the OESC (Ontario Electrical Safety Code):
- Extra-low voltage – any voltage not exceeding 30 V.
- Low voltage - any voltage exceeding 30 V but not exceeding 750 V
- High voltage – any voltage exceeding 750 V.

Wire gauge - wire size or diameter (technically, the cross-sectional area).

Zero Energy State – an energy level that is not harmful to an individual. Methods for achieving a zero-energy state in a system include de-energization of electrical sources and discharging of capacitive and inductive elements (absence of voltage and current), blocking or total release of mechanical energy (kinetic or potential), and dissipating chemical or thermal energy.

2. PURPOSE

The purpose of this program is to prevent injuries to individuals from the unexpected energizing, startup, or release of stored electrical energy from machines, equipment, or processes, when such workers are engaged in activities where they are at risk from these hazardous energy sources related to facilities management. The program is intended to protect individuals against electrical shock, burns and other potential electrical safety hazards and to comply with regulatory requirements. This program requires departments to establish and implement procedures for affixing the appropriate lockout/tag out devices to energy isolating devices, and to otherwise disable machines, equipment, or processes to prevent unexpected energizing, startup, or the release of stored energy.

3. SCOPE

This program applies to all UofT staff, faculty and departments who are required to perform maintenance, testing/troubleshooting, inspections, or routine service on equipment or machinery that may contain or produce an electrical energy source that could cause harm to personnel, equipment and infrastructure. Similar lockout-tagout (LOTO) procedures also exist for other stored forms of energy beside electrical energy (e.g., hydraulic, pneumatic, gas or steam pressure, vacuum; high temperature or stored mechanical energy). For more information, please refer to the UofT Lockout/Tagout Standard and UofT Lockout/Tagout: General Procedure.

All contractors who are hired by the University to maintain or service machinery or equipment must implement similar procedures that afford equal or greater protection of contract employees and work in compliance with the Ontario Occupational Health and Safety Act (OHSA) and its regulations and applicable electrical authorities.

4. LEGISLATION

Occupational Health and Safety Act (Industrial Establishments, O. Reg. 851)

41. The entrance to a room or similar enclosure containing exposed live electrical parts shall have a conspicuous sign, warning of the danger, and forbidding entry by unauthorized persons. R.R.O. 1990, Reg. 851, s. 41.

42. (1) The power supply to electrical installations, equipment or conductors shall be disconnected, locked out of service and tagged before any work is done, and while it is being done, on or near live exposed parts of the installations, equipment or conductors. O. Reg. 630/94, s. 1.

(2) Before beginning the work, each worker shall determine if the requirements of subsection (1) have been complied with. O. Reg. 630/94, s. 1.

(3) Locking out is not required,

(a) if the conductors are adequately grounded with a visible grounding mechanism; or

(b) if the voltage is less than 300 volts and there is no locking device for the circuit breakers or fuses and procedures are in place adequate to ensure that the circuit is not inadvertently energized. O. Reg. 630/94, s. 1.

(4) If locking out is not required for the reason set out in clause (3)(b), the employer shall ensure that the procedures required by that clause are carried out. O. Reg. 630/94, s. 1.

(5) If more than one worker is involved in the work referred to in subsection (1), the worker who disconnected and locked out the power supply shall communicate the purpose and status of the disconnecting and locking out. O. Reg. 630/94, s. 1.

(6) If a tag is used as a means of communication, the tag,

(a) shall be made of non-conducting material;

(b) shall be secured to prevent its inadvertent removal;

(c) shall be placed in a conspicuous location;

(d) shall state the reason the switch is disconnected and locked out;

(e) shall show the name of the worker who disconnected and locked out the switch; and

(f) shall show the date on which the switch was disconnected and locked out. O. Reg. 630/94, s. 1.

(7) The employer shall establish and implement written procedures for compliance with this section. O. Reg. 630/94, s. 1.

42.1 (1) This section applies, and section 42 does not apply if it is not practical to disconnect electrical installations, equipment or conductors from the power supply before working on, or near, live exposed parts of the installations, equipment or conductors. O. Reg. 630/94, s. 1.

(2) The worker shall use rubber gloves, mats, shields and other protective equipment and procedures adequate to ensure protection from electrical shock and burns while performing the work. O. Reg. 630/94, s. 1.

(3) If the installation, equipment or conductor is operating at a nominal voltage of 300 volts or more, a suitably equipped competent person who is able to recognize the hazards and perform rescue operations, including artificial respiration, shall be available and able to see the worker who is performing the work. O. Reg. 630/94, s. 1.

(4) Subsection (3) does not apply to equipment testing and trouble-shooting operations. O. Reg. 630/94, s. 1.

42.2 Work performed on electrical transmission systems or outdoor distribution systems rated at more than 750 volts shall be performed in accordance with the document entitled “Electrical Utility Safety Rules”, published by the Infrastructure Health and Safety Association and revised in 2019. O. Reg. 60/18, s. 3; O. Reg. 186/19, s. 3.

43. Tools and other equipment that are capable of conducting electricity and endangering the safety of any worker shall not be used in such proximity to any live electrical installation or equipment that they might make electrical contact with the live conductor. R.R.O. 1990, Reg. 851, s. 43.

44. (1) Cord-connected electrical equipment and tools shall have a casing that is adequately grounded. O. Reg. 630/94, s. 2.

(2) Subsection (1) does not apply to cord-connected electrical equipment or tools that are adequately double-insulated and whose insulated casing shows no evidence of cracks or defects. O. Reg. 630/94, s. 2.

(3) Subsection (1) does not apply to a portable electrical generator in which the electrical equipment or tools are not exposed to an external electric power source if the casing of portable electrical equipment or tools connected to the generator is bonded to a non-current-carrying part of the generator. O. Reg. 420/10, s. 7.

44.1 When used outdoors or in wet locations, portable electrical tools shall be protected by a ground fault circuit interrupter installed at the receptacle or on the circuit at the panel. O. Reg. 630/94, s. 2.

44.2 A ground fault that may pose a hazard shall be investigated and removed without delay. O.

Reg. 630/94, s. 2

5. RESPONSIBILITIES

Role of Supervisor and Management

- Identifying and eliminating electrical hazards and assessing and controlling associated risks. This may be performed in several ways, such as routine maintenance activities and reviewing/implementing design standards that meet or exceed the code requirements.
- Develop, document and implement appropriate procedures and ensure Job Safety Analysis (JSA) are completed where necessary.
- Departments are responsible for developing work procedures (EHS can be contacted for assistance). Before each job that involves exposure to energized electrical hazards, the supervisor must provide the procedure and conduct a job briefing with the workers involved.
- Ensure applicable worker review the Electrical Safety Program (current document) on an annual basis.
- Ensure workers comply with all provisions of the electrical safety program and written procedures, the UofT Lockout/Tagout Standard and the UofT Lockout/Tagout: General Procedure.
- Ensure workers receive appropriate training and the training is documented.
- Develop and maintain a listing of all Qualified workers under their supervision.
- Ensure workers are provided with and use appropriate protective equipment and approved lockout / tag out equipment and hardware, i.e., locks, tags, multiple lock holders.
- Ensure that only Authorized persons, trained in lockout / tagout procedures, service and maintain machinery or equipment that may contain or produce an energy source that could cause harm to personnel or equipment by transferring or generating energy (including stored energy such as electrical, hydraulic, pneumatic, gas or steam pressure, etc.)
- Keep a log of all lockouts and locations.
- Ensure all affected persons are notified when equipment and machinery is being locked out.
- Ensure that contractors or subcontractors follow the requirements of the lockout / tagout program.
- If there is an incident involving electrical safety, ensure that an online incident report is completed and investigate the cause of the incident.

Role of Authorized Person/Worker

- Work in compliance with the University's Electrical Safety Program and written procedures, the UofT Lockout/Tagout Standard and the UofT Lockout/Tagout: General Procedure, including safe work practices and the use of appropriate protective equipment and tools.
- Review the Electrical Safety Program (current document) on an annual basis.
- Workers will not reach blindly into electrical equipment (e.g., reaching into live equipment) or into areas that might contain exposed energized electrical conductors or circuit parts where an electrical hazard exists.
- Participate in all training required relative to this program.
- Immediately report any concerns related to electrical safety to the supervisor. Where requested, assist in the investigation of electrical safety incidents.
- Ensure the security of their personal locking devices.
- Ensure that all relevant information is shown on the lockout tag (i.e., reason for lockout, date of lockout and name of authorized person).

Role of Contractor

- All contractors who are hired by the University to maintain or service machinery or

equipment must implement similar procedures that afford equal or greater protection of contract employees and work in compliance with the Ontario Occupational Health and Safety Act (OHSA) and its regulations and applicable electrical authorities (e.g., ESA, CSA Z462, NFPA 70E, TSSA for elevators and elevating devices), including work practices and the use of appropriate protective equipment and tools.

- Any Company / Individual contracted by the University to service and/or maintain machinery or equipment must follow strict adherence to lockout / tag out procedures.
- Inform their UofT contact person of any hazards resulting from their work that may affect the UofT community.
- Inform their UofT contact person of any hazards identified by their work that was not previously identified.
- Where applicable, report any corrective actions taken to identified non-compliances to their UofT contact.

6. DESIGN STANDARDS

Where applicable and appropriate, facilities owners and project management (e.g., design engineer/consultant, project managers) should integrate risk reduction strategies during the design phase of new electrical power systems, electrical equipment and related to their installation. Design options should consider the following: reducing the frequency of exposure, reducing the potential severity of injury or damage to health and enabling an electrically safe work condition during maintenance/repair work. Design standads for the St. George campus can be found on the Facilities & Services (F&S) Design Standards webpage (see Division 26 for Electrical): https://www.fs.utoronto.ca/projects/design-standards-and-project-forms/.

7. ELECTRICAL INJURIES

There are two ways to be injured by electricity:

- Electric Shock
- Arc Flash

Electric Shock

Electric shock is the passing of electric current through the body.

Currents above 10 mA can cause muscles to contract. When this happens, a person is no longer able to release a tool, wire, or other object. In fact, the electrified object may be held even more tightly, resulting in longer exposure to the shocking current. For this reason, handheld tools that give a shock can be very dangerous.

Hazards related to electric shock include:

- Loss of balance and falls, throwing a person into contact with a higher voltage conductor.
- Severe internal burns.
- Fatalities: For example, 0.1 amp of electricity going through the body for 2 seconds can cause death. A person can stop breathing when shocked with currents from voltages as low as 49 volts. Heart or respiratory paralysis and ventricular fibrillation (very rapid, ineffective heartbeat) can also occur.

The severity of injury from electrical shock depends on: the amount of electrical current, the amount of time the current passes through the body and the path through the body. Therefore, low voltages can still be dangerous because the degree of injury also depends on the length of time the body is in

contact with the circuit.

Table 1 shows the effects on the body for a range of currents lasting one second at typical household voltages. Longer exposure times increase the hazard. For example, a current of 100 mA applied for 3 seconds is as hazardous as a current of 900 mA applied for 0.03 seconds. The muscle structure of the person also makes a difference. People with less muscle tissue are typically affected at lower current levels.

Table 1: Effects of Electrical Current on the Body
(Source: NIOSH Electrical Safety, Safety and Health for Electrical Trades, Student Manual).

Effects of Electrical Current* on the Body[3]

Current	Reaction
1 milliamp	Just a faint tingle.
5 milliamps	Slight shock felt. Disturbing, but not painful. Most people can "let go." However, strong involuntary movements can cause injuries.
6–25 milliamps (women)† **9–30 milliamps** (men)	Painful shock. Muscular control is lost. This is the range where "freezing currents" start. It may not be possible to "let go."
50–150 milliamps	Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible.
1,000–4,300 milliamps (1–4.3 amps)	Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles contract; nerve damage occurs. Death is likely.
10,000 milliamps (10 amps)	Cardiac arrest and severe burns occur. Death is probable.
15,000 milliamps (15 amps)	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit!

*Effects are for voltages less than about 600 volts. Higher voltages also cause severe burns.
†Differences in muscle and fat content affect the severity of shock.

High voltages produce greater currents and can lead to more severe injuries:

- Muscle contractions may cause bone fractures from either the contractions themselves or falls. A person may lose their balance and fall, resulting in other severe, even fatal, injuries.
- Severe burns.
- Internal bleeding and damage to internal organs (e.g., heart), muscles, tissues blood vessels and nerves at the point of contact.
- Delayed fatalities from the disruption to the heart's rhythm (i.e., arrhythmia or ventricle fibrillation). If the shock is short and the heart has not been damaged, a normal heartbeat may resume if contact with the electrical current is eliminated although this type of recovery is rare.

Resistance hinders current. The lower the resistance (or impedance in AC circuits), the greater the current will be. Dry skin may have a resistance of 100,000 ohms or more and wet skin may have a resistance of only 1,000 ohms. Wet working conditions or broken skin will drastically reduce resistance. The low resistance of wet skin allows current to pass into the body more easily and give a greater shock. When more force is applied to the contact point or when the contact area is larger, the resistance is lower, causing stronger shocks.

The path of the electrical current through the body affects the severity of the shock. Currents through

the heart or nervous system are the most hazardous. If you contact a live wire with your head, your nervous system will be damaged. Contacting a live electrical part with one hand—while you are grounded at the other side of your body will cause electrical current to pass across your chest, possibly injuring your heart and lungs.

Arc Flash

An arc flash is a release of energy caused by an electrical arc. The flash causes explosive expansion of air and metal, and the blast produces:

- A dangerous pressure wave
- A dangerous sound wave
- Shrapnel
- Extreme heat
- Extreme light

This can result in blast injuries, ruptured eardrums, shrapnel wounds, severe burns, blindness and fatalities. If a worker is near energized electrical equipment, the worker may be exposed to a flash hazard even if the source of the arc flash is not being worked on.

In some situations, it may be possible to eliminate the electrical hazard by using equipment designed to offer flash protection (e.g., flash hazard switch plugs).

Procedures to reduce arc flash hazard include:

- Standing as far away as possible from the hazard (lowers intensity of an arc flash);
- Standing to the side when opening electrical box doors to reduce exposure to the full force of a blast.

8. PORTABLE ELECTRICAL EQUIPMENT AND EXTENSION CORDS

All electrical equipment including extension cords, power bars and portable equipment shall have an approved CSA label and shall be properly maintained and in good working condition. Before using any electrical equipment and electrical extension cords, workers must inspect their equipment. Damaged equipment must not be used. They must be taken out of service and destroyed to prevent accidental use. If not possible to destroy immediately, they must be tagged out of service due to the damage. Examples of damage include but are not limited to:

- Breaks, cracks, cuts, or crushed damage, alterations to any part (e.g., cords, terminals, pins, contacts, etc.), missing cover plates, stray strands, loose terminals, etc.
- Make sure that all prongs on the male end are secure and not missing, broken or cracked. All cords and cables must have a ground plug. *(Note: small tools, which are manufactured with a 2-prong plug, are an exception.).*
- Never use cords or cables which are found to be in an unsafe condition as they may cause electrical shocks and/or fires.
- Make sure the polarity is correct.

The following requirements apply to the use of cord-and-plug-connected equipment and flexible cord sets (extension cords):

1) Extension cords may only be used to provide temporary power. Extension Cords **MUST NOT** be used as permanent wiring.

2) Extension cords must be of the three-wire type. Extension cords and flexible cords must be designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval must be visible.

3) Job-made extension cords are not permitted.

4) For renovation or construction sites, or for work in outdoor or damp/wet locations, a Class A ground-fault circuit interrupter (GFCI) must be provided.

5) Extension cords should be plugged in to a Class A GFCI. If not available, use an in-line GFCI plugged directly into the supply receptacle.

6) Portable equipment must be handled in a manner that will not cause damage. Flexible electric cords connected to equipment must not be used for raising or lowering the equipment.

7) Cords must be covered by a cord protector or tape when they extend into a walkway or other path of travel to avoid creating a trip hazard.

8) Extension cords used with grounding-type equipment must contain an equipment-grounding conductor (i.e., the cord must accept a three-prong, or grounded, plug).

9) Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.

10) Flexible cords may only be plugged into grounded receptacles. The continuity of the ground in a two-prong outlet must be verified before use. It is recommended that the receptacle be replaced with a three-prong outlet. Adapters that interrupt the continuity of the equipment grounding connection may not be used.

11) All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where workers are likely to contact water or conductive liquids, must be approved for those locations.

12) Hands must be dry when plugging/unplugging flexible cords and cord-and-plug connected equipment if energized equipment is involved.

13) If the connection could provide a conducting path to hands (e.g., if a cord connector is wet from being immersed in water), the energized plug and receptacle connections must be handled only with insulating protective equipment.

14) While working outside:

- Plug into a Class “A” GFCI.
- Use heavy duty grade cords designed for outdoor use.
- For longer runs or bigger tools, use heavier gauge wire.
- Protect cord (e.g., mat or other protective covering) from water, pedestrian and vehicle traffic, closing doors and windows.
- Check tool ground pin or on double-insulated tools, ensure that casing is not cracked.

15) Locking-type connectors must be properly locked into the connector.

16) Lamps for general illumination must be protected from breakage (e.g., wire guard), and metal shell sockets must be grounded.

17) Temporary lights must not be suspended by their cords unless they have been designed for this purpose.

18) Portable lighting used in wet or conductive locations, such as tanks or boilers, must be operated at no more than 12 volts or must be protected by GFCIs.

19) Extension cords are considered temporary wiring and must also comply with the section on "Temporary Wiring Requirements" in this program.

9. ELECTRICAL EQUIPMENT AND TOOLS

1) All equipment and tools should be used, stored and maintained per manufacturer's instruction.

2) Protect yourself:
   - Do not wear loose fitting clothing or loose-fitting gloves.
   - Do not wear jewelry, such as rings, bracelets, wristwatches, bands, necklaces, etc., which may come into contact with the rotating part of a tool or cause burns and shocks when in contact with an electrical current or when you are within the restricted approach boundary.
   - Use a face shield or safety glasses, if your electrical tools operation creates sparks or flying particles, to prevent against face or eye injuries.
   - Hands should be dry.

3) Before using an electrical tool, inspect the tool to ensure it is in good condition, review manufacturer instructions on safe usage and check the following:
   - Any breaks, cuts or crushed areas in the power cord.
   - A good 3-prong grounding connector on the male end of the power cord, which is not broken, cracked or otherwise damaged.
   - Damage to the housing of the electrical tool.
   - Switch is in good operating condition.
   - Attachments or accessories are securely attached to the tool.

4) Disconnect the power supply cord:
   - Before attaching or removing an accessory.
   - When tool is not in use.
   - When making adjustments.

5) Never tie, tape, or otherwise fasten the switch of an electrical tool in the "ON" position.

6) Avoid using electrical tools while standing in water or in moist conditions. In emergency situations such as floods, plug into GFCIs.

7) Keep hands away from rotating and moving parts.

8) Do not operate electrical tools in areas where there is a danger of fire and explosion from

sparks, because of fumes and gases.

9) Keep “breathing holes” clear in the housings of electrical tools to avoid the tool being over heated.

10) Keep tools clean, free of dust and oil build-up.

11) After use, return all electrical tools to their designated storage areas.

12) Unless they are double-insulated, tools must have the casing grounded and a polarized plug connection.

13) Portable ladders with non-conductive siderails are used when working near or on exposed energized conductors. Do not use aluminum ladders near electrical hazards.

14) Physical barriers shall be installed no closer than the limited approach boundary distance or the electrical conductors or circuit parts shall be in an electrically safety work condition.

10. TEMPORARY WIRING REQUIREMENTS

Temporary electrical power and lighting installations 600 volts or less, including flexible cords, cables and extension cords, should only be used during renovation, maintenance or repair. The following additional requirements apply where applicable:

1) Ground-fault protection (Class A) must be provided on all temporary-wiring circuits, including extension cords, used on construction sites.

2) In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances do not have to be grounded.

3) Feeders must originate in an approved distribution center, such as a panel board, that is rated for the voltages and currents the system is expected to carry.

4) Branch circuits must originate in an approved power outlet or panel board.

5) Bare conductors or earth returns may not be used for wiring of any temporary circuit.

6) Receptacles must be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.

7) Flexible cords and cables must be of an approved type and suitable for the location and intended use. They may only be used for pendants, wiring of fixtures, connection of portable lamps or appliances, elevators, hoists, connection of stationary equipment where frequently interchanged, prevention of transmission of noise or vibration, data processing cables, or where needed to permit maintenance or repair. They may not be used as a substitute for the fixed wiring.

8) Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

9) Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture or by providing a suitable guard. Hand lamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a protective guard.

10) Flexible cords and cables must be protected from accidental damage. Sharp corners and projections are to be avoided. Flexible cords and cables must be protected from damage when they pass through doorways or other pinch points. If passing through doorway, security considerations should be reviewed (if applicable).

11. PORTABLE GENERATORS

Portable generators with no connection between the neutral and the case cannot be used as stand-alone electric supply for the operation of portable equipment. Typically, generators with no connection between the neutral and the case are intended to be connected through a transfer switch to a distribution system for use as a standby back up system in a residential home, in case of power outage.

Labeling on newer portable generators must indicate the status of the neutral conductor and shall be marked on each machine as follows: NEUTRAL FLOATING or NEUTRAL BONDED TO FRAME.

12. WET AND CONDUCTIVE LOCATIONS

Work in wet (i.e., areas surrounded or near water or other liquids) or conductive locations should be avoided. The use of portable tools and equipment powered by sources other than 120 V ac (e.g., batteries, air, hydraulics) should be minimized in wet or conductive locations. If it is necessary to work in a damp or wet location, a ground-fault circuit interrupter (GFCI) Class A must be provided.

Where possible, remove water and use fans/dehumidifiers to assist in drying the area before work begins.

13. WORKING ON DE-ENERGIZED SYSTEMS

The most important principle of electrical safety is to **assume all electric circuits are energized unless each involved worker ensures they are not.** Every circuit and conductor must be tested every time work is done on them.

Proper personal protective equipment (PPE) such as the following must be worn until the equipment is proven to be de-energized:

- Voltage-rated gloves and leather protectors
- Electrically insulated shoes
- Approved insulating mats
- Safety glasses
- Appropriate Arc Flash PPE

The National Fire Protection Association (NFPA) lists six steps to ensure conditions for electrically

safe work:

1) Identify all sources of power to the equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
2) Remove the load current, and then open the disconnecting devices for each power source.
3) Where possible, visually verify that blades of disconnecting devices are fully open or that draw out-type circuit breakers are fully withdrawn.
4) Apply lockout/tag out devices in accordance with the UofT Lockout/Tagout Standard and UofT Lockout/Tagout: General Procedure and any department specific procedures.
5) Test each phase conductor or circuit part with an adequately rated voltage detector to verify that the equipment is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Check the voltage detector before and after each test to be sure it is working.
6) Properly ground all possible sources of induced voltage and stored electric energy (such as capacitors) before touching. If conductors or circuit parts that are being de-energized could contact other exposed conductors or circuit parts, apply ground-connecting devices rated for the available fault current.

The process of de-energizing is **"live"** work and can result in an arc flash due to equipment failure. When de-energizing, follow the procedures described in "Working On or Near Live Equipment" section.

14. OPERATING EQUIPMENT NEAR ENERGIZED POWERLINES AND HIDDEN POWER SUPPLIES

Overhead powerline incidents may involve dump trucks, cranes, elevated work platforms, ladders and rolling platforms. No equipment or object shall be brought within the minimum distance to an energized overhead electrical conductor based on the voltage ratings set out in *O. Reg. 213/91, Construction Projects, s. 188*.

In addition:

- Be aware of weather conditions (e.g., wind) that could cause you to cross into the minimum distance.
- Where possible, plan work to avoid powerlines and/or follow the minimum distances above. For example, do not store materials under powerlines.
- Identify powerline hazards to workers.
- Where avoiding powerlines is not possible, written procedures with additional measures such as moving the power line, insulating or de-energizing may be required.

On a construction project, if it is necessary to encroach these limits, the constructor is required to have written procedures to prevent contact from occurring and provide copies of these procedures to every employer on the project. Procedures may include measures such as signage, written notification of the hazard, training/instruction on the procedure and providing a signaler. For more information, please refer to O. Reg. 213/91, Construction Projects, s. 188.

In the event of contact between equipment and overhead powerline:

1. Contact your supervisor for assistance.
2. Stay on equipment. Do not touch equipment and the ground at the same time. Touching anything in contact with the ground can be fatal. Stay on the equipment unless forced off because of a life-threatening hazard, such as fire.
3. Keep others away. Warn everyone not to touch the equipment or its load (including

buckets, outriggers, load lines and any other part of the machine). Beware of time-delayed relays. After line damage trips a breaker, relays may still try to restore power. They may reset automatically two or three times.

4. Break contact. If possible, break contact by moving the equipment clear of the wires. This may not be feasible where contact has welded conductors to equipment, the hoist line or the load.
5. Call the local Utility (Toronto Hydro or Alectra Utilities). Stay on equipment until the utility shuts down the line and confirms that power is off. Report incidents of powerline contact so that the utility can check for damage.
6. Jump clear. If forced to leave the equipment, jump carefully off the equipment onto the ground landing only to touch your feet with your feet *together*. Touching the equipment and the ground at the same time can be fatal or touching the ground at different points can be fatal. *Shuffle slowly away* from the equipment using very small steps to minimize contact area with the ground.
7. Report the incident to supervisor who will submit the UofT online incident report and report to the electrical authority as appropriate (ESA, Ministry of Labour) and the JHSC/union.

Source: Infrastructure Health and Safety Association (IHSA).

Buried infrastructure is all over Ontario. You must contact Ontario One Call to have buried cables, pipes and wires located before digging: https://ontarioonecall.ca/

15. NEWLY INSTALLED OR MODIFIED ELECTRICAL EQUIPMENT OR SYSTEMS

Newly-installed or -modified electrical equipment or systems must be inspected to comply with applicable installation codes and standards prior to being placed into service.

16. WORKING ON OR NEAR ENERGIZED EQUIPMENT

Working on live circuits means actually touching energized parts. Working near live circuits means working close enough to energized parts to pose a risk even though work is on de-energized parts.

Common tasks where there may be a need to work on or near live circuits include:

- Taking voltage measurements
- Opening and closing disconnects and breakers
- Racking breakers on and off the bus
- Removing panels and dead fronts
- Opening electric equipment doors for inspection

Departments are responsible for developing/implementing standard operating procedures (SOPs) and training. For instance, when opening and closing disconnects, use the **left-hand rule** when possible (stand to the right side of the equipment and operate the disconnect switch with the left hand).

Where possible, work on energized equipment should be avoided and all effort should be made to turn off the power or isolate the power source before starting work. Where it is not possible to turn off or isolate the power, work on energized equipment may be permitted under the following circumstances:

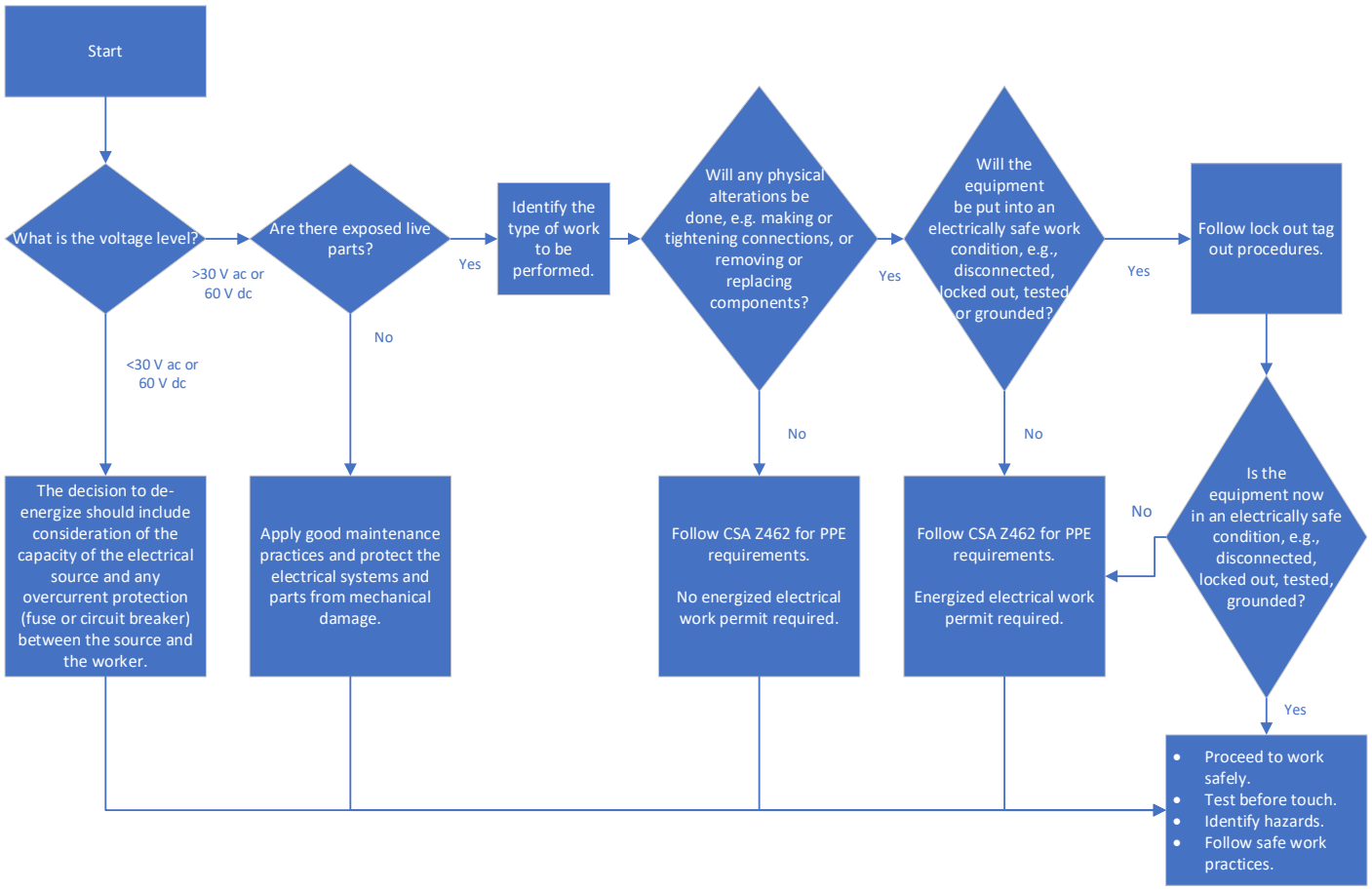
- The equipment is rated at a nominal voltage of 600 volts or less AND disconnecting would create a greater hazard than proceeding without disconnecting it.
- The work consists of diagnostic testing ONLY.

If the work (other than diagnostic work) involves a nominal voltage above 300 volts, an adequately equipped competent worker must be stationed in view of the worker to perform rescue operations, including cardiopulmonary resuscitation (CPR).

Energized Electrical Work Permit

- A written electrical safety work permit is required in the circumstances outlined in the flow chart below (source: CSA Z462-21). E.g., When there is physical alteration, and it is not possible to de-energize and put into an electrically safe condition.

Figure 1: Energized Work Permit Flow Chart
Adapted from CSA Z462-21



- A copy of the University's Energized Electrical Work Permit can be found in **Appendix 1** of this document. The intent of this permit is to ensure that all appropriate safety precautions are taken prior to starting energized electrical work.

- Work related to testing, troubleshooting, and voltage measuring may be completed without a permit provided appropriate safe work practices and PPE are used.

- The permit must be originated by the Qualified Electrical Worker. The permit must be maintained for a period of one (1) year after the work has been completed.

- The permit must be posted in an appropriate location where the energized work is taking place for the duration of the task.

- Work Permits are NOT required if a qualified person is provided with and uses appropriate safe work practices under the following circumstances:

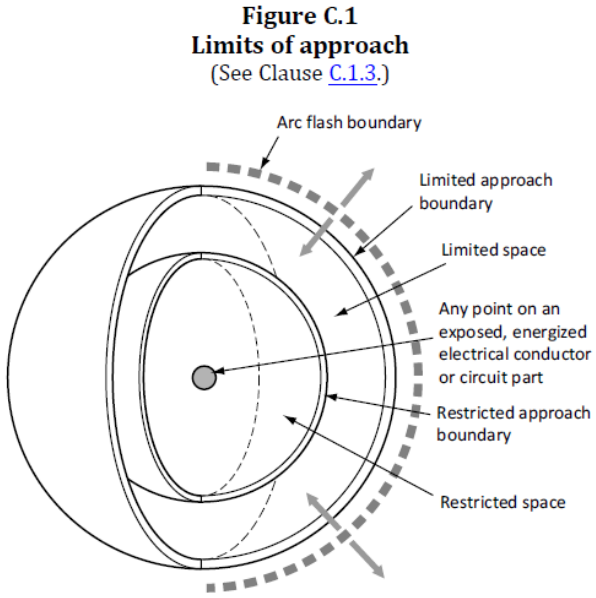
    - Testing, troubleshooting or voltage measuring.
    - Thermography, ultrasound or visual inspections if the restricted approach boundary is NOT crossed.
    - Access/egress into an area with energized equipment if no electrical work is performed and the restricted approach boundary is not crossed.
    - General housekeeping and miscellaneous non-electrical activities if the restricted approach boundary is not crossed.

Approach Distances To Exposed Live Parts

Energized electrical conductors and circuit parts operating at voltages > 30 V ac or 60 V dc should be put into an electrically safe condition before a worker works within the limited approach boundary of those conductor parts. CSA Z462-21 defines the three boundaries discussed below.

Note: the shock protection boundaries and the arc flash boundary are independent of each other. In some cases, the arc flash boundary may be greater than the boundaries for shock.

Figure 2: Limits of Approach (Source: CSA Z462-21).



The **restricted approach boundary** is the distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc over combined with movement. To cross the restricted approach boundary, the qualified person must:

1. Have an energized work permit (as applicable) that is approved by the supervisor or manager responsible.

2. Use PPE suitable for working near exposed lived parts and rated for the voltage and

energy level involved.

3. Minimize the likelihood of bodily contact with exposed energized conductors and circuit parts from inadvertent movement by keeping as much of the body out of the restricted space as much as possible, using only protected body parts in the space to the extent necessary to accomplish the work.

4. Use insulated tools and equipment.

5. Not approach or bring conductive objects within the restricted approach boundary > 30 V ac or 60 V dc unless requirements in CSA-Z462 are followed.

The **limited approach boundary** is the distance from an exposed live part within which a shock hazard exists. To cross the limited approach boundary, the qualified person must wear flash protective equipment. If an unqualified person works near or close to the boundary, they must be advised to stay outside of this boundary by a qualified person. If crossing the limited approach boundary, workers must be:

- Be trained and qualified for the task which includes being able to identify the hazards and associated risk.

The **arc flash boundary** is the approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur. The arc flash boundary is defined as the approach limit from an arc source at which incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

1. Use PPE appropriate for working near exposed live parts and rated for the voltage and energy level involved.
2. For systems of 600 volts and less, the flash protection boundary is 4 feet, based on an available bolted fault current of 50 kA and a clearing time of 6 cycles for the circuit breaker to act, or any combination of fault currents and clearing times not exceeding 300 kA cycles. Always review labels on panels which contains information about energies and boundaries before starting work.
3. When working on de-energized parts and inside the flash protection boundary for nearby live exposed parts:
    a. If the parts cannot be de-energized, use barriers such as insulated blankets to protect against accidental contact or wear proper PPE.
4. When working near exposed live parts, provide suitable safe work zone barriers to maintain a safe distance for non-workers in the area.

Shock Hazard Analysis

As part of the job planning process, a shock hazard analysis should be completed where there is a risk of a shock hazard. The shock hazard should determine the likelihood and severity of injury (taking into consideration the electrical design, the guarding of energized electrical conductors and circuit parts, the operating conditions and the condition of maintenance). The shock hazard analysis will determine if additional protective measures such as PPE is required and identify the limited and restricted approach boundaries.

Arc Flash Hazard Analysis

An arc flash hazard analysis shall determine the arc flash protection boundary and the personal

protective equipment that personnel within the arc flash protection boundary shall use. Requirements for arc flash analyses are outlined in the latest CSA Z462 standard.

The analysis shall be updated when a major modification or renovation takes place. It shall be reviewed periodically by all affected staff, not to exceed five (5) years, to account for changes in the electrical distribution system that could affect the results of the analysis.

The analysis shall take into consideration the design of the overcurrent protective device and its opening time, including its condition of maintenance.

Incident Energy Analysis

An incident energy analysis determines the incident energy exposure of the worker (in cal/m^2). It determines the distance of the arc flash boundary. The incident energy exposure level shall be based on the working distance of the worker's face and chest areas from a prospective arc source for the task to be performed, the characteristics of the overcurrent protective device and its fault clearing time, and the condition of maintenance.

Arc-rated flame resistant (FR) clothing and personal protective equipment shall be used by the worker and selected based on the incident energy exposure associated with the specific task. Because incident energy increases as the distance from the arc flash decreases, additional personal protective equipment shall be used for any parts of the body that are closer than the distance at which the incident energy was determined.

Other Precautions

When working on de-energized parts, but still inside the flash protection boundary for nearby live exposed parts:

- If the parts cannot be de-energized, barriers such as insulated blankets must be used to protect against accidental contact or PPE must be worn.
- Workers shall not reach into areas that might contain exposed live parts.
- Workers shall not enter spaces containing live parts unless lighting is provided that allows the work to be performed safely.
- Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts or within the restricted approach boundary.
- Conductive materials, tools, and equipment that are in contact with any part of a worker's body shall be handled in a manner that prevents accidental contact with live parts. Such materials and equipment include, but are not limited to, long conductive objects such as ducts, pipes, tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, and chains.
- When an individual works in a confined space or enclosed spaces (such as a manhole) that contains exposed live parts, the worker shall use protective shields, barriers or insulating materials as necessary to avoid contact with these parts. Also refer to the UofT Confined Spaces Program for procedures when working in a confined space.

- Where applicable, doors and hinged panels are secured to prevent accidental swinging and causing workers to make contact with energized equipment.

17. EQUIPMENT ARC FLASH LABELING

Equipment shall be field marked with a label specifying the following:

1) Available incident energy or required level of personal protective equipment; and
2) Date of evaluation.

Per CSA Z462-21, labels (Figure 3) must adhere to the following description:

1) Label content: labels consist of a signal word panel (“DANGER”, “WARNING”, or “CAUTION”) plus a message panel (concise explanation of the hazard). The signal word panel may include a safety alert symbol (triangle and exclamation mark). The label may also include a safety symbol panel (a symbol that effectively communicates the message in the message panel).
2) Safety alert symbol: if a safety alert symbol is used, it needs to precede the signal word. The base of the symbol needs to be on the same horizontal line as the base of the signal word and the height of the symbol needs to be equal to or greater than the signal word.
3) Border: the label may include a contrasting border.
4) Colours:
    a. Danger labels need to have the word “DANGER” in safety white letters on a safety red background;
    b. Warning labels need to have the word “WARNING” in safety black letters on a safety white background; and
    c. If a safety alert symbol is used, it needs to be the same colour as the signal word lettering and the exclamation mark needs to be the same colour as the signal word panel background.
5) Location: a label needs to be readily visible to the worker and alert the worker to the potential hazard in time to take appropriate action.

Note: Individuals who will be producing and/or installing arc flash and shock warning equipment labels should consult ANSI/NEMA Z535.4, CAN/CSA-Z431, and CSA Z321 to ensure that all applicable requirements are met.

Figure 3: Example of an arc flash and shock warning label
Always follow that most recent requirements of CSA Z462.

When a detailed arc flash hazard analysis has been completed, a detailed label (Figure 4) may be installed by the owner to provide additional information. A typical label consists of four sections:

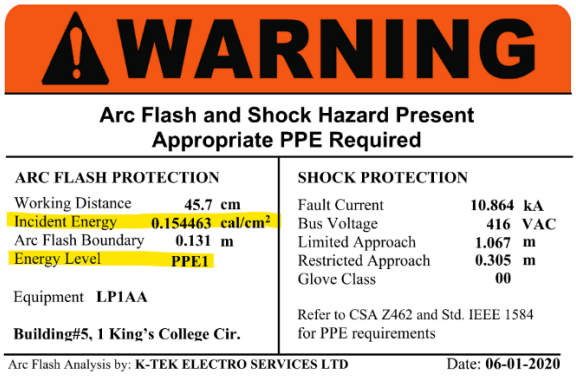
1) The first section contains the information from the label required by Rule 2-306 of the Canadian

Electrical Code, Part I.

2) The second section contains information on arc flash hazards, e.g., arc flash protection boundary distances, arc flash incident energy levels that could be experienced, and the required level of personal protective equipment.
3) The third section contains information on electrical shock hazards, e.g., voltage level, safe approach distances, and insulation value of insulating tools and PPE.
4) The fourth section contains information on the designation of the equipment. In addition, it can also identify the name of the individual or company that performed the analysis and the power system study file designation. To meet the requirements of CSA Z462-21**,** it should record the date that the analysis was completed.

Figure 4: Detailed arc flash hazard analysis label

Always follow that most recent requirements of CSA Z462.



Procedures for Labeling of Equipment

For all new installations, the university **requires** switchboards, panel boards, industrial control panels, and motor control centers **to be field marked** to warn workers of potential electric arc flash hazards.

1) The term Industrial Control Panel covers every enclosure that may contain exposed energized conductors or components.

2) Marking and labeling are intended to reduce the occurrence of serious injury or death due to arcing faults to workers working on or near energized electrical equipment.

3) Markings (labels) shall be located so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.

4) The first, “WARNING or DANGER” label shall be used when information is not presently available.

5) The DANGER label should remind a qualified worker who intends to open the equipment for analysis or work:
    a. Electric arc flash hazard exists.
    b. Turn off all power before opening.
    c. Follow all requirements of CSA Z462-21 for safe work practices and wear appropriate personal protective equipment (PPE) for the specific hazard.

6) The second DANGER label shall be used when a qualified electrical worker or electrical engineer determines the values of the shock and flash protection information.

7) When arc flash and shock data are available for industrial control panels, labels shall include information on flash hazard boundary, the hazard category, required PPE, minimum arc rating, limited approach distances, restricted approach distances and prohibited approach distances.

8) All unqualified workers are strictly forbidden from coming into contact or working near open energized equipment.

Implementation Procedures

1) Immediately place danger labels on equipment required to be labeled by CSA Z462-21 and the Ontario Electrical Safety Code (OESC).

2) Until an arc flash hazard analysis can be made, a Qualified Electrical Worker using NFPA Table 130.7(C)(9)(a), Hazard/Risk Category Selections, or CSA Z462-21 Table 4 Hazard/Risk category classifications and use of rubber insulating gloves and insulating hand tools, shall for each situation:

    a. Determine the hazard/risk category.

    b. Determine the use of V-rated gloves.
        i. V-rated gloves are gloves rated and tested for the maximum line-to-line voltage.

    c. Determine the use of V-rated tools.

    d. V-rated tools are tools that are rated and tested for the maximum line-to-line voltage

3) A licensed electrical engineer shall complete an arc flash hazard analysis as required by the most recent CSA Z462-21 standard:

- An arc flash hazard analysis shall be completed for all new electrical system installations and for all major electrical system upgrades or renovations.
    - The up-to-date arc flash hazard analysis is maintained by the designated UofT departments (UTSG F&S Utilities & Building Operations, UTM FMP Utilities, UTSc FMD Engineering).
    - The U of T facilities owner is responsible for ensuring the arc flash analysis is up-to-date and current and have the latest analysis available for review. The arc flash analysis will be completed by a qualified professional engineer employed by the owner. Any changes to the electrical distribution system requires the engineered stamped drawings prepared by a professional engineer, and as part of the project execution, the arc flash analysis will be completed to reflect the changes made as part of the project.

- Only designated UofT staff (UTSG F&S Utilities & Building Operations, UTM FMP Utilities, UTSc FMD Engineering) will oversee/review the arc flash hazard analysis when considered immediately necessary. Reasons for conducting the analysis include the following:
    - Some equipment may be old, possibly in poor condition creating a greater potential for flashover.
    - Equipment is requiring greater than average maintenance.
    - Frequent use of high hazard/risk category personal protective equipment during the conduct of maintenance. Qualified electrical workers are frequently wearing high

hazard/risk PPE.

18. LOCKOUT TAGOUT (LOTO)

For more information, please refer to the UofT Lockout/Tagout Standard and UofT Lockout/Tagout: General Procedure. In addition:

- Suitable documentation, including up-to-date drawings and diagrams, shall be consulted to ensure that no electrical circuit interlock operation can result in re-energizing the circuit being worked on.
- Locks and information tags shall be installed only on circuit-disconnecting means. Control devices, e.g., push buttons or selector switches, shall not be used as primary isolating devices.

19. TRAINING

The following table outlines recommended minimum training and competency requirements required for electrical workers and others who work near electrical systems. Additional training may be required based on tasks assigned to the worker (e.g., fire and gas detection systems). Department-specific training/instruction (e.g., specific tasks, equipment) or on-boarding processes (e.g., job shadowing, site orientation, etc.) should also be provided where applicable.

Role	Additional Training	Tasks that are NOT permitted
Apprentice Electrician	• Lockout tagout (EHS527) • CPR • CSA Z462 Workplace Electrical Safety • Arc flash training as appropriate to local site requirements	Cannot be in charge of a group or complex lock out. Cannot perform work or be within the limited or restricted approach boundary; cannot perform diagnostic testing.
Journeyman (or higher) Electrician	• Lockout tagout (EHS527) • CPR • CSA Z462 Workplace Electrical Safety • Arc flash training as appropriate to local site requirements	High voltage work (unless trained per below).
Electrician performing High Voltage Work	• Lockout tagout (EHS527) • CPR • CSA Z462 Workplace Electrical Safety • Arc flash training as appropriate to local site requirements • Powerline Technician (also known as Linesman) training OR qualified electrician with high voltage training	

Operating engineers, building engineers, TSSA certified elevating device mechanics	Based on local risk assessment, review if the following is required: • Lockout tagout (EHS527) • CSA Z462 Workplace Electrical Safety (non-electrical workers) • Arc flash training as appropriate to local site requirements	Engineers are not licensed electrician and therefore should not be performing any work that requires a licensed electrician. Operating Engineers and TSSA certified elevating device mechanics (non-electrical workers) are permitted per local conditions to operate Low Voltage electrical equipment but only when wearing the required PPE for the equipment rating. The equipment shall be enclosed and in normal operating condition with no exposed live parts.
Other non-electrical workers, for example (e.g., changing light bulbs): supervisor of maintenance workers, accessing electrical rooms	Based on local risk assessment and the tasks required, review *if* the following is required: • Lockout tagout (EHS527), where applicable • CSA Z462 Workplace Electrical Safety (non-electrical workers) • Arc flash training as appropriate to local site conditions • Site-specific training or instruction where applicable	Caretaking, maintenance or other staff who are not licensed electrician should not be performing any work that requires a licensed electrician. Other non-electrical workers, should never touch electrical equipment unless properly trained. Where permitted, equipment rated less than 1.2 cal/cm^2, can be operated provided the appropriate PPE is worn. *If a breaker repeatedly trips, staff should seek advice from the facilities owner, instead of resetting repeatedly on their own.

Test instruments: Workers shall receive instruction to select an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training/instruction shall include information that enables the worker to understand all the limitations of every test instrument that might be used.

Work activities that occur less often than once per year: Training should be provided at least every 3 years to maintain appropriate levels of awareness.

Documentation: Records of training shall include the following as applicable: course syllabus, course curriculum, outline, table of contents or training objectivities, attendance, date of training,

name of training provider. Departments are responsible for documenting department-specific training and verifying the training of their staff at least annually. ***For external training, also provide proof of training (e.g. certificate, attendance sheet) to EHS to document in the individual's training record.

20. PERSONAL PROTECTIVE EQUIPMENT (PPE)

General Requirements

Individuals working in areas where there are potential electrical hazards must be provided with and use personal protective equipment (PPE) that is appropriate for the specific work. The electrical tools and protective equipment must be specifically approved, rated, and tested for the level of voltage relevant to the work activity.

Workers should be provided with training and/or instruction on the proper use, care and storage of PPE. PPE should be used and maintained per manufacturer's instructions. PPE, like other equipment, should be inspected prior to use.

Insulating PPE, such as insulating gloves, must be rated for the voltage for which they will be exposed. Tests to verify the insulating properties of the PPE should be conducted every 36 months (3 years). Units are responsible for maintaining records of these tests.

In general, underlayers should consist of non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd^2. Meltable fibres, e.g., acetate, nylon, polyester, polypropylene, and spandex should not be used as underlayers. However, non-melting fabric undergarments or socks that contain incidental amounts of elastic may be used. Clothing should be loose fitting to provide additional thermal insulation due to the air spaces beneath the clothing.

Eyewear / Face Protection Requirements

Eyewear should meet the most current version of CSA standard Z94.3. Eye protection that meets or exceeds American National Standards Institute (ANSI) standards Z87.1-89 and Z87.1A-91 **may not meet Canadian impact-protection standards**.

When working on live electrical equipment, non-conducting frames with scratch resistant clear polycarbonate lenses or CR-39 (plastic) lenses with ultraviolet (UV400) protection are acceptable. Shaded lenses with ultraviolet protection to a maximum shade rating of 1.7 may only be worn when the work area is bright.

Face shields must be arc rated to at least 8 cal/cm^2 and be worn with safety glasses which have side shields. To achieve full-face protection, a chin cup must be worn if the chin is not fully protected by the design of the face shield.

Footwear Protection Requirements

Protective footwear should meet the most current version of CSA Standard, Z195-M92: *Protective Footwear*. Protective footwear must have an external rectangular patch colour with the Greek letter

omega in orange, denoting electrical shock resistant soles as per picture below:

Head, Face, Neck and Chin Protection Requirements

Loose hair must be fully restrained using a non-conductive hairnet, cap or hard hat. Hardhats must meet the most current version of CSA Standard Z94.1*: Industrial Protective Headwear*. There are three electrical classifications for hard hats:

1. Type 2, Class 'E' (Electrical): rated for 20,000 volts – required for construction projects including electrical construction projects.
2. Type 2, Class 'G' (General): rated for 2,200 volts – provides head protection against low voltage conductors (general trades).
3. Type 2, Class 'C' (Conductive): does not offer electrical protection – **not suitable for electrical work.**

"Type 2" refers to headwear that provides protection from impact, penetration at the crown (top) and laterally (sides and back). Type 1 headwear only provides impact and penetration at the crown (top).

Workers shall wear non-conductive protective equipment for the face, neck, and chin whenever there is a danger of injury from exposure to electric arcs or flashes or from flying objects resulting from electrical explosion. Hairnets and beard nets, if worn, shall be non-melting and arc-rated.

Hand Protection

Rubber insulating gloves shall be air (inflation) tested and inspected. Maximum use voltages for rubber insulating gloves shall not exceed that specified in **Appendix 5**. The top of the cuff of the protector glove shall be shorter than the rolled top of the cuff of the rubber insulating glove by at least the distance specified in **Table 4A** in **Appendix 5**.

Rubber insulating gloves or sleeves that have been electrically tested but not issued for service shall not be placed into service unless they have been electrically tested within the previous twelve months. The test voltages shall be as specified in **Table 4B** in **Appendix 5**.

Hearing Protection

Workers shall wear hearing protection whenever working within the arc flash boundary.

Shock Protection

The best shock protection is to turn off or isolate electrical power. Unless this is unavoidable, all work should be planned such that power is shut off or isolated.

Rubber gloves and leather protectors are the most common PPE for shock protection. These must be adequate to protect the worker from electrical shock and burn. The rubber gloves must have been tested and certified. Leather protectors should be used with insulating gloves – contact your supervisor if it is not possible to use leather protectors. Additional measures may be required in

these situations.

Class O and Class OO gloves must be air tested and visually inspected for damage and adequacy immediately before each use. They are exempt from regular recertification unless work is carried out under the Electrical Utility Safety Rules.

Rubber gloves rated for use with voltages above 5000 volts AC must be regularly tested and certified to ensure that they can withstand the voltages they are rated for at least once every three months if they are in service or once every six months if they are not in service. Additional protection may be required if there is a danger of arm contact with exposed energized electrical conductors or circuit parts.

Arc Flash PPE

Workers shall wear arc-rated clothing wherever exposure to an electric arc flash above the threshold incident-energy level for a second-degree burn, i.e., 1.2 cal/cm^2 (5 J/cm^2), is possible. There are two ways of selecting the appropriate arc flash PPE (please refer to the most recent CSA Z462 standard for more details):

1) The incident energy analysis method (**Appendix 4**)
2) The Arc flash PPE category method

All parts of the body inside the arc flash boundary shall be protected including the hand, arm and back of the head. When arc-rated clothing is worn to protect a worker, it must cover all ignitable clothing and allow for movement and visibility.

If wearing outer layers, any garment worn over arc-rated clothing should also be made of arc-rated materials.

Note: Layering of arc clothing – it is important to understand that the total system arc rating cannot be determined by adding the arc rating of individual layers. In some cases, the total system arc rating decreases when another arc-rated layer is added. The only way to determine total system arc rating is to conduct a multi-layer arc test in accordance with ASTM standards.

21. TEST INSTRUMENT REQUIREMENTS

Electrical test equipment (multimeters) must be designed to meet the CAT Category (III) standards or higher. CAT III are designed to give the user protection when there are electrical spikes. The test device (multimeter) should have a CSA International logo (approval) and a CAT III designation and be rated above any voltage being tested. Multimeters should also have proof of independent testing by an organization accredited by the Standards Council of Canada (e.g., CSA). Test leads should also be rated at the same or greater voltage than the multimeter.

Test instruments and associated test leads used to verify the absence or presence of voltage shall be maintained per manufacturer's instructions. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before each use. If there is a defect or evidence of damage that might expose a worker to injury, the defective or damaged item shall be removed from service. Workers shall not use the defective or damaged item until repairs and tests necessary to render the item safe have been conducted by person(s) qualified.

When test instruments are used to test for the absence of voltage on conductors or circuit part operating at voltages greater than 30 V ac or 60 V dc, the operation of the test instrument shall be

verified on any known voltage source before and after an absence of voltage test is performed.

Safe Use of Multimeters

- Use only multimeters that display the CSA logo. Categories I-IV apply to low voltage (less than 1000 V) test equipment.
- Use PPE such as arc flash fire-resistant clothing, eye and face protection, long-sleeved shirts, dielectric safety boots, rubber gloves with leather protectors and mats, blankets or shields as required. **Do not wear synthetic or outer clothing that can melt if an arc flash occurs.**
- Check to ensure that the meter's voltage rating is appropriate for the work being done. Be aware of multimeters with maximum voltage ratings typical of other controls (550V for example).
- Review manufacturer's instruction including special precautions. Moisture and temperature can affect the meter.
- Wipe the multimeter and test leads clean to remove any surface contamination prior to use.
- Use fused test leads. Ensure fused leads and internal probe fuses are rated as high or higher than the equipment you are working on. A minimum of 200 kA is recommended. Some local site conditions may require a minimum of 200 kA – contractors should discuss with their local UofT contact.
- Verify test leads are in the correct input jacks.
- When the values to be measured are uncertain, start testing with higher ranges of the multimeter, then move to lower ranges.
- Connect to the ground first and disconnect from the ground last.
- Test the multimeter on a known power source to verify that meter is functioning properly before and after testing the suspect circuit, using the same power function for all three tests.

Testing for Power with a Meter

Follow manufacturer's instructions. Some general steps are:

- Set the meter to the power function to be used for validating the zero energy.
- Test to ensure the meter is functioning correctly by testing on a known power source, then test the locked-out circuit to verify that the power has been effectively isolated.
- Finally, re-test on the same known power supply to verify the meter's fuse has not blown and the meter is still functioning correctly on that power setting.

22. INSULATED TOOLS AND ELECTRICAL PROTECTIVE EQUIPMENT

All tools and handling equipment within the restricted approach boundary must be insulated. All tools must be insulated and certified for voltages above any expected voltages, inspected before each use and used/stored/maintained per manufacturer's instructions.

Proper/certified fuse pullers and other specialized electrical tools must be used to remove or install a fuse if the fuse terminals are energized.

Ropes and hand-lines used within the limited approach boundary shall be non-conductive.

Fibreglass-reinforced plastic rods and tubes used for live line tools shall meet the requirements of CAN/ULC-60855 or ASTM F5711.

Electrical Protective Equipment

Protective equipment should be inspected before each use and be rated for the voltage. They should be used, stored and maintained per manufacturer's instructions.

Rubber mats and shields can also be used with standard PPE to protect from electric shock and burn. The rubber mat must also be tested and certified.

Periodic electrical tests: Rubber insulating equipment that has been issued for service shall be subjected to periodic electrical tests. The interval between date of issue and retesting shall not exceed those intervals specified in **Appendix 5**.

23. ELECTRICAL FIRES

- Report fires immediately.
- Never put water on fires in live electrical equipment or wiring. Water is a conductor and increases the risk of arc flash and electrocution. Use a **Class C** fire extinguisher (non-conductive materials, intended for electrical fires). An ABC fire extinguisher may also be used on an electrical fire.
- Know the location of the nearest fire extinguisher before staring work. Instructions should be posted.
- An electrical fire in a confined space can deplete oxygen rapidly and release toxic fumes. If possible, switch off power. Vacate area immediately.

APPENDIX 1: ENERGIZED ELECTRICAL WORK PERMIT

UNIVERSITY OF TORONTO	**ENERGIZED ELECTRICAL WORK PERMIT**
	Part I: General Description (to be completed by the requestor).
Name of Requestor	Will this work be performed by a contractor (Y/N)?: ____
Date	
Service Order	
Project Name and Project Manager (if applicable)	
Brief Description: 1) circuit/equipment (e.g., panel no.); 2) building and room number; 3) Fed from	
Job Briefing	Date: Names of attendees:
Details on why de-energization or deferral until the next scheduled shutdown is not possible.	
	Part II: Safe Work Practices (to be completed by the requestor and supervisor of workers completing the work)
Detailed job procedures to be used:	
Description of safe work practices (Electrical safety job planning checklist has also been completed.)	
Results of the shock risk assessment: 1) Voltage to which personnel will be exposed 2) Limited approach boundary 3) Restricted approach boundary 4) PPE required	
Results of arc flash assessment: 1) Available incident energy at the work distance or arc flash category 2) Arc flash boundary 3) PPE available	
Detailed access restriction controls:	
Part III: Approvals	The undersigned acknowledge that the electrician(s) who works on LIVE electrical equipment has been advised of the risk and the proper safety precautions and equipment to be used. The undersigned also acknowledge that *contractors* who work on LIVE equipment (without shutdown) will be liable for injuries and/or damages for any power disruption that may cause, even if

	permission is granted to work on "LIVE."	
Acknowledged by Electrical Contractor	Name:	Signature:
UofT Project Manager/Requestor	Name:	Signature:
Director / Head of Department	Name:	Signature:
For UTSG F&S Utilities & Building Operations, UTM FMP Utilities or UTSc FMD Engineering Use only: Approved by (name): _____ Signature: _____ Date of approval: _____ Date of completion: _____		

APPENDIX 2: ELECTRICAL SAFETY JOB PLANNING CHECKLIST

*Optional checklist

Date	
Location	
Service Order	
Person completing the checklist	
Brief Description of work	
Job Briefing	When: Attended by:

Item	**Yes, No or N/A (not applicable)**	**Comment**
Work Planning		
1) Single-line diagram consulted.		
2) Energy has been de-energized where possible.		
3) Hazards and controls (other than PPE) have been identified and reviewed with workers. E.g., energized work, overhead lines, damp conditions and non-electrical hazards (e.g., asbestos, working at heights, portable ladders, lighting, etc.)		
4) Required equipment, tools and PPE identified, available and appropriate (rated) for the work. E.g., rubber mats, insulated tools, testing equipment, guards, etc.		
5) Lockout tag procedures reviewed and appropriate locks/tools/equipment available.		
6) Switching sequence prepared.		
7) Temporary protective grounding discussed		
8) Training appropriate to the task has been provided.		
9) Additional worker has current CPR training.		
Emergency Response Planning		
1) Method of communications, contacts and phone numbers have been provided to workers.		
2) Emergency response plan have been reviewed with worker(s).		
3) Location of first aid kit(s), AED and fire extinguishers have been identified.		
Controls in place		
1) Energy has been de-energized.		
2) Equipment, tools, PPE identified during planning have been inspected and is on-site.		
3) LOTO procedure followed.		
4) Controls as per planning are in place. No new hazards have been identified.		
5) Cords are protected from damage.		

Energized work		
1) Jumpers and test leads removed.		
2) Energized Work Permit completed.		
3) Temporary protective grounds removed and accounted for.		
4) Locks removed.		
5) Site access control measures are in place (e.g., prevent others from entering or pass approach boundaries).		

Additional Information (where applicable)

Hazards	**Controls (follow hierarchy of controls). Provide details (e.g., list PPE to be used).**

Shock Risk Assessment				
Tasks with a Shock Hazard	**Nominal Voltage**	**Class of Gloves**	**Limited Approach boundary**	**Restricted Approach Boundary**

Arch Flash Risk Assessment		
Tasks with an Arc Hazard	**Incident energy or PPE category***	**Arc flash boundary**

*Indicate PPE Selection Method (incident energy or Arc Flash PPE category): _____

APPENDIX 3: SHOCK PROTECTION BOUNDARIES

*Please check for the most recent CSA Z462 standard before using the information.

Table 1A
Shock protection approach boundaries to exposed energized electrical conductors or circuit parts for ac systems*
(See Clauses 4.1.8.1.2, 4.3.4.5, 4.3.4.7, 4.3.7.4.11, 4.3.7.5.2, 4.3.9.5, 4.3.9.6.1, 6.2.4.1, C.2, C.2.1, and R.2.2.)

(1)	(2)	(3)	(4)
Nominal system voltage range, phase to phase†	Limited approach boundary		Restricted approach boundary (includes inadvertent movement adder)
	Exposed movable conductor‡	Exposed fixed circuit part	
Less than or equal to 30 V	Not specified	Not specified	Not specified
31–150 V §	3.0 m (10 ft 0 in)	1.0 m (3 ft 6 in)	Avoid contact
151–750 V	3.0 m (10 ft 0 in)	1.0 m (3 ft 6 in)	0.3 m (1 ft 0 in)
751 V–15 kV	3.0 m (10 ft 0 in)	1.5 m (5 ft 0 in)	0.7 m (2 ft 2 in)
15.1–36 kV	3.0 m (10 ft 0 in)	1.8 m (6 ft 0 in)	0.8 m (2 ft 9 in)
36.1–46 kV	3.0 m (10 ft 0 in)	2.5 m (8 ft 0 in)	0.8 m (2 ft 9 in)
46.1–72.5 kV	3.0 m (10 ft 0 in)	2.5 m (8 ft 0 in)	1.0 m (3 ft 6 in)
72.6–121 kV	3.3 m (10 ft 8 in)	2.5 m (8 ft 0 in)	1.0 m (3 ft 6 in)
138–145 kV	3.4 m (11 ft 0 in)	3.0 m (10 ft 0 in)	1.2 m (3 ft 10 in)
161–169 kV	3.6 m (11 ft 8 in)	3.6 m (11 ft 8 in)	1.3 m (4 ft 3 in)
230–242 kV	4.0 m (13 ft 0 in)	4.0 m (13 ft 0 in)	1.7 m (5 ft 8 in)
345–362 kV	4.7 m (15 ft 4 in)	4.7 (15 ft 4 in)	2.8 m (9 ft 2 in)
500–550 kV	5.8 m (19 ft 0 in)	5.8 m (19 ft 0 in)	3.6 m (11 ft 8 in)
765–800 kV	7.2 m (23 ft 9 in)	7.2 m (23 ft 9 in)	4.9 m (15 ft 11 in)

** See the "Boundary" definitions in Clause 3. See also Clause 4.3.4 and Annex C.*
† For single-phase systems above 250 V, select the range that is equal to the system's maximum phase-to-ground voltage times 1.732.
‡ A condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.
§ This includes circuits where the exposure does not exceed 120 V.

Notes:
1) *All dimensions are distance for exposed energized electrical conductors or circuit parts to the worker.*
2) *For the arc flash boundary, see Clause 4.3.5.5.*

Table 1B
Shock protection approach boundaries to exposed energized electrical conductors or circuit parts for dc systems*
(See Clauses 4.1.8.1.2, 4.3.4.5, 4.3.4.7, 4.3.7.4.11, 4.3.7.5.2, 4.3.9.5, 4.3.9.6.1, C.2.1, and R.2.2.)

(1)	(2)	(3)	(4)
Nominal voltage conductor to ground	Limited approach boundary		Restricted approach boundary (includes inadvertent movement adder)
	Exposed movable conductor†	Exposed fixed circuit part	
Less than or equal to 60 V	Not specified	Not specified	Not specified
61–300 V	3.0 m (10 ft 0 in)	1.0 m (3 ft 6 in)	Avoid contact
301 V–1 kV	3.0 m (10 ft 0 in)	1.0 m (3 ft 6 in)	0.3 m (1 ft 0 in)
1.1–5 kV	3.0 m (10 ft 0 in)	1.5 m (5 ft 0 in)	0.4 m (1 ft 5 in)
5.1–15 kV	3.0 m (10 ft 0 in)	1.5 m (5 ft 0 in)	0.7 m (2 ft 2 in)
15.1–45 kV	3.0 m (10 ft 0 in)	2.5 m (8 ft 0 in)	0.8 m (2 ft 9 in)
45.1–75 kV	3.0 m (10 ft 0 in)	2.5 m (8 ft 0 in)	1.0 m (3 ft 6 in)
75.1–150 kV	3.4 m (10 ft 8 in)	3.0 m (10 ft 0 in)	1.2 m (3 ft 10 in)
150.1–250 kV	4.0 m (11 ft 8 in)	4.0 m (11 ft 8 in)	1.6 m (5 ft 3 in)
250.1–500 kV	6.0 m (20 ft 0 in)	6.0 m (20 ft 0 in)	3.5 m (11 ft 6 in)
500.1–800 kV	8.0 m (26 ft 0 in)	8.0 m (26 ft 0 in)	5.0 m (16 ft 5 in)

** See the "Boundary" definitions in Clause 3. See also Clause 4.3.4 and Annex C.*
† A condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

Notes:
1) *All dimensions are distance for exposed energized electrical conductors or circuit parts to the worker.*
2) *For the arc flash boundary, see Clause 4.3.5.5.*

APPENDIX 4: SELECTION OF ARC-RATED PPE USING THE INCIDENT ENERGY ANALYSIS

*Please check for the most recent CSA Z462 standard before using the information.

Table 3
Selection of arc-rated clothing and other PPE when the incident energy analysis method is used
(See Clauses 4.3.5.6.2 and Q.4.)

Incident energy exposures equal to 1.2 cal/cm² (5 J/cm²) up to and including 12 cal/cm² (50 J/cm²)
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy*
• Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
• Arc-rated faceshield and arc-rated balaclava or arc flash suit hood (SR) †
• Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)‡
Heavy duty leather gloves, arc-rated gloves or rubber insulating gloves with leather protectors (SR) §
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear**
Incident energy exposures greater than 12 cal/cm² (50 J/cm²)
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy *
• Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
• Arc-rated arc flash suit hood
• Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)‡
Arc-rated gloves or rubber insulating gloves with leather protectors (SR)§
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear**

Legend:

SR = selection of one in group is required

AN = as needed

** 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.*
† Faceshields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by Clause 4.3.7.3.10 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.
‡ The arc rating of outerwear worn over arc-rated clothing that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

Table 3 (Concluded)

§ 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.
*** Footwear other than leather or dielectric may be used provided it has been tested for and demonstrates no ignition, melting or dripping at or greater than the estimated incident energy exposure.*

APPENDIX 5: RUBBER INSULTING GLOVES (MAXIMUM USE VOLTAGE) AND RUBBER INSULTING EQUIPMENT (TEST INTERVALS)

*Please check for the most recent CSAZ462 standard before using the information.

Table 4A
Maximum use voltage for rubber insulating gloves
(See Clause 4.3.7.3.7.)

Class designation of glove or sleeve	Maximum AC use Voltage rms, V	Maximum DC use Voltage avg, V	Distances between gauntlet and cuff, min
00	500	750	13 mm (0.5 in)
0	1000	1500	13 mm (0.5 in)
1	7500	11 250	25 mm (1 in)
2	17 000	25 500	51 mm (2 in)
3	26 500	39 750	76 mm (3 in)
4	36 000	54 000	102 mm (4 in)

Table 4B
Rubber insulating equipment test intervals
(See Clauses 4.3.7.2.4 and 4.3.7.3.7.)

Type of rubber insulating equipment	When to test	Governing Standard for test voltage
Blankets	Before first issue and every 12 months thereafter	ASTM F479
Covers	Upon indication that insulating value is suspect	ASTM F478
Gloves	Before first issue and every 6 months thereafter	ASTM F496
Line hose	Upon indication that insulating value is suspect	ASTM F478
Sleeves	Before first issue and every 12 months thereafter	ASTM F496