ALGONQUIN COLLEGE | Risk Management

Electrical Safety Program

OCCUPATIONAL HEALTH & SAFETY

Revision Date: May, 2016

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Program Review History

Issue	Description of Changes	Implemented By	Date
1.	Revised to incorporate changes	Sloane Gagnon	May 6th, 2016
2.	Revised to incorporate the new CSA Z462.15 changes	Sloane Gagnon	

GLOSSARY

Affected employee - an employee who performs the duties of his or her job in an area in which the energy control procedure is implemented and servicing or maintenance operations are performed. An affected employee does *not* perform servicing or maintenance on machines or equipment and, consequently, is not responsible for implementing the energy control procedure. An affected employee becomes an "authorized" employee whenever he or she performs servicing or maintenance functions on machines or equipment that must be locked or tagged.

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

Amperage - strength of an electrical current, measured in amperes

Ampere (amp) - unit used to measure current

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 employee - an employee who performs servicing or maintenance on machines and equipment. Lockout or tag out is used by these employees for their own protection.

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, 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.

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 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.

Conductor, covered - a conductor encased within material of a composition or thickness that is not recognized by this Standard as electrical insulation.

Conductor, insulated - a conductor encased within material of a composition and thickness that is recognized by this Standard as 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 - any mechanical device that physically prevents the transmission or release of energy. 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.

Energy control procedure - a written document that contains those items of information an authorized employee needs to know in order to safely control hazardous energy during servicing or maintenance of machines or equipment. (A more comprehensive explanation is given beginning on page 6.)

Energy control program - a program intended to prevent the unexpected energizing or the release of stored energy in machines or equipment on which servicing and maintenance is being performed by employees. The program consists of energy control procedure(s), an employee training program, and

periodic inspections.

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 of 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 - voltage a grounded part should have; 0 volts relative to ground

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 - 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.

Lockout device - any device that uses positive means such as a lock, either key or combination type, to hold an energy - isolating device in a safe position, thereby preventing the energizing of machinery or equipment. When properly installed, a blank flange or bolted slip blind are considered equivalent to lockout devices.

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 - 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

PPE - personal protective equipment (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 arc-flash, insulating and shielding materials, and insulated tools and test equipment. A person

can be considered qualified with respect to certain equipment and methods but is unqualified for others.

- An employee who is undergoing on-the-job training and who, in the course of such training, has performed duties safely at his or her level of training and who is under the direct supervision of a qualified person shall be considered to be qualified.

- Only a Qualified Electrical Worker is allowed to work on energized circuits.
- Qualified electrical workers **shall not** be assigned to work alone, 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, clearing trouble, or emergencies involving hazard to life or property.

Note One: 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.

Note Two: An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

Resistance - 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 - the placement of a tag out 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 tag out device is removed.

Tag out device - any prominent warning device, such as a tag and a means of attachment that can be securely fastened to an energy - isolating device in accordance with an established procedure. The tag indicates that the machine or equipment to which it is attached is not to be operated until the tag out device is removed in accordance with the energy control procedure.

Trip - automatic opening (turning off) of a circuit by a GFCI or circuit breaker

Voltage - measure of electrical force

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

Zero Energy State – the mechanical potential energy in all elements of a machine is eliminated so that operation of any control will not produce a movement that could cause injury or damage to the machine.

ACRONYMS

AWG:	American Wire Gauge—measure of wire size
GFCI:	Ground fault circuit interrupter—a device that detects current leakage from a circuit to ground and shuts the current off
LOTO:	Lockout / Tag out
OH&S Act:	Occupational Health and Safety Act
JOHSC:	Joint Occupational Health and Safety Committee

2.0 PURPOSE

The purpose of this program is to prevent injuries to employees from the unexpected energizing, start-up, or release of stored energy from machines, equipment, or processes when such employees are engaged in activities where they are at risk from these hazardous sources. The program is intended to protect employees against electrical shock, burns and other potential electrical safety hazards as well as 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, start-up, or the release of stored energy.

3.0 SCOPE

This program applies to all staff and departments who are required to perform maintenance or routine service on equipment or machinery that may contain or produce an energy source that could cause harm to personnel or equipment by transferring or generating electrical energy; hydraulic; pneumatic; gas or steam pressure; vacuum; high temperature; or stored mechanical energy.

All contractors who are hired by Algonquin College to maintain or service machinery or equipment must implement similar procedures that afford equal or greater protection of contract employees.

4.0 LEGISLATION

Occupational Health and Safety Act (Industrial Regulations)

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.

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.

(2) Before beginning the work, each worker shall determine if the requirements of subsection (1) have been complied with.

(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.

(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.

(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.

(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.

(**7) *The employer shall establish and implement written procedures for compliance with this section.***

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.**
(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.
(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.
(4) Subsection (3) does not apply to equipment testing and trouble-shooting operations.

42.2 Work performed on electrical transmission systems or outdoor distribution systems rated at more than 750 volts shall be performed in accordance with,

(a) the *Rule Book, Electric Utility Operations* published in 1990 by the Electrical Utilities Association of Ontario, Incorporated; or
(b) the *Ontario Hydro Corporate Safety Rules and Policies*, dated 1994.

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

44. (1) Cord-connected electrical equipment and tools shall have a casing that is adequately grounded.
(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.
(3) Subsection (1) does not apply to a portable electrical generator in which the equipment is not exposed to an external electric power source if the casings of portable electrical tools connected to the generator are bonded to a non-current-carrying part of the generator.

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.

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

5.0 RESPONSIBILITIES

5.1 Role of Directors, Deans, Chairs, Managers, Supervisors:

- Promote electrical safety awareness to all employees.
- Ensure employees comply with ALL provisions of the electrical safety program.
- Ensure employees receive training appropriate to their assigned electrical tasks and maintain documentation of such training.
- Develop and maintain a listing of all qualified employees under their supervision.
- Ensure employees are provided with and use appropriate protective equipment.
- Provide the resources and direction necessary to ensure that an effective lockout / tag out program is in place and is strictly adhered to;
- Ensure that only authorized persons, trained in lockout / tag out 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 electrical energy; hydraulic; pneumatic; gas or steam pressure; vacuum; high temperature; or stored mechanical energy at the college.
- Keep a log of all lock-outs and locations.
- Provide approved lockout / tag out equipment and hardware i.e. locks, tags, multiple lock holders.

- 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 / tag out program.

5.2 Role of Authorized Person:

- Work in compliance with the colleges Electrical Safety program.
- Follow the work practices described in this document, including the use of appropriate protective equipment and tools.
- Participate in all training required relative to this program.
- Immediately report any concerns related to electrical safety to supervision.
- Ensure the security of their personal locking devices.
- Follow all documented lockout / tag out procedures.
- Ensure that all relevant information is shown on the lockout tag i.e. reason for lockout, date of lockout and name of authorized person.

5.3 Role of Contractor:

- Work in compliance with the colleges Electrical Safety program.
- Follow the work practices described in this document, including the use of appropriate protective equipment and tools.
- Any Company / Individual contracted by the college to service and/or maintain machinery or equipment shall follow strict adherence lockout / tag out procedures.

6.0 Dangers of Electrical Shock

The severity of injury from electrical shock depends on two things,

- the amount of electrical current and,
- the amount of time the current passes through the body.

For example, 1/10 of an ampere (amp) of electricity going through the body for just 2 seconds is enough to cause death. The amount of internal current a person can withstand and still be able to control the muscles of the arm and hand can be less than 10 milliamperes (milliamps or mA). Currents above 10 mA can paralyze or “freeze” muscles. When this “freezing” 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. If you can’t let go of the tool, current continues through your body for a longer time, which can lead to respiratory paralysis (the muscles that control breathing cannot move). You stop breathing for a period of time. People have stopped breathing when shocked with currents from voltages as low as 49 volts. Usually, it takes about 30 mA of current to cause respiratory paralysis. Currents greater than 75 mA cause ventricular fibrillation (very rapid, ineffective heartbeat). This condition will cause death within a few minutes unless a special device called a defibrillator is used to save the victim. Heart paralysis occurs at 4 amps, which means the heart does not pump at all. Tissue is burned with currents greater than 5 amps. The table shows what usually happens for a range of currents (lasting one second) at typical household voltages. Longer exposure times increase the danger to the shock victim. For example, a current of 100 mA applied for 3 seconds is as dangerous as a current of 900 mA applied for a fraction of a second (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. Even low voltages can be extremely dangerous because the degree of injury depends not only on the amount of current but also on the length of time the body is in contact with the circuit.

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.

Sometimes high voltages lead to additional injuries. High voltages can cause violent muscular contractions. You may lose your balance and fall, which can cause injury or even death if you fall into machinery that can crush you.
High voltages can also cause severe burns. At 600 volts, the current through the body may be as great as 4 amps, causing damage to internal organs such as the heart. High voltages also produce burns. In addition, internal blood vessels may clot. Nerves in the area of the contact point may be damaged. Muscle contractions may cause bone fractures from either the contractions themselves or from falls.
A severe shock can cause much more damage to the body than is visible. A person may suffer internal bleeding and destruction of tissues, nerves, and muscles. Sometimes the hidden injuries caused by electrical shock result in a delayed death. Shock is often only the beginning of a chain of events. Even if the electrical current is too small to cause injury, your reaction to the shock may cause you to fall, resulting in bruises, broken bones, or even death. The length of time of the shock greatly affects the amount of injury. If the shock is short in duration, it may only be painful. A longer shock (lasting a few seconds) could be fatal if the level of current is high enough to cause the heart to go into ventricular fibrillation. This is not much current when you realize that a small power drill uses 30 times as much current as what will kill. At relatively high currents, death is certain if the shock is long enough. However, 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. (This type of recovery is rare.) The amount of current passing through the body also affects the severity of an electrical shock. Greater voltages produce greater currents. So, there is greater danger from higher voltages. 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. 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 most dangerous. 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.

(The paragraph "Dangers of Electric Shock" has been extracted from the NIOSH Electrical Safety, Safety and Health for Electrical Trades Student Manual, Pg 5-6.)

7.0 PORTABLE ELECTRICAL EQUIPMENT AND EXTENSION CORDS

Before using any electrical extension cords in the college always check the following:

1. For breaks cuts or crushed damage to the outer insulated covering.
2. To make sure the ends are secure on the cord or cable and not broken or cracked.
3. To 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 to the previous statement.)* Never use cords or cables which are found to be in an unsafe condition as they may cause electrical shocks and/or fires.
4. Any defective cord or cord-and-plug-connected equipment must be removed from service

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 **WILL 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 forbidden per the electrical code.

4) Staff or contractors performing work on renovation or construction sites using extension cords or where work is performed in damp or wet locations must be provided, and must use, a ground-fault circuit interrupter (GFCI).

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

6) 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.

7) 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).

8) 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.

9) 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.

10) 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 employees are likely to contact water or conductive liquids, must be approved for those locations.

11) Employee's hands must be dry when plugging and unplugging flexible cords and cord-and-plug connected equipment if energized equipment is involved.

12) If the connection could provide a conducting path to employees hands (for example, 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.

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

14) Lamps for general illumination must be protected from breakage, and metal shell sockets must be grounded.

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

16) 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 GFCI's.

17) Extension cords are considered to be temporary wiring, and must also comply with the section on "Requirements for Temporary Wiring" in this program.

8.0 ELECTRICAL TOOLS

1) Protect Yourself.
    a) Do not wear loose fitting clothing or loose fitting gloves.
    b) Never wear jewelry such as rings, bracelets, wristwatches, bands, necklaces etc. which may come into contact with rotating part of the tool or cause burns and shocks when in contact with an electrical current.
    c) Use a face shield if your electrical tools operation creates sparks or flying particles, which may cause face or eye injuries.

2) Before using an electrical tool, check the power supply cord for:
    a) any breaks, cuts or crushed areas
    b) a good 3 - prong grounding connector on the male end of the cord, which is not broken, cracked or otherwise damaged.

3) Before using an electrical tool, check:
    a) housing to make sure it is not cracked, broken or otherwise damaged.
    b) to make sure that the switch is in good operating condition.
    c) that the attachment or accessory is securely attached to the tool.

4) Disconnect the power supply cord:
    a) before attaching or removing an accessory.
    b) when tool is not in use.
    c) when making adjustments.

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

6) Do not use electrical tools while standing in water or in moist conditions.

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.

9.0 TEMPORARY WIRING REQUIREMENTS

1) Temporary electrical power and lighting installations 600 volts or less, including flexible cords, cables and extension cords, may only be used during and for renovation, maintenance, repair, or experimental work. The duration for temporary wiring used for decorative lighting for special events and similar purposes may not exceed 90 days. The following additional requirements shall apply:

2) Ground-fault protection (e.g., ground-fault circuit interrupters, or GFCI) must be provided on all temporary-wiring circuits, including extension cords, used on construction sites.

3) In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded.

4) 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.

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

6) Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.

7) 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.

8) 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, where run through holes in walls, ceilings or floors, where run through doorways, windows or similar openings, where attached to building surfaces, or where concealed behind building walls, ceilings or floors.

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

10) 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 substantial bulb guard.

11) 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.

10.0 WET OR DAMP LOCATIONS

Work in *wet* or *damp locations* (i.e., areas surrounded or near water or other liquids) is strictly prohibited by college staff at any time.

11.0 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 PPE must be worn until the equipment is proven to be de-energized.

- Voltage rated gloves and leather protectors must be worn
- Electrically insulated shoes should be worn
- Approved insulating mats
- Safety glasses must be worn
- The required Arc Flash PPE must also be worn

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 drawout-type circuit breakers are fully withdrawn.
4) Apply lockout/tag out devices in accordance with a formal, written policy.
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."

12.0 WORKING ON OR NEAR AN ENERGIZED SYSTEM

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

Facilities should adopt standard written procedures and training for these common tasks. 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).

12.1 Arc Flash 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. 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 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.

However, an arc flash hazard analysis shall not be required when the following is met:

a) circuit is rated 240 V or less;
b) circuit is supplied by one transformer; and
c) transformer supplying the circuit is rated less than 125 kVA.

A detailed incident energy analysis need not be performed if staff are following proper PPE and following PPE procedures.

12.2 Incident Energy Analysis

An incident energy analysis shall determine, and the employer shall document, the incident energy exposure of the worker (in cal/m^2). 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.
Arc-rated FR clothing and personal protective equipment shall be used by the worker and selected on the basis of 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.

12.3 Energized Electrical Work Permit For 240 Volts And Higher

- If live parts are not placed in an electrically safe condition, work to be performed shall be considered energized electrical work and shall be performed by written permit only.

- A copy of the college Energized Electrical Work Permit can be found in the Appendix 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.

- Energized Work Permits shall be submitted to the Electrical Lead Hand in C-100.

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

12.4 Approach Distances To Exposed Live Parts

The National Fire Protection Association (NFPA) defines 3 approach distances for shock hazards and one for arc flash.

The **limited approach boundary** is the distance from an exposed live part within which a shock hazard exists.

The **restricted approach boundary** is the closest distance to exposed live parts a qualified person can approach with without proper PPE and tools. Inside this boundary, accidental movement can put a part of the body or conductive tools in contact with live parts or inside the prohibited approach boundary. To cross the restricted approach boundary, the qualified person must:

1. Have an energized work permit that is approved by the supervisor or manager responsible or the safety plan.

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

3. Be certain that no part of the body enters the prohibited space.

4. Minimize the risk from unintended movement, by keeping as much of the body as possible out of the restricted space; body parts in the restricted space should be protected.

The **prohibited approach boundary** is the minimum approach distance to exposed live parts to prevent flashover or arcing. Approaching any closer is comparable to making direct contact with a live part. To cross the prohibited approach boundary, the qualified person must:

1. Have specified training to work on exposed live parts.
2. Have a permit with proper written work procedures and justifying the need to work that close.
3. Do a risk analysis.
4. Have (2) and (3) approved by the appropriate supervisor.
5. Use PPE appropriate for working near exposed live parts and rated for the voltage and energy level involved.

The **Arc Flash Protection 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.

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.
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 insulted blankets to protect against accidental contact or wear proper PPE.

12.5 Other Precautions

When working on de-energized the 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.

- Employees shall not reach blindly into areas that might contain exposed live parts.

- Employees shall not enter spaces containing live parts unless illumination 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.

- Conductive materials, tools, and equipment that are in contact with any part of an employee'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 employee works in a confined space or enclosed spaces (such as a manhole or vault) that contains exposed live parts, the employee shall use protective shields, barriers or insulating materials as necessary to avoid contact with these parts. Doors, hinged panels, and the like shall be secured to prevent them from swinging into employees. Refer to the confined space entry program.

12.6 Equipment Labeling

Equipment shall be field marked with a label specifying the;

(a) available incident energy or required level of personal protective equipment; and
(b) date of evaluation.

In order to follow and respect CSA-Z462-08, labels must adhere to the following description:

a) 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).
b) 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.
c) Border: the label may include a contrasting border.
d) Colours:
    - danger labels need to have the word "DANGER" in safety white letters on a safety red background;
    - warning labels need to have the word "WARNING" in safety black letters on a safety black background; and
    - 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.
e) 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: *Persons who will be producing and/or installing arc flash and shock warning labels should consult ANSI Z535.4 to ensure that all applicable requirements of ANSI Z535.4 are met.*

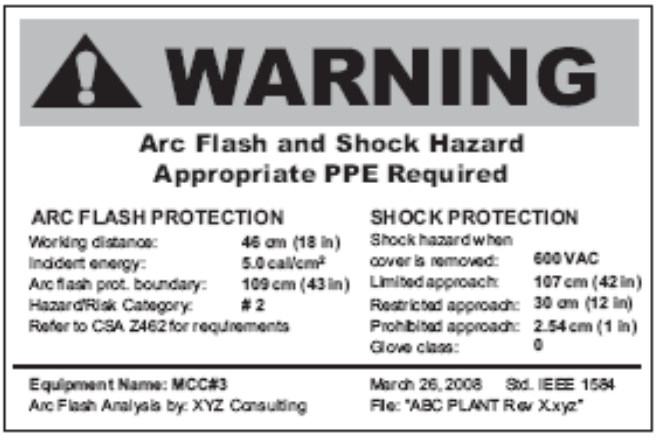
Examples of such Labels include:

Example of an arc flash and shock warning label that meets the requirements of Rule 2-306 of the *Canadian Electrical Code, Part I*

Detailed arc flash hazard analysis label

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

a. The first section contains the information from the label required by Rule 2-306 of the Canadian Electrical Code, Part I.
b. 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.
c. The third section contains information on electrical shock hazards, e.g., voltage level, safe approach distances, and insulation value of insulating tools and PPE.
d. 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 Z462-08**,** it should record the date that the analysis was completed.



12.7 Procedures for Labeling of Equipment

The college **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 is 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. Labels shall be either of the 2 examples (or similar) shown in Figure 1 depending on the available resources of the agency.

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

6. The DANGER label should remind a qualified worker who intends to open the equipment for analysis or work:
   - Electric arc flash hazard exists
   - Turn off all power before opening
   - Follow all requirements of CSA Z462-08 and NFPA 70E for safe work practices and wear appropriate personal protective equipment (PPE) for the specific hazard.

7. 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.

8. 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.

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

12.8 Implementation Procedures

1. Immediately place danger labels on equipment required to be labeled by CSA Z462-08 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 Z462-08 Table 4 Hazard/risk category classifications and use of rubber insulating gloves and insulated and insulating hand tools, shall for each situation:

   - Determine the hazard/risk category

   - Determine the use of V-rated gloves
     - V-rated gloves are gloves rated and tested for the maximum line-to-line voltage upon work will be done.

   - Determine the use of V-rated tools

- V-rated tools are tools rated and tested for the maximum line-to-line voltage upon work will be done.

3. A licensed electrical engineer shall complete an arc flash hazard analysis as required by NFPA 70E.
   - The arc flash hazard analysis shall be completed on all major electrical system upgrades or renovations.
     - The arc flash hazard analysis is a responsibility of the Physical Resources.

   - The arc flash hazard analysis shall be done for all new electrical system installations.
     - This is a responsibility of the Physical Resources.

   - Only Physical Resources Electrical staff will conduct 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.

   - OHS in conjunction with Physical Resources Electrical staff shall develop an arc flash hazard analysis program including an implementation plan for all college facilities.

12.9 Arc Flash Hazard Analysis

An arc flash hazard analysis includes the following:

- Collect data on the facility's power distribution system.
  - Arrangement of components on a one-line drawing with nameplate specifications of every device.
  - Lengths and cross-section area of all cables.

- Contact the electric utility for information including the minimum and maximum fault currents that can be expected at the entrance to the facility.

- Conduct a short circuit analysis followed by a coordination study is performed.

- Feed the resultant data into the NFPA 70E-2000 or CSA Z462-08 equations.
  - These equations produce the necessary **flash protection boundary distances** and **incident energy** to determine the minimum PPE requirement.
  - The **flash protection boundary** is the distance at which PPE is needed to prevent incurable burns (2nd degree or worse) if an arc flash occurs. (It is still possible to suffer 1st or 2nd degree burns.)

- For systems of 600 volts and less, the flash protection boundary is 4 feet, based on an available bolted fault current of 50 kA (kiloamps) and a clearing time of 6 cycles (0.1 seconds) for the circuit breaker to act, or any combination of fault currents and clearing times not exceeding 300 kA cycles (5000 ampere seconds).

- For other fault currents and clearing times, *see* NFPA 70E or CSA Z462-08.

13.0 PERSONAL PROTECTIVE EQUIPMENT

13.1 General Requirements

Employees 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 to be performed. The electrical tools and protective equipment must be specifically approved, rated, and tested for the levels of voltage of which an employee may be exposed.

Protective clothing is required when a person is within an area around exposed live electrical equipment called the *'flash protection boundary'*. The protection is required to be worn by everyone within the hazardous zones - not just the worker(s). The following distances are the minimum safety zones as specified by NFPA standard 70E:

Flash Protection Boundary		
Voltage	***Distance***	
	Meters (m)	***Feet (ft)***
50 to 750	0.9	3
750 to 2000	1.2	4
2000 to 15, 000	4.8	16
15, 000 to 36, 000	5.7	19
Over 36, 000	Calculate	Calculate

Clothing requirements become more stringent as the risk of electrical arc burns (flash) increases either with the different types of work and/or increasing voltages. NFPA 70E requires that the arc rating be calculated for specific operations. The clothing is not intended to protect the worker from shocks but will protect the workers body from the heat (radiation) from flashes. Protective clothing includes hand, foot and face flash arc protection which is usually incorporated into the specific protective equipment for those areas of the body.

NFPA 70E has a simplified reference for some routine maintenance work:

Hazard/ Risk Category	**Required minimum Arc rating of PPE**	**Examples from NFPA 70**
Risk Category 0	Up to 1.2 cal/cm²	**-** operating an exposed breaker up to 240 volts **-** using a meter switch over 1000 volts
Risk Category 1	1.3 to 4 cal/cm²	- voltage testing or installing a breaker in a live panel up to 240 volts. **-** Operating an exposed circuit breaker up to 600 volts
Risk Category 2	4.1 to 8 cal/cm²	- work on control circuits above 120 volts changing live breakers up to 600 volts **-** voltage testing and parts at or above 600 volts
Risk Category 3	8.1 to 25 cal/cm²	- starter "buckets at 600 volts
Risk Category 4	25.1 to 49 cal/cm²	**-** voltage testing and working on parts at or above 1000 volts

Required minimum standard for clothing or minimum Arc Rating of PPE based on energy protection required (cal/cm). Shirts must be long sleeved and pants must fully cover the workers legs. Electrical protective clothing can not have any part made out of conductive materials. Conductive (metallic and some plastics) buttons, zippers, pins, eyelets and other decorative items must not be present.

Risk Category	Protective Clothing Required	Examples
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd2.	- 100% cotton shirt - jeans or - !00% cotton slacks
1	FR shirt and FR pants or FR coverall.	- Nomex clothing - FR pants - Denim jeans > 12 oz/yd2
2	Cotton underwear – conventional short sleeve and brief/shorts, plus FR shirt and FR pants Face shield with side protection, chin cups	Flash suits and Flash hoods must be rated above the flash energy levels expected and meet the appropriate ASTM standard.
3	Cotton underwear plus FR Shirt and FR pants plus FR coverall and Flash hood, or cotton underwear plus two FR coveralls and Flash hood. *or* Flash suit and Flash hood.	
4	Cotton Underwear plus FR Shirt and FR Pants plus multilayer flash suit. *or* Flash suit meeting ASTM F1506 and ASTM F2178	

13.2 Test Instrument Requirements

Electrical test equipment (multimeters) must be designed to meet the International Electrotechnical Commission (IEC) 1010 Category (III) standards.

Note: CAT III are designed to give the user protection when there are electrical spikes. The test device (multimeter) should have both a CSA International (or equivalent) logo (approval) and a CAT III designation and be rated above any voltage being tested. Moisture and temperature can affect the meter – see the manufacturer's specifications and limitations.

13.3 Tool Requirements

All tools must be insulated and certified for voltages above any voltages expected. Proper/certified fuse pullers and other specialialized electrical tools must be used.

13.4 Eyewear / Face Protection Requirements

Use CSA standard Z94.3-00 (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/cm2 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.

13.5 Footwear Protection Requirements

Electrically rated steel toed footwear
Use CSA standards: Canadian Standards Association (CSA), Z195-M92: *Protective Footwear*
Must have an external rectangular patch colour with Greek letter omega in orange, denoting electrical shock resistant soles. As per picture:

13.6 Head Protection Requirements

Loose hair mist be fully restrained using a non-conductive hairnet, cap or hard hat. In hazardous or construction areas where a hard hat is required use a CSA approved hard hat: CSA standards: Canadian Standards Association (CSA) Standard Z94.1-92 (R2003),'*Industrial Protective Headwear*'. There are three electrical classifications for hard hats:

- Class ‘E’ (Electrical): tested using 20,000 volts
- Class ‘G’ (General): tested using 2,200 volts
- Class ‘C’ (Conductive): not tested for electrical insulation

14.0 REFERENCES

1. NIOSH Electrical Safety, Safety and Health for Electrical Trades Student Manual, (Pg 5-6.)
2. McMaster University, Lockout/Tag out Program
3. Occupational Health and Safety Act – Industrial Establishments
4. OSHA 29 CFR 1910.147, Control of Hazardous Energy (Lockout/Tag out)
5. Guide to Good Practices for Lockouts and Tag outs. (U.S. Doe – STD-1030-96)
6. CSA Z462-08 Workplace Electrical Safety
7. Ontario Electrical Safety Code (Canadian Electrical Safety Code with Ontario Amendments)
8. CSA 22.2 No.950 / UL1950 – 'Safety of Information Technology Equipment, Including Electrical Business Equipment.'
9. ASTM Specifications for PPE for Electrical Work
10. IEC 1010 and CAT(category) III standards for equipment
11. NFPA 70B - 'Recommended Practice for Electrical Equipment Maintenance'
12. NFPA 70E- 'Standard for Electrical Safety in the Workplace'

15.0 APPENDICES

15.1 Energized Electrical Work Permit
15.2 Electrical Safety Training Checklist
15.3 Approachable Boundaries to Electrical or Circuit Parts for Shock Protection Table
15.4 Hazard/ Risk Category and Use of Rubber Insulating Gloves and Hand Tools table

ALGONQUIN COLLEGE	**ENERGIZED ELECTRICAL WORK PERMIT (For Applications of 240 volts or greater)**

The following permit MUST be filled out properly and fully and must be cleared by the Algonquin College Electrical Lead Hand before any work is started. Failure to comply with this process will provide grounds for college staff to remove the contractor from the job and college property.

Work Location: **Building:**

Project Manager Responsible:

Worker Conducting Work: **Company:**

Description of the work to be done:

_____
_____
_____
_____
_____
_____
_____

Check the following if they apply:

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

Signature of Electrical Lead Hand: _____ Date: _____
Signature of Worker Conducting Work: _____ Date: _____

ELECTRICAL SAFETY TRAINING CHECKLIST

ELECTRICAL SAFETY TRAINING CHECKLIST			
TRAINING ITEM	**YES ☑**	**N/A ☑**	**COMMENTS**
SCOPE AND TRAINING			
1. All employees who work on, near or with premises wiring, wiring for connections to supply, other wiring, and installation of optical fiber cable along with electrical conductors have been trained as either qualified or unqualified workers.	❑	❑	
2. Unqualified person have been trained in and are familiar with any electrically related safety practices not covered by this standard but necessary for their safety.	❑	❑	
3. Qualified persons trained in and familiar with:			
a) Skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.	❑	❑	
b) Voltage determination.	❑	❑	
c) Clearance distances that must be maintained.	❑	❑	
d) Training conducted has been specific to the hazards to which the employee may or will be exposed and their particular job duties.	❑	❑	
SELECTION AND USE OF WORK PRACTICES			
1. Work practices used to prevent electric shock and other injuries address de-energized parts which may be energized.	❑	❑	
2. Work practices used to prevent electric shock and other injuries address exposure to energized parts.	❑	❑	
3. Procedure provided for work on or near exposed de-energized parts includes:			
a) Written procedures specific to the equipment or worksite.	❑	❑	
b) De-energizing equipment.	❑	❑	
c) Application of locks and tags.	❑	❑	
4. Working on or near exposed energized parts:			
a) All employees near enough to be exposed to a hazard have been trained, and are aware of the practices that must be followed to protect them from the hazard.	❑	❑	
b) Only qualified employees work on energized parts.	❑	❑	
c) Overhead lines de-energized and grounded prior to working near them **or** other protective measures used.	❑	❑	
d) Unqualified persons working near overhead lines are aware that they may not come approach, or use conductive objects closer than, 10 feet for lines up to 50 kV, or 10 feet plus 4 inches for every 10 kV over 50 kV.	❑	❑	
e) Qualified persons are have a working knowledge of the allowable approach distances of this program.	❑	❑	
f) Vehicle and mechanical equipment operators understand that they must maintain:			
i) A clear distance of 10 feet plus 4 inches for every 10 kV over 50 kV while working near energized overhead lines.	❑	❑	
ii) A clear distance of 4 feet plus 4 inches for every 10 kV over 50 kV while in transit.	❑	❑	
iii) Insulating barriers are used and installed as required.	❑	❑	
iv) Insulated aerial lift operated by a qualified person must comply with the separation distances.	❑	❑	

v)	Employees standing on the ground understand they may not contact the vehicle unless using protective equipment rated for the voltage or the equipment located so no un-insulated part can provide a conductive path to persons on the ground.	❑	❑	
g)	Illumination is provided at all worksites to assure safe work.	❑	❑	
h)	Protective shields and barriers provided and used for work in confined spaces to prevent contact with exposed energized parts.	❑	❑	
i)	All conductive materials such as pipes, rods, etc. are handled so as to prevent contact with exposed energized parts.	❑	❑	
j)	Conductive articles of clothing and jewelry such as watches, rings, etc. are not worn if they might contact exposed energized parts unless rendered nonconductive.	❑	❑	
k)	Portable ladders with nonconductive siderails are used when working near or on exposed energized conductors.	❑	❑	
l)	Housekeeping conducted only when exposed energized parts may not be contacted. Barriers provided and nonconductive cleaning materials used.	❑	❑	
m)	Only qualified persons allowed to defeat electrical interlocks on temporary basis while they work on equipment.	❑	❑	
USE OF EQUIPMENT				
1. Portable electric equipment such as cord-and-plug connected equipment, including flexible cords:				
a)	Handled in a manner to avoid damage.	❑	❑	
b)	Not used to raise or lower equipment.	❑	❑	
c)	Not fastened with staples or hung so as to damage insulation.	❑	❑	
d)	Visually inspected before each use on each shift.	❑	❑	
e)	Defective items removed from service and not used until rendered safe.	❑	❑	
f)	Plugs and receptacles mate properly.	❑	❑	
g)	Flexible grounding-type cords have a grounding conductor.	❑	❑	
h)	Grounding plug not defeated.	❑	❑	
i)	Adapters which interrupt grounding continuity not used.	❑	❑	
j)	Approved equipment used for work in conductive work locations (e.g. wet locations, etc.).	❑	❑	
k)	Locking-type connectors are properly secured after connection.	❑	❑	

ELECTRIC POWER AND LIGHTING CIRCUITS			
1. Only load rated switches or circuit breakers used as disconnecting means.	❑	❑	
2. Circuits not manually reenergized until it is determined that it is safe to do so.	❑	❑	
3. Overcurrent protection of circuits not modified.	❑	❑	
TEST INSTRUMENTS AND EQUIPMENT			
1. Used by qualified persons only.	❑	❑	
2. Visually inspected before use.	❑	❑	
3. If circuit tested is over 600 volts, nominal, test instrument tested for proper operation before and immediately after the test.	❑	❑	
4. Test instrument rated for the circuit to be tested and appropriate for the environment.	❑	❑	
5. Electrical equipment capable of igniting flammable or ignitable materials not used if present in the worksite.	❑	❑	
SAFEGUARDS FOR PERSONNEL PROTECTION			
1. Protective equipment used when there is exposure to potential electrical hazards.	❑	❑	
2. Protective equipment maintained in safe and reliable condition and tested and inspected as required.	❑	❑	
3. Protective equipment protected from damage during use.	❑	❑	

4. Approved electrically rated hardhats used as needed to protect head from electric shock or burns.	❑	❑	
5. Safety glasses or goggles used as needed to protect eyes or face when there is a danger of arcs, flashes or flying objects.	❑	❑	
6. Approved gloves worn that are appropriate for the hazard present	❑	❑	
7. Insulated tools or handling equipment used when conductors may be contacted.	❑	❑	
8. Insulated fuse handling equipment used to remove or install fuses when terminals are energized.	❑	❑	
9. Ropes and handlines used near energized parts are nonconductive and are protected from moisture.	❑	❑	
10. Protective shields, barriers or insulating materials are used to protect employees working near exposed energized parts.	❑	❑	
ALERTING TECHNIQUES			
1. Safety signs and tags used when necessary to warn employees about electrical hazards.	❑	❑	
2. Barricades used with safety signs when necessary to prevent or limit employee access to work areas with un-insulated energized conductors or parts.	❑	❑	
3. Attendants stationed as needed to warn when signs or barricades are not sufficient to prevent unauthorized access.	❑	❑	
Name of Employee:	Date:		

Table 1
Approach boundaries to energized electrical conductors or circuit parts for shock protection (distance from energized electrical conductors or circuit part to worker)

(See Clauses 4.1.6.4.1, 4.3.2.2, 4.3.2.3, 4.3.5.4, 4.3.5.5.1, 4.3.7.4.11, 4.3.7.5.2, 6.2.4.1, C.2, and C.2.1 and Figure F.1.)

(1) Nominal system voltage range, phase to phase†	(2) Limited approach boundary*	(3)	(4) Restricted approach boundary* (includes inadvertent movement adder)	(5) Prohibited approach boundary*
	Exposed movable conductor‡	Exposed fixed circuit part		
Less than 50 V	Not specified	Not specified	Not specified	Not specified
50–300 V	3.05 m (10 ft 0 in)	1.07 m (3 ft 6 in)	Avoid contact	Avoid contact
301–750 V	3.05 m (10 ft 0 in)	1.07 m (3 ft 6 in)	304.8 mm (1 ft 0 in)	25.4 mm (0 ft 1 in)
751 V–15 kV	3.05 m (10 ft 0 in)	1.53 m (5 ft 0 in)	660.4 mm (2 ft 2 in)	177.8 mm (0 ft 7 in)
15.1–36 kV	3.05 m (10 ft 0 in)	1.83 m (6 ft 0 in)	787.4 mm (2 ft 7 in)	254 mm (0 ft 10 in)
36.1–46 kV	3.05 m (10 ft 0 in)	2.44 m (8 ft 0 in)	838.2 mm (2 ft 9 in)	431.8 mm (1 ft 5 in)
46.1–72.5 kV	3.05 m (10 ft 0 in)	2.44 m (8 ft 0 in)	991 mm (3 ft 3 in)	660 mm (2 ft 2 in)
72.6–121 kV	3.25 m (10 ft 8 in)	2.44 m (8 ft 0 in)	1.02 m (3 ft 4 in)	838 mm (2 ft 9 in)
138–145 kV	3.36 m (11 ft 0 in)	3.05 m (10 ft 0 in)	1.17 m (3 ft 10 in)	1.02 m (3 ft 4 in)
161–169 kV	3.56 m (11 ft 8 in)	3.56 m (11 ft 8 in)	1.29 m (4 ft 3 in)	1.14 m (3 ft 9 in)
230–242 kV	3.97 m (13 ft 0 in)	3.97 m (13 ft 0 in)	1.73 m (5 ft 8 in)	1.57 m (5 ft 2 in)
345–362 kV	4.68 m (15 ft 4 in)	4.68 m (15 ft 4 in)	2.79 m (9 ft 2 in)	2.64 m (8 ft 8 in)
500–550 kV	5.8 m (19 ft 0 in)	5.8 m (19 ft 0 in)	3.61 m (11 ft 10 in)	3.45 m (11 ft 4 in)
765–800 kV	7.24 m (23 ft 9 in)	7.24 m (23 ft 9 in)	4.85 m (15 ft 11 in)	4.70 m (15 ft 5 in)

**See the "Boundary" definitions in Clause 3. See also Clause 4.3.2.4.3 and Annex C.*

†For single phase systems, 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.

Note: *For the arc flash protection boundary, see Clause 4.3.3.2.*

***The following table has been extracted from CSA Z462-08 Workplace Electrical Safety**

Table 4
Hazard/risk category classifications and use of rubber insulating gloves and insulated and insulating hand tools

(See Clauses 3, 4.3.1.2.2, 4.3.7.3.6, 4.3.7.3.9, 4.3.7.3.10, 4.3.7.3.11, 4.3.7.4.2, B.2, and H.1 and Tables 5 and H.1.)

Task(s) performed on energized equipment	Hazard/ risk category	Rubber insulating gloves required?	Insulated and insulating hand tools required?
Panelboards or other equipment rated 240 V and below[1]			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused-switch operation with covers on	0	N	N
CB or fused-switch operation with covers off	0	N	N
Work on exposed 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)	0	N	N
Work on exposed energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
Panelboards or switchboards rated more than 240 V and up to 600 V (with moulded-case or insulated-case circuit breakers)[1]			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused-switch operation with covers on	0	N	N
CB or fused-switch operation with covers off	1	Y	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on exposed energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y
600 V class motor control centres (MCCs)[2] (except as indicated)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB, fused-switch, or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB, fused-switch, or starter operation with enclosure doors open	1	N	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y

(Continued)

Table 4 (Continued)

Task(s) performed on energized equipment	Hazard/ risk category	Rubber insulating gloves required?	Insulated and insulating hand tools required?
600 V class motor control centres (MCCs)[2] (except as indicated) (continued)			
Work on control circuits with exposed energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts greater than 120 V, exposed	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC[3]	4	Y	N
Application of safety grounds after voltage test	2*	Y	N
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)[3]	4	N	N
Opening of hinged covers (to expose bare energized electrical conductors and circuit parts)[3]	1	N	N
Work on exposed energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y
600 V class switchgear (with power circuit breakers or fused switches)[4]			
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	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused-switch operation with enclosure doors open	1	N	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts greater than 120 V, exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds after voltage test	2*	Y	N
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)	4	N	N
Opening of hinged covers (to expose bare energized electrical conductors and circuit parts)	2	N	N

(Continued)

Table 4 (Continued)

Task(s) performed on energized equipment	Hazard/ risk category	Rubber insulating gloves required?	Insulated and insulating hand tools required?
Other 600 V class (277 to 600 V, nominal) equipment[2]			
Lighting or small power transformers (600 V, maximum)	—	—	—
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)	2*	N	N
Opening to hinged covers (to expose bare energized electrical conductors and circuit parts)	1	N	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds after voltage test	2*	Y	N
Revenue meters (kW-h 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 safety grounds after voltage test	2*	Y	N
Insertion of or removal of plug-in devices into or from busways	2*	N	N
NEMA E2 (fused contactor) motor starters, 2.3 to 7.2 kV			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2*	N	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts greater than 120 V, exposed	3	Y	Y
Insertion or removal (racking) of starters from cubicles, doors open or closed	4	N	N
Application of safety grounds after voltage test	3	Y	N
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)	4	N	N
Opening of 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	0	N	N

(Continued)

Table 4 (Continued)

Task(s) performed on energized equipment	Hazard/ risk category	Rubber insulating gloves required?	Insulated and insulating hand tools required?
Metal-clad switchgear, 1 to 38 kV			
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	0	N	N
CB operation with enclosure doors open	4	N	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with exposed energized electrical conductors and circuit parts greater than 120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds after voltage test	4	Y	N
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)	4	N	N
Opening of hinged covers (to expose bare energized electrical conductors and circuit parts)	3	N	N
Opening of voltage transformer or control power transformer compartments	4	N	N
Arc-resistant switchgear Type 1 or 2 (for clearing times of less than 0.5 s, with a protective fault current not to exceed the arc-resistant rating of the equipment)			
CB operation with enclosure door closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	0	N	N
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or off the bus, door closed	0	N	N
Other equipment 1 to 38 kV			
Metal-enclosed interrupter switchgear, fused or unfused	—	—	—
Switch operation of arc-resistant type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on exposed energized electrical conductors and circuit parts, including voltage testing	4	Y	Y

(Continued)

Table 4 (Concluded)

Task(s) performed on energized equipment	Hazard/ risk category	Rubber insulating gloves required?	Insulated and insulating hand tools required?
Other equipment 1 to 38 kV (continued)			
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)	4	N	N
Opening of 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

Notes:

[1] *Maximum of 25 kA short-circuit current available and maximum of 0.03 s (2 cycle) fault-clearing time.*

[2] *Maximum of 65 kA short-circuit current available and maximum of 0.03 s (2 cycle) fault-clearing time.*

[3] *Maximum of 42 kA short-circuit current available and maximum of 0.33 s (20 cycle) fault-clearing time.*

[4] *Maximum of 35 kA short-circuit current available and maximum of 0.5 s (30 cycle) fault-clearing time.*

(1) *In this Table, "2*" is a hazard/risk category designation. The asterisk is not being used to reference a specific note to this Table.*

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

(3) *Insulated and insulating hand tools are tools*

(a) rated and tested for the maximum line-to-line voltage on which work will be done; and

(b) manufactured and tested in accordance with CAN/ULC-D60900 or ASTM F 1505.

(4) *For systems rated less than 1000 V, the fault currents and upstream protective device clearing times are based on a 46 cm (18 in) working distance.*

(5) *For systems rated 1 kV and greater, the hazard/risk categories are based on a 91 cm (36 in) working distance.*

(6) *For equipment protected by upstream current-limiting fuses with arcing fault current in their current-limiting range (1/2 cycle fault-clearing time or less), the hazard/risk category required may be reduced by one level.*

(7) *See Table 5 for a list of protective clothing and personal protective equipment for each hazard/risk category.*

4.3.7.3.10 Protective clothing and personal protective equipment

Once the hazard/risk category has been identified from Clause 4.3.7.3.9 and Table 4 (including associated notes), Table 5 shall be used to determine the required personal protective equipment (PPE) for the task. Table 5 specifies requirements for protective clothing and other protective equipment based on hazard/risk category numbers 0 to 4. This clothing and equipment shall be used during work within the arc flash protection boundary.

Notes:

(1) *See Annex H for a suggested simplified approach to ensure adequate PPE for electrical workers in facilities with large and diverse electrical systems.*

(2) *The requirements of this Clause are intended to protect workers from arc flash and shock hazards. While some situations could result in burns to the skin, even with the protection specified in Table 5, burn injury will likely be reduced and be survivable. Due to the explosive effect of some arc events, physical trauma injuries can occur. The requirements of this Clause do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.*

***The following table has been extracted from CSA Z462-08 Workplace Electrical Safety**