

## ALERT

### Electrical hazards

It has come to the attention of the Education Safety Association that most of our clients are missing an important component in their policies and procedures for electrical safety.

ESAO conducted an informal survey of a group of our clients to determine how many had policies and procedures for electrical safety. What we found was that most organizations had some form of basic electrical safety and many had formal lockout procedures but most organizations lacked any procedures to deal with staff or contractors working on energized (live) circuits.

Most organizations assume that since they have an electrical and/or a lockout procedure requiring the de-energizing (removal or isolation) of power sources before work is performed on those circuits they were covered and safe from accidents. The difficulty with this approach is that it ignores the reality that some tests, such as testing power sources or line voltages and performing some types of maintenance work, can only be performed on an energized system. The other issue of concern is the issue of when is a voltage 'safe' to work with or near. There is no clear answer to this question! It depends on the equipment involved and the area where the work is carried out. Even a flashlight is dangerous in some hazardous locations!

The concern becomes greater when the use of low voltage controllers, communication systems and monitors is considered. Most of these devices are designed to use voltages and current levels that are non-hazardous in the normal work environment. This makes them intrinsically safe in the work place **OR DOES IT?**

- Do the devices meet the appropriate CSA/UL standards for low voltage isolation?
- Are the main control devices or monitors directly connected to a high voltage power source?
- Do the wires run in the same areas as high voltage wiring?
  - Are they properly identified?
- Are the low voltage devices located in the same area as the main electrical power systems?

**Or**

- To simplify the questions could the person working on a low voltage powered system be exposed either accidentally or as a result of the design to a lethal higher voltage?

**YOU NEED POLICIES AND PROCEDURES FOR WORKING ON ENERGIZED (LIVE) CIRCUITS AND EQUIPMENT.** These policies and procedures must include guidelines for individuals who work primarily on low voltage equipment.

ESAO has placed several documents on the ESAO WEB site to assist our clients in addressing these concerns and developing appropriate policies and procedures. These are not intended to be final documents but to serve as resources for the development of your own procedures. They will have to be modified to suit each organization and the type of work performed.

The documents are:

1. 'Working on Indoor Energized Electrical Systems - Standards for Personal Protection'
2. 'Working on Indoor Energized Electrical Systems - Legal Requirements / Legislative Extracts'
3. 'Working on Indoor Energized Electrical Systems - Contents of Policies and Procedures'

# ESAO Resource

## Information to Assist with the Development of Policies and Procedures for Working on Indoor Energized Electrical Systems Standards for Personal Protection

### Classification of Voltages Used for Safety Equipment:

Class 00	– Up to 500 volts
Class 0	– Up to 1000 volts
Class 1	– Up to 7500 volts
Class 2	– Up to 17,000 volts
Class 3	– Up to 26,500 volts
Class 4	– Up to 36,000 volts

### Clothing Requirements for Different Classifications of Electrical Hazards

FR – 'fire retardant'

'Arc Rating' – energy released by electrical arcing, which causes burns. Expressed in calories per centimeter squared per second

#### When is protective clothing required?

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	feet
50 to 750	0.9	3
750 to 2 000	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/cm <sup>2</sup>	<ul style="list-style-type: none"> <li>- operating an exposed breaker up to 240 volts</li> <li>- using a meter switch over 1000 volts</li> </ul>
Risk Category 1	1.3 to 4 cal/cm <sup>2</sup>	<ul style="list-style-type: none"> <li>- voltage testing or installing a breaker in a live panel up to 240 volts.</li> <li>- Operating an exposed circuit breaker up to 600 volts</li> </ul>
Risk Category 2	4.1 to 8 cal/cm <sup>2</sup>	<ul style="list-style-type: none"> <li>- work on control circuits above 120 volts changing live breakers up to 600 volts</li> <li>- voltage testing and parts at or above 600 volts</li> </ul>
Risk Category 3	8.1 to 25 cal/cm <sup>2</sup>	<ul style="list-style-type: none"> <li>- starter "buckets at 600volts</li> </ul>
Risk Category 4	25.1 to 49 cal/cm <sup>2</sup>	<ul style="list-style-type: none"> <li>- voltage testing and working on parts at or above 1000 volts</li> </ul>

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/yd <sup>2</sup> .	<ul style="list-style-type: none"> <li>- 100% cotton shirt</li> <li>- jeans or</li> <li>- 100% cotton slacks</li> </ul>
1	FR shirt and FR pants or FR coverall.	<ul style="list-style-type: none"> <li>- Nomex clothing</li> <li>- FR pants</li> <li>- Denim jeans &gt; 12 oz/yd<sup>2</sup></li> </ul>
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	

## 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.

## Tool Requirements

All tools must be insulated and certified for voltages above any voltages expected.

Proper/certified fuse pullers and other specialized electrical tools must be used.

## 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/cm<sup>2</sup> 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

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 ( $\Omega$ ) in orange, denoting electrical shock resistant soles.

## Head Protection Requirements

Loose hair must 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

## Personal Protective Equipment Standards for Energized Electrical Work (ASTM standards):

**Note** The ASTM standards below refer to Rubber. The items do not have to be made of rubber as long as the material used has similar (or better) electrical resistance as rubber.

### 1. Gloves:

Standard: ASTM D120-95 '*Standard Specification for Rubber Insulating Gloves*'

- Must be of seamless manufacture and clearly marked for electrical use and class.
- The gloves used must be rated for the maximum voltage the worker could make contact with.

Voltage classes and identifier colour codes:	Class 00	- beige
	Class 0	- red
	Class 1	- white
	Class 2	- yellow
	Class 3	- green
	Class 4	- orange

Types – I – not ozone resistant  
II – ozone resistant

Electrical protective gloves are generally soft and easily subject to mechanical and chemical damage. For general work when dexterity is not required they should be used with leather protectors to provide mechanical protection.

### Leather Protectors:

Standard: ASTM F696-97 '*Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens*'

### 2. Sleeves

Standard: ASTM D1051-95 '*Standard Specification for Rubber Insulating Sleeves*'

- Same as gloves

### 3. Blankets

Standard: ASTM D1048-99 '*Standard Specification for Rubber Insulating Blankets*'

- Blanket should be labelled with the rating.
- Damaged or frayed edges of blankets should be trimmed.

### 4. Insulating Covers

Standard: ASTM D1049-98 '*Standard Specification for Rubber Insulating Covers*'

- Same as gloves

### 5. Insulating matting

Standard: ASTM D178-93 (1998) '*Standard Specification for Rubber Insulating Matting*'

- Same as gloves

### 6. Insulator in tools

Standard: ASTM F711-97 '*Standard Specification for Fiberglass Reinforced Plastic (FRP) Rod and Tube used in Live Line Tools*'

- Statement of standard and voltage met should be embedded in the tubing or on a permanent label attached to a tool manufactured using the tubing.

## Testing Requirements for personal protective equipment

Wear, tears, cracks, dents and chemicals or metal embedded in the surface can make protective equipment ineffective. Some items can be checked by the user; however many items should only be checked by a qualified person. Check the manufacturer's recommendations. The following list indicates how often personal protective equipment should be checked.

- |                     |   |
|---------------------|---|
| General insulating  | - when there is any indication that insulating value is suspect |
| Insulating covers   | - when there is any indication that insulating value is suspect |
| Insulating blankets | - before first issue and every 12 months                        |
| Insulating gloves   | - before first issue and every 6 months                         |
| Insulating sleeves  | - before first issue and every 12 months                        |
| Others              | - the user must visually inspect each item each day before use  |

# ESAO Resource

## Information to Assist with the Development of Policies and Procedures for Working on Indoor Energized Electrical Systems

### Contents of Polices and Procedures

#### Legal references:

1. Ontario Electrical Safety Code (Canadian Electrical Safety Code with Ontario Amendments)
2. CSA 22.2 No.950 / UL1950 – 'Safety of Information Technology Equipment, Including Electrical Business Equipment.'
3. ASTM Specifications for PPE for Electrical Work
4. IEC 1010 and CAT(category) III standards for equipment
5. NFPA 70B - 'Recommended Practice for Electrical Equipment Maintenance'
6. NFPA 70E- 'Standard for Electrical Safety in the Workplace'

ASTM - ASTM International / American Society for Testing and Materials  
CSA - CSA International / Canadian Standards Association  
IEC - International Electrotechnical Commission  
NFPA - National Fire Protection Association  
UL - Underwriter Laboratories Inc.

This reference material is titled '*Supplemental Policies*' and '*Supplemental Procedures*' because the assumption has been made that the employer using this information already has an *Electrical Policy and Procedures* as well as a *Lockout Policy and Procedures*.

#### Some definitions:

##### 'Qualified Person':

The *Ontario Electrical Safety Code* defines a qualified person as:

'Qualified person means one familiar with the construction and operation of the apparatus and the hazards involved'

##### 'Authorized Person':

The *Ontario Electrical Safety Code* defines a qualified person as:

'means a qualified person who, by the nature of their duties or occupation, is obliged to approach or handle electrical equipment; or a person who, having been warned of the hazards involved, has been instructed or authorized to do so by someone having authority to give the instruction or authorization.'

##### 'Competent Person'

The *Occupational Health and Safety Act* defines a competent person as:

"competent person' means a person who,

- (a) is qualified because of knowledge, training and experience to organize the work and its performance,
- (b) is familiar with this Act and the regulations that apply to the work, and
- (c) has knowledge of any potential or actual danger to health or safety in the workplace;'

## Some suggested content for:

# Policies - Energized Electrical Systems

## SUPPLEMENTAL ELECTRICAL SAFETY FOR 'LIVE' EQUIPMENT AND WIRING

### General:

Electrical work may only be performed by a knowledgeable worker qualified by the appropriate training and / or knowledge and experience to perform the type of work involved. The worker must know the risks and hazards associated with the process, the equipment, the work area and any adjacent areas affected by the work.

***Work 'Permits' or an 'unusual hazards' electrical work approval process should be developed.***

*The approval process for working on energized (live) equipment or services over 45 volts could be modeled on a 'confined space permit'.*

### Second Person – 'Safety Monitor'

Where a worker is either working on live equipment;

or

where a worker is near exposed live electrical equipment or wiring and, because of the nature of the work or the conditions and/or the location of the work place, it is necessary for another person to be in the area to ensure the safety of the worker, a second worker who is not engaged in the work must be appointed by the supervisor as a 'safety monitor'.

The function of the 'safety monitor' is to:

- 1) warn other people in the area of the hazard; and
- 2) ensure that all safety precautions and procedures are complied with.

A 'safety monitor' must be:

- 1) informed of the duties of a 'safety monitor' and of the hazards involved in the work;
- 2) trained and instructed in the procedures to follow in the event of an emergency;
- 3) authorized to immediately stop any part of the work that the monitor considers dangerous; and
- 4) not have any other duties or interruptions that might interfere with the duties as 'safety monitor'.

### Safety Procedures

All testing or work performed on electrical equipment must be performed by a qualified person or a worker under the direct supervision of the qualified person.

Where the electrical equipment has a voltage in excess of 120 V (?) between any two conductors or between one conductor and ground:

1. the qualified person, and any individuals assisting, must use all required insulated protection equipment and tools necessary to protect themselves from injury during the performance of the work; and
2. all employees working with, or near, the live electrical equipment must be instructed and trained in the use of the insulated protective equipment and tools.

Where electrical equipment is not live, but is capable of becoming live:

1. no employee is to work on the equipment unless it is completely isolated by a locking device,
2. a safety ground is properly connected to that equipment, and
3. the equipment is locked out as required by the (*name of your organization*) lockout procedures.

## **Rubber Gloves and Mitts**

Gloves and mitts issued, or available, to workers must be tested by the worker before being used. Visual and air testing methods are to be used for daily checks

Gloves and mitts issued to or available for use by a worker are to be electrically retested following the CAN/CSA Z259.4-M standard after a maximum of four months usage. Testing must be carried out by an approved testing facility. For added personal safety, it is strongly recommended that any type 3 (30,000 volts) gloves and all frequently worn rubber gloves be electrically retested every 60 days.

## **Qualified Person**

Where there is a dispute regarding the term 'qualified person' for purposes of this occupational safety and health standard, the following procedure will be used:

1. The worker or other individual(s) with concerns must raise the matter directly with the supervisor in charge of the area or work.
2. The employee's supervisor will review the employee's qualifications, level of knowledge and experience and decide upon the employee's status and work limitations as a qualified person.

## **Requirements of the 'Electrical Safety Monitor'**

Safety monitors must be present during any work that may breach exclusion zones or during work involving energized equipment or wiring. The 'monitor' does not need to be a licensed electrician or be able to perform the electrical work themselves.

The requirements the 'safety monitor' meet are that they:

1. are competent in emergency electrical response;
2. are aware of hazards and risks;
3. be competent to observe, warn and communicate effectively;
4. warn other individuals about unsafe approaches to the electrical equipment;
5. are competent to assist with the electrical work;
6. are authorized to stop the work if necessary; and
7. not be assigned to other duties while monitoring.

To 'assist' means to facilitate the performance of the work and:

1. be competent in isolation techniques;
2. be competent to rescue the person performing the electrical work; and
3. be able to provide direct assistance in an emergency; and if necessary
4. able to provide resuscitation (assessed in the last 6 months).

## **Live test**

When Lockout Procedures are being used no employee is to give a 'guarantee' of isolation for the performance of a test on isolated electrical equipment where an auxiliary power source could make the equipment live. This does not apply when any live test to be performed on the electrical equipment will not be hazardous to the safety or health of the person performing the live test.

Where a 'guarantee' of isolation for the performance of a live test of isolated electrical equipment is given to a person in charge of the test, that person then becomes the person in charge of the tests, the work area and all related equipment, while the test is being performed. That person is also the person in charge of any other work that is being performed on the equipment while the 'guarantee' is in effect.

Every person performing a live test must warn all people who, during or as a result of the test, are likely to be exposed to a hazard.

Unless otherwise specified in writing by a competent electrical safety person; no employee is to work on or near live electrical equipment or wiring unless the employee is wearing outer clothing with full-

length sleeves fastened at the wrists and the clothing is fabricated from tightly woven natural materials as outlined in the electrical work clothing requirements (NFPA 70E).

### **Testing of insulated clothing, equipment and tools**

Determination of the protective clothing and equipment to be used is to be based on the appendices attached to this policy.

Every article of insulated protective clothing, insulated equipment and insulated device or tool referred to in this policy must be designed, constructed and maintained to ensure it remains safe, adequate and reliable under all conditions of its intended use.

Unless each article has been certified by a recognized testing agency before initial use, it must be checked and tested by a qualified person. It also must be tested annually (or more frequently) using an approved method to ensure it retains its integrity.

No employee is authorized to work on electrical equipment unless that employee uses all protective and insulated clothing and equipment as required or is necessary to ensure their safety.

### **Electrical Test Equipment Inspections**

#### **1) Visual:**

Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected daily for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item is to be removed from service, and it can not be used until repairs and tests necessary to render the equipment safe have been made.

#### **2) Specification Check:**

Look for the 1000-volt, CAT III (or 600-volt, CAT IV - not recommended for main panel boxes) rating on the front of meters and testers, and a 'double insulated' symbol on the back. There should be approval symbols from two or more independent testing agencies, such as CSA, UL, CE or TUV.

Ensure that the amperage and voltage of meter fuses is correct. Fuse voltage must be as high or higher than the meter's voltage rating and able to support the full surge current of the maximum listed voltage at the voltage input terminals. Test equipment must perform properly in the presence of impulses on volts and amps measurement functions. Ohms and continuity functions are required to handle the full meter voltage rating without becoming a hazard.

Check the instrument's specifications to verify that the ohms and continuity circuit is protected to the same level as the voltage test circuit. If the manual does not include that information, the supplier should be able to determine whether the meter complies with IEC61010 or ANSI S82.02.

### **Separation of access to hazardous and non- hazardous wiring and equipment**

Every reasonable attempt must be made to keep electrical wiring and equipment used for communications and covered by CSA standard 22-950 separate from higher voltage electrical power wiring and equipment.

Where any of the following conditions occur:

- 1) electrical power is supplied to communication equipment using hard wiring into a panel box; or
- 2) the electrical power panels are located in the same electrical room; or
- 3) the wiring for the electrical power supply and the wiring for the communications system share the same or similar conduits or raceways.

the panel boxes and / or wiring must be clearly identified as to the hazard and voltages.

Electrical power panel boxes, breaker boxes and any equipment which could be a hazard must be isolated or secured in a manner which prevents a communication specialist, or an unqualified person,

from accidentally; or within reason; intentionally opening any box or accessing any other source of voltage over the voltages determined to be safe as defined by CSA standard 22.2 No 950.

The power lines into the communication panels must be protected in a manner so that a communication specialist, or an unqualified person, can not make accidental contact with any voltage defined as hazardous in CSA standard 22.2 No 950

# Some suggested content for: Procedures - Energized Electrical Systems

## SUPPLEMENTAL ELECTRICAL SAFETY FOR 'LIVE' EQUIPMENT AND WIRING

When working on an electrical system always consider exposed electrical parts to be 'live' until you have personally ensured that they have been properly disconnected and locked/tagged out and it has been verified that the equipment is off and all components which could store a charge have been discharged!

Electrical wiring and equipment may be:

1. De-energized:  
Which means that any source of energy (electrical, mechanical, pneumatic, chemical, hydraulic) has been removed, lock/tagged out, and the removal or 'isolation' has been verified or 'guaranteed' before the work is started. *Lockout/Tagout* (see Lockout Procedures) is the placement of a padlock and/or a warning tag on an energy-isolating device (disconnect) which ensures that equipment being controlled cannot be operated until the lockout device is removed.
2. Energized (live):  
This means that the equipment is energized, or some energized parts of the equipment, have either not had all sources of electrical power turned off, or are not locked/tagged out, or are in the 'on' position.  
Live parts which a worker could make contact with must always be turned off and de-energized unless:
  1. The de-energization of the equipment is not possible, due to the design of the equipment or the necessity of checking a power source or power function.
  2. The de-energization of the equipment will cause an additional or increased hazard such as deactivation of emergency alarm systems, shutdown of hazardous location ventilation systems, or removal of illumination for an area.

If it is determined that work on energized electrical equipment is necessary, safe work practices, as outlined in these policies and procedures, must be followed to prevent injury or death while the work is in process. Safe work practices include following safe procedures, using the correct personal protective equipment, using insulated tools, ensuring a 'safety monitor' is present, and having an emergency plan in place and ensuring appropriate on the job training had taken place.

## Personal Protective Equipment

All workers who work in/around energized equipment and have the potential to come into contact with 'live' exposed parts must be provided with and use Personal Protective Equipment (PPE).

The following guidelines must be followed:

- 1) PPE must be used whenever there is a chance of coming into contact with exposed electrical parts. This includes simple operations such as resetting a switch inside a piece of equipment or a panel box that contains exposed live wires, connectors or contacts. .
- 2) The PPE used must be appropriate for the work being performed. Ensure that electrical rated gloves, insulated tools, and other test equipment or protective devices are rated in excess of the voltage levels they will be used around. Electrically rated tools must be clearly labeled with the level of voltage for which they are approved. Never exceed the tool's electrical rating!
- 3) Always inspect electrical tools and PPE before each use to make sure they are in good condition and work properly. If a tool has been damaged, or the PPE has tears or holes, replace the item(s) before conducting the assigned work. In order to protect electrical

insulated gloves from puncture, they can be worn under thicker, heavier electrically rated leather gloves.

- 4) Wear non-conductive head protection if working in a location that presents a possible electrical hazard to the head (bumping into exposed lines, parts, etc.).  
Head Protection: Class 'E' (Electrical): is tested using 20,000 volts; or  
Class 'G' (General): is tested using 2,200 volts
- 5) Wear eye and face PPE, such as an approved electrical face shield and safety glasses, (on higher voltages a chin cup is required) whenever there is a possibility of electrical arcs or explosion. Non-conductive safety glasses with side shields should always be worn underneath a face shield. A face shield alone does not provide enough protection.
- 6) All test instruments and equipment (volt, amp, ohm meters) and associated leads, cables, power cords, probes, and connectors must be visually inspected for external defects and damage before the equipment is used. If any defect or damage is noted remove the item from service.
- 7) All electrical workers are required to wear electrically rated steel-toed boots, identified with the omega symbol ( $\Omega$ ), at all times.
- 8) Utilize approved electrical tools and fuse handling equipment that is insulated in excess of the circuit voltage indicated on the box. Never use a non-insulated tool to remove a fuse.
- 9) You may need to utilize insulating materials, such as non-conductive matting and insulated blankets. They are intended to provide a barrier between your body and the energized parts.

## Safe Work Practices

The following work practices are part of all live electrical work procedures:

- 1) When normally enclosed live parts are exposed for maintenance or repair, they must be guarded to protect people from making accidental contact. Barricades can be used. If barricades are not sufficient, then an 'Electrical Safety Monitor' must be used.
- 2) Safety signs and tags must be used to warn employees of electrical hazards.
- 3) Never approach, or take any conductive object without an approved insulating handle, closer than 1 meter to any exposed energized parts. Approved electrical gloves, sleeves and/or tools must be utilized if approaching closer than 1 meter.
- 4) Conductive items must not be worn in the vicinity or while working on exposed energized parts.  
Examples of items to avoid - jewelry, body jewelry, watch bands, bracelets, rings, key chains, necklaces, hair bands, conductive buttons, metal zippers or zipper parts, coins, etcetera.
- 5) Always use non-conducting ladders intended for electrical work when working around electricity. Ensure the ladder is clear of oils, grease or spilled liquids which could conduct electricity.
- 6) Do not work on circuits in wet locations or on outside outlets which don't have GFCI's (ground fault circuit interrupters) to prevent the worker's body from becoming the path to ground for 'leaking' current.
- 7) Ensure that all electrical boxes remain accessible at all times and never place equipment, etc. in front of them. Flammable and combustible materials should not be stored in electrical equipment rooms at any time.
- 8) Use instructions, signs, or barriers to protect people from electrical hazards. Always consider electrical equipment energized unless proven otherwise.
- 9) Never modify electrical devices beyond the intent of their design.

## Rescue Procedures

A person working on live power voltage should never be working alone. A 'Safety Monitor', who can assist the worker, but not in the hazardous zones should be present.

Electricity, even at voltages of 115V, can cause severe injury or death by causing a person's heart or lungs to stop working. Electricity can also cause minor to severe burns. Serious electrical burns often appear to be minor since most of the damage to body tissues and organs is internal.

If a worker has come into contact with electricity the worker may not be able to remove themselves from the electrical source.

**DO NOT ATTEMPT TO PULL THE PERSON FROM THE ELECTRICAL SOURCE WITH YOUR BARE HANDS, YOU MAY BE ELECTROCUTED.**

The human body is a good conductor of electricity. If you touch a person while they are in contact with the electrical source, the electricity will flow through your body causing electrical shock. Always attempt to turn off the source of the electricity (disconnect). If the electrical source can not readily and safely be turned off, **use a non-conducting object**, such as a fiber glass object or a wooden pole, to remove the person from the electrical source. Emergency medical services should be called as soon as possible.

When the victim has been removed from the electrical source, check to see if the person is breathing and if they have a pulse. If necessary, administer CPR (if you are trained) until emergency personnel arrive at the scene.

Never go near a victim that has been electrocuted by a high voltage transformer or line, even if they are no longer in direct contact with the power source, because electricity from the line or other source can arc several feet through the air and you could be electrocuted.

# ESAO Resource

## Information to Assist with the Development of Policies and Procedures for Working on Indoor Energized Electrical Systems Legal Requirements / Legislation Extracts

### Ontario (Canadian) Electrical Safety Code

#### Ontario amendments to the Canadian Electrical Safety Code

**2-000 Scope** - This Code does not apply to:

"(b) Electrical equipment and electrical installations in communication systems from the transformer or other current limiting device used at the junction of the communication system with the electric circuit supplying the communication system;"

(CSA 22.2 No. 950 "Safety Standard for Information Technology Equipment" applies.)

Exception: The code applies to low voltages, including batteries, in hazardous / flammable areas.

#### Defined Voltage Levels

- Extra low voltage      - up to 30 V
- Low voltage              - 31 to 750
- High voltage above      - 750 volts

#### General and Safe Work Rules

The Ontario Electrical Safety Code sets safety standards and guidelines for the installation and maintenance of wiring and electrical equipment. The intent of the code is to prevent electrical fire, electrical failures, and shock hazards by referencing or setting minimum standards for materials used as well as how they are installed and tested.

#### Section 2 - Working safely

This gives very general rules on working safely and using personal protection when operating and maintaining electrical equipment. It provides minimum standards for clearances and some guidance on how to arrange electrical facilities so as to reduce electrical hazards. These are minimal the minimum safety requirements for working with electrical equipment and are intended to be used with other regulations, guidelines, standards and best practices.

#### 2-302 - Hazardous Locations

Prohibits alterations and repairs on energized (live) equipment and equipment in hazardous locations and requires that all electrical equipment in hazardous locations be maintained in its original, safe condition. The rule is not very specific but it does say that; except for approved, intrinsically safe instruments; electrical tools and equipment must meet the standards for use in each hazardous location as well as electrical safety requirements.

#### 2-304 - Energized Electrical Work

Prohibits working on live electrical equipment unless absolutely necessary. This section recognizes that there are times when shutting down power may be impracticable or when inspection and testing of live equipment becomes necessary. This section also requires a lockout procedure, warning signs and "monitors or sentries" to ensure that equipment is not accidentally re-energized while people are working. This section is intended to be used in conjunction with other legislated requirements, such as the Industrial Regulations; standards, such as NFPA 70 (US National Electrical Code) and guidelines, such as lockout procedures, disconnection procedures and working with live equipment.

## **2-306 - Personal Protection**

This sets some basic standards for personal protection when work must be performed with the power on. It states that the following personal protective equipment must be used but gives no specific details. Use tongs, rubber gloves, footwear and rubber mats to isolate workers from electrical shock risks and make the task as safe as possible.

Not included in this list are fire-resistant clothing, face and eye protection, head protection and other precautions also required to protect a worker from harmful effects of an electrical flash or explosion. This section must also be used in conjunction with other standards and guidelines.

## **2-308 - Clearances**

Defines clearances around electrical panels and other equipment requiring electrical servicing as a minimum of one meter with secure footing working space at all locations where access is required for operation or maintenance. This clearance always applies to the front, but may also apply to the sides or backs of equipment where access is necessary. The prescribed minimum distance is in addition to any space necessary for devices such as draw-out circuit-breakers or motor starters when in their fully drawn out positions. The rule also refers to minimum working space around bare live parts.

## **2-310 - Exits Paths**

This requires that when equipment is rated at or above 1200 amperes or above 750 volts, the route to the exit of the room (means of egress) must be clear and at least 1.5 meters wide. The electrical room access doors must also be capable of being opened from inside the room without using a key or tools.

## **2-312 to 2-320 Storage and Misc.**

Require that working space and exits not be blocked by storage, that flammable materials not be stored near electrical equipment and that adequate lighting and drainage be provided.

# **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.

## **CSA International (Canadian Standards Association)**

### **CSA 22.2 No. 950/UL 1950**

#### **Safety Standard for Information Technology Equipment, IEC 60950**

##### **Hazardous Energy Level**

A stored energy level of 20J or more, or an available continuous power level of 240 VA or more, at a potential of 2V or more.

##### **Hazardous Voltage**

A voltage exceeding 42.4V peak or 60V d.c., existing in a circuit which does not meet the requirements for either a Limited Current Circuit or a TNV Circuit.

## **US Legislated Standards Referenced**

### **Definition of hazardous voltage in the National Electric Code (NEC):**

A hazardous voltage is a voltage greater than 50 V. (Article 720) [SEMI S2-93]

### **NFPA 70E and OSHA**

US standards referred to in Canadian legislation. The US and Canada are in the process of harmonizing regulations and standards and these US standards will probably apply in Canada. These standards currently set the requirements for electrical hazard classes, personal protective equipment and best practices.