

Electrical Safety

Guideline

Office of Risk Management

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INTRODUCTION

The University of Ottawa is committed to providing a healthy and safe work and educational environment for all of its employees, students and visitors. The intent of this document is to provide general information on electrical safety and an overview of the legislation applicable in Ontario. It does not replace any relevant laws, regulations or codes for which the University must comply. When applicable, consult the Occupational Health and Safety Act, the Industrial Establishments Regulation, the Construction Projects Regulations, and / or the Ontario Electrical Safety Code for detailed information and specific requirements and restrictions.

OBJECTIVE

These guidelines provide information to the university community to safely use common electrical equipment, supplies or devices. The document also describes elements to consider prior to using new equipment or used equipment newly acquired in order to ensure your safety and that it meets current regulation, code or standard.

SCOPE

This document applies to anyone within the University of Ottawa workplace such as employees, students, contractors, volunteers as well as visitors who may be exposed to potential electrical hazards.

TRAINING AND EDUCATION

According to the Ontario Occupational Health and Safety Act and its Regulations:

Ontario Regulation 213/91, section 182:

- 182.** (1) No worker shall connect, maintain or modify electrical equipment or installations unless,
- a) The worker holds a certificate of qualification issued under the *Ontario College of Trades and Apprenticeship Act, 2009*, that is not suspended, in the trade of,
 - i. electrician — construction and maintenance, or
 - ii. electrician — domestic and rural, if the worker is performing work that is limited to the scope of practice for that trade; or
 - b) The worker is otherwise permitted to connect, maintain or modify electrical equipment or installations under the *Ontario College of Trades and Apprenticeship Act, 2009* or the *Technical Standards and Safety Act, 2000*.

RESPONSIBILITIES

According to Policy 77 of the University of Ottawa

Principal Investigators, Supervisors and those in Authority

- Must incorporate preventive measures in all functions and activities in which there may be some incident or accident with health-related consequences;
- Must provide information, instruction, and supervision to employees to protect their health or their safety;
- Must provide safety training opportunities for all their personnel;
- Must ensure that employees under their authority use or wear the equipment, protective devices or clothing required;
- Provide equipment, materials and protective devices, and ensure they are maintained in good condition and used as prescribed under the OH&S Act

Workers

- Must work in compliance with the provisions of the *OH&S Act* and all health and safety procedures and instructions;
- Must use or wear the equipment, protective devices or clothing that the University requires to be used or worn and report to their supervisors the absence of or defect in any equipment or protective device of which they are aware and which may endanger themselves or other employees;
- Must report to the appropriate supervisory staff all known health and safety hazards or any violation of the *OH&S Act* or its regulations;
- Must not use or operate any equipment, machine, device or thing or work in a manner that endangers themselves or other employees and not remove or make ineffective any protective device required by the regulation or by the University, without providing an adequate temporary protective device; when the need for removing the protective device has ceased, the original protective device shall be reinstalled immediately

Disciplinary Measures

Employees who contravene this policy are subject to disciplinary measures in accordance with the policies ([Policy 2d Disciplinary Measures for Reprehensible Acts](#)) and collective agreements governing their work conditions.

When non staff personnel violate this policy, the person in charge of the activity taking place must take the necessary measures to have the policy followed.

LEGISLATION

Below are the main requirements related to the use, handling or repair of electrical equipment, according to the *Industrial Establishments Regulation (Reg. 851)*, under the *Occupational Health and Safety Act*.

- *Electrical equipment, insulating materials and conductors shall be,*
 - a) *Suitable for its use; and*
 - b) *Certified by,*
 - i. *The Canadian Standards Associations, or*
 - ii. *The Electrical Safety Authority, as defined in the Electricity Act.*

(Reg. 851, s.40).

- *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. (Reg. 851, s.43).*
- *Cord-connected electrical equipment and tools shall have a casing that is adequately grounded. (Reg. 851, s.44 (1)).*

-It 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. (Reg. 851, s.44 (2)).

-It 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. (Reg. 851, s.44 (3)).

- *When used outdoors or in wet locations, portable electric tools shall be protected by a ground fault circuit interrupter installed at the receptacle or on the circuit at the panel. (Reg. 851, s. 44.1)*
- *A ground fault that may pose a hazard shall be investigated and removed without delay. (Reg. 851, s. 44.2)*
- *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. (Reg. 851, s. 41)*
- *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 installation, equipment or conductors. (Reg. 851, s. 42 (1)).*

Facilities Service developed, in collaboration with the Office of Risk Management (ORM), a lockout procedure. If you need to develop guidelines for your unit, we invite you to consult the Office of Risk Management.

Provisions are provided when lockout is not required. For further information on this, consult Section 42 of the *Industrial Establishments Regulation*.

ELECTRICAL EQUIPMENT

By law, no piece of electrical equipment in Ontario may be sold, displayed or even connected to a source of power unless it is approved (Ontario Electrical Safety Code Rule 2-022).

To ensure the safety of everyone on campus, and to meet current Ontario legislation, all electrical equipment must be suitable for its use and certified by:

- i. The Canadian Standards Association (CSA); or
- ii. The Electrical Safety Authority (ESA); or

- iii. An equivalent certifying organization.

The Ontario Electrical Safety Code recognizes certification organizations accredited by the Standards Council of Canada to approve electrical equipment. Only equipment bearing one of the marks or labels shown in Appendix 1 is approved.

The Electrical Safety Authority (ESA) warns the Ontario public that unapproved electrical products present a high-risk of potential electrical shock and fire hazard. Prior to obtaining electrical products, verify the existence of a certification mark from a recognized certification agency.

GENERAL PRECAUTIONARY MEASURES FOR ELECTRICAL HAZARDS

The following tips will provide you with general information on electrical safety:

- Verify that all electrical equipment is “approved” with recognized approval markings to ensure they meet the electrical safety requirements for Ontario.
- Electrical equipment that is plugged into a power source should NEVER be handled if your hands or feet are wet.
- Do not allow cables and plugs to get wet. Keep liquids away from electrical equipment.
- Electrical equipment used in wet locations must be protected with a GFCI (Ground-Fault Circuit Interrupter).
- Unplug equipment by pulling on the plug, not the cord.
- Damaged electrical equipment that constitutes an electrical hazard is not to be used until properly repaired and / or replaced.
- Never connect electrical cords in a series (i.e. power bar to power bar, extension cord to extension cord, or in combination).
- Multiple outlets and power bars should have an automatic circuit breaker, surge protector and on/off switch.
- All electrical circuit disconnects or panels must have free access to them (i.e. not blocked). The standard is 1 meter.
- Know the manufacturer’s recommended limits on the use of the electrical product(s) and follow those recommendations precisely. These limits may be found on written instructions that accompany the electrical product.
- Ground pins on the plugs and the devices plugged into the receptacles must be intact.
- Do not use any personal electrical equipment without proper approval from your supervisor (i.e. personal heaters, electronics, kettles, coffee machines, etc.).
- Do not store flammable liquids near electrical equipment.

For qualified personnel only (see TRAINING AND EDUCATION)

- Evaluate the risk prior to initiating any electrical work, please refer to section 11.
- Prior to working on electrical equipment, de-energize the power source. Lock and tag the disconnect switch. (Please refer to Lock-Out Procedure at:
<http://www.facilities.uottawa.ca/en/documents>)

- Ensure that operating procedures are up to date and appropriate for the working conditions.
- Never leave unprotected systems unattended.
- Use protective equipment such as safety glasses, hard hat, electrically insulated gloves, arc flash suits, etc. when working on live circuits. Consult the [Personal Protective Equipment guideline](#).

Specific Information on Electrical Components

Plugs

- Regularly check for loose or damaged plugs / prongs.
- You should never remove the 3rd prong.
- Use polarized plugs (one large or wide prong and one narrow one). This ensures that the plug is inserted correctly in a socket for proper flow of electrical current.

Electrical Cords

- Electrical cords must be in good working condition before use.
- Inspect electrical cords to ensure they are not frayed or damaged. Examples of damage include loose prongs, splits in the cord jacket / insulation, heat excessively when in use, etc.
- Extension cords or power bars must be three-pronged and appropriately sized for the intended load.
- Ensure that the chosen electrical extension cord capacity is the same size or larger than the electrical cord capacity for the tool.
- Make sure the rating on the cord is the same as, or higher than the number of watts needed by the product that will be plugged into the cord.
- Never overload extension cords. The cord's rating capacity is labeled on the cord. For assistance, see Section 11.
- Extension cords or power bars must not be connected in a series.
- Do not attempt to repair a damaged cord or electrical part yourself. Have it replaced instead.
- Never place cords under carpets, over or through doorways, windows or in paths of travel; this helps to eliminate tripping hazards.
- For **temporary situations**, electrical and extension cords must be adequately protected in the presence of traffic to avoid a safety hazard.
- In the event you need an extension cord, use only one temporarily (i.e. a few hours) and make sure it is long enough between both ends without stretching it too much.
- Electrical and extension cords must not be coiled or looped when in use. Cords generate heat which can damage the insulation.
- Store all electrical and extension cords in an interior location at a temperature greater than 0°C as to not promote deterioration of the cords over time.
- Electrical cords should not be located where flammable chemicals are handled.

Outlets, Multiple Outlets and Power Bars

- Plug only one high-wattage appliance into each receptacle outlet at a time.
- Never overload outlets by plugging in too many plugs or equipment connected in a series.

- Multiple outlets and power bars should be used only for a short-term power source solution.
- Multiple outlet with surge protection, if graded appropriately, can be used for a longer period – for example when used for computers, basic office equipment or low demand equipment.
- If outlets or switches feel warm, shut off the circuit and have them checked by an electrician (i.e. contact 2222 for assistance).
- Multiple outlet surge protectors should be equipped with an automatic circuit breaker. Outlet strips with fuses or without over-current protection should not be used.
- Multiple outlet surge protectors should not have a cord greater than 6 feet in length and must be plugged directly into a wall receptacle.
- Multiple outlet surge protectors are not to be exposed to traffic unless otherwise adequately protected.
- Multiple outlet surge protectors may only be used for appliances that draw no more than 200 watts or less per outlet. Such applications include computer terminals, calculators, cell phones, etc. Other applications, with higher wattage, are not to be connected, such as photocopiers, space heaters, microwave ovens, and refrigerators. Always verify the limit allowed before the equipment's use.
- Multiple outlet surge protectors should have an on / off switch.
- Multiple outlet surge protectors or power bars should not be located where flammable chemicals are handled.

Breakers

Tripped circuit breakers, circuits that won't work when fuses are replaced or breakers resetting often indicate a serious electrical hazard. Discontinue use and immediately report any problems to Facilities Service at ext. 2222. Do not attempt to address the issue; contact Facilities Service at ext. 2222.

Electrical Circuit Panels or Disconnects

- Electrical panels or disconnects must never be blocked.
- Ensure a clearance radius of at least 1 meter from the panel.

Electrical Equipment Used in Wet Locations

Equipment used in wet areas must be designated and approved for use in wet locations. When it is not possible to ensure protection from contact with water, the equipment must be protected by a ground-fault circuit interrupter (GFCI).

A GFCI must be installed when an electrical outlet is at close proximity (1.5 meter) to water, for example near sinks. This includes greenhouses, animal rooms, around swimming pools and fountains, wet laboratory, outdoor receptacles, etc.

A GFCI is a device that can detect any leakage current in an electrical circuit and turns off the circuit whenever the leakage current is greater than a maximum tolerable limit, usually 5 mA. A leakage current is when electricity escapes to the ground. GFCIs are designed to provide protection against dangerous situations.

There are three types of GFCIs that can be used on worksites or workplaces:

1. A GFCI receptacle can be used in place of a standard receptacle, shown below
2. A portable GFCI, when plugged into a standard receptacle, converts a standard receptacle into a GFCI one.
3. A GFCI circuit breaker, installed at the panel, combines leakage current detection with the function of a circuit breaker.

It is important to note that GFCIs are subject to wear and therefore damage over time. For example, GFCIs may undergo damage due to a strong power surge during an electrical storm. Therefore, GFCIs must be tested regularly. The recommended frequency is once every month. Many installations at the University are now equipped with GFCI-ST – otherwise known as Ground Fault Circuit Interrupter – Self Testing. These units self-test during their lifecycle.

DETECTING DAMAGED EQUIPMENT

Electrical equipment can become damaged over time. Such damaged equipment can lead to serious injury or cause fires. The most effective method in detecting damaged electrical equipment is through visual inspection. Everyone is capable of conducting a visual inspection.

The following is a list of important points to consider when verifying your electrical equipment:

- Identify your equipment. You should know what it is, where it is, and how it is used.
- Attempt to discover any damage, such as cuts, abrasion to the cable covering, damage to the plug, the actual unit etc.
- Verify whether the cord casing is cracked or the pins are bent.
- Ensure that no colored insulation of the internal wires is showing.
- Ensure that there is no damage to the outer cover of the equipment or no obvious loose parts or screws.
- Ensure that there has been no overheating of equipment which would be visually apparent by the presence of burn marks or staining of equipment.
- Verify that no bare wire is visible other than at the terminals (i.e. the prongs).
- Ensure that the terminal screws are tight.
- Verify that there is no sign of internal damage, entry of liquid, dust or dirt.

REPAIRING DAMAED ELECTRICAL EQUIPMENT

Contact Facilities Service at extension 2222 or fill out a request form using the MAXIMO system to report the need for equipment repair, electrical failure or assistance for choosing the appropriate type of electrical cords or power bars, etc. Do not attempt to repair your own electrical equipment.

TRANSFERRING USED EQUIPMENT AND DONATIONS

This section deals with the transfer of used electrical equipment to the University of Ottawa. The origin of such equipment varies and can be from other educational institutions, government establishments or from private business and even other countries.

The regulation of such equipment is thus in the hands of the receiving party at the University of Ottawa. That is, the individual in receipt of the transfer or donation of electrical equipment must ensure that all equipment received bears the proper approval marks and must undergo inspection to validate correct and safe operation. All received equipment must follow and respect the Ontario Electrical Safety Code (See Appendix 1).

CERTIFYING EQUIPMENT

All electrical equipment at the University of Ottawa which does not have the approved certification marks, as defined in Appendix 1, must undergo an inspection to receive the certification by an approved inspection authority in Ontario.

Electrical products can only be approved by agencies that have been accredited by the Standards Council of Canada to approve electrical equipment. No other product approval markings are accepted in Ontario. Electrical Products can be approved by:

- Getting it “certified” by a recognized testing agency.
- Arranging to have the product “Field approved” by a recognized field approval agency.

You may directly contact an approved inspection Agency (see Appendix 1) or you can contact the Faculty of Science, Electronics Shop. The Electronics Shop has the authority to inspect and assess the equipment to meet the ESA and CSA requirements and make any necessary modifications. The equipment can subsequently be “field approved” by the Approved Inspection Agency. There is a fee associated with this service. For more information, please visit the [Faculty of Science Electronics Shop website](#).

RISKS ASSOCIATED WITH ELECTRICITY

Everyone is exposed to electrical energy during the performance of their daily duties. Therefore, it is important to understand potential electrical hazards present in your environment in order to recognize, evaluate and control hazards associated with the electricity.

Evaluation of Risk

The evaluation of risk is a critical component to the prevention of electrical injuries. Therefore, it is of the utmost importance to include a procedure around risks which can be analyzed. Electricity can hurt you by electrical contact, flash, or fire and explosion. All individuals who are exposed to electrical equipment in any manner should consider the following factors. The consideration of these factors will facilitate the evaluation of the risk of injury around electrical equipment:

- A. The environment in which the electrical equipment is used
 - a. Condition – wet or dry
 - b. Location – indoors or outdoors
 - c. Spacing – open, crowded, restricted
 - d. Lighting – lit or dim

- e. Existence of hazards such as metal ladders, overhead wires, presence of electrical conductors, electrical cords over a heat source, or overloaded electrical outlets
- B. Condition of the electrical equipment in use
- a. Presence and integrity of grounding system
 - b. State and age of equipment
 - c. Presence of internal safety mechanisms
 - d. The actual operating voltage
 - e. The electrical wiring and loads incurred

Electrical Shock

Shocks happen due to electrical current (amperes) flowing through the human body. Misunderstanding often plays a part in these unfortunate accidents in the workplace. "Switching off" electrical equipment doesn't mean there is no electricity in it. As long as the equipment is plugged into an outlet, parts of it are still "live". Cleaning a switched-off, but still plugged-in coffee pot in the kitchen sink can be fatal.

Fire Hazards

Electrical fires can be caused by overloads on circuits not meant to carry the current flowing through them, and by poor electrical connections. A short circuit occurs when the normal current path is changed, by passing through broken insulation or a bad connection to another conductor - thus causing the short circuit. As a result of the short circuit, a very hot spark or electric arc occurs, which can ignite insulation or nearby combustibles.

Fire Extinguishers

Use "ABC", "BC" or "C" class fire extinguishers for electrical fires. The use of fire extinguishers requires training – hands on training is offered free of charge to employees and students. [Visit the Office of Risk Management](#) for details on upcoming course dates.

Type of Injuries

Electrical injuries consist of five main types: electrocution, electric shock, amputation, burns and falls. The severity of an electric shock depends on the following factors:

- The intensity of the current running through the body
- The path of the current (an 80 milliamper current that passes through the heart is enough to trigger a heart attack)
- The duration of contact with the source
- The body's resistance: this is the deciding factor in an electrical accident. The intensity of the shock increases when the body's resistance decreases.

Examples of injuries sustained with different amounts of current:

Amount of Current (mA)*	Type of Injury Sustained
0.5 -3	Energy sense begins, a tingling sensation can be felt
3 -10	Threshold around which pain is experienced, muscle contractions occur

Amount of Current (mA)*	Type of Injury Sustained
10 – 30	Grip paralysis threshold in which, despite efforts to do so, the individuals cannot detach themselves from the energy source
30 – 75	Respiratory systems ceases to operate
100 – 200	Heart fibrillation begins
200 – 500	Heart clenches tightly
≥ 1,500	Organs and tissues are burnt

* Based upon a 60 Hz AC

EMERGENCY

In the case of an emergency related to electrical shock or injuries derived from electrical equipment, it is critical to follow a set procedure in order to minimize damages and most importantly, to save lives. Regardless of the perceived severity of the injury, ensure the injured person receives professional medical attention as soon as possible. It is not uncommon for injured persons to have experienced heart failure hours subsequent to the initial exposure to electricity.

Procedures

In case of an emergency, immediately **contact Protection Services** (or 911) by pressing the emergency button located on any University phone or dialing extension 5411. If using a cell phone, dial 613-562-5411. Protection Services will provide assistance by dispatching an officer, and contacting emergency services as necessary. If you are off-campus (i.e. 1100 Polytek, 1 Nicholas, 1000 Belfast, etc.) contact 911 for assistance. Report the incident to Protection Services when possible.

Attempt to separate the person from the energy source only **if it is safe to do so** and move the injured person into a safe area, away from the electrical source.

- Do not attempt to remove the injured person from the electrical source directly with your hands; by doing this you will essentially become part of the circuit and injure yourself in the process. In order to remove or detach the injured person from the electrical source use a non-conductive material such as dry wood, plastic or leather – **but only if safe to do so**.
- If you are qualified to do so, administer first-aid until further assistance arrives, unless the injured person refuses.

APPENDIX 1 – CERTIFICATION AND FIELD EVALUATION MARKS ACCEPTABLE IN ONTARIO

A list of recognized certification and field evaluation agencies is maintained by the [Ontario Electrical Safety Authority](#).

Table 1 – Allowable Ampacity of Flexible Copper Conductor Cord and Equipment Wire

Extracted from the Ontario Electrical Safety Code, 25th Edition
Based on Ambient Temperature of 30 degree Celcius.

Size AWG	Allowable Ampacity											
	Flexible Cord							Equipment Wire				
	Tinsel Cords	Christmas-tree Cord		Elevator cable	Types NISPT-1, NISPT-2, SV, SVO, SVOO, SJ, SJO, SJOO, SJOW, SJOOW, S, SO, SOO, SOW, SOOW, SPT-1, SPT-2, SJTO, SJTOO, ST, STO, STOO, SJTW, SJTOW, SJTOOWS, STW, STOW, STOOW		Types HSJO, HSJO, HSJOO, HPN	Types TXF	Type DRT	Type TXFW	Types GTF, TEW,SEW,REW, TEWN,SEWF,TBS, SIS	
Types TPT, TST	Type CXWT, PXWT, TXFW	Type PXT TXF	Type E, EO, ETT, ETP	2 Current- Carrying Conductors	3 Current- Carrying Conductors							
27	0.5	-	-	-	-	-	-	-	-	-	-	
26	-	-	-	-	-	-	-	-	-	-	1	
24	-	-	-	-	-	-	-	-	-	-	2	
22	-	1.8	1.8	-	-	-	-	-	-	-	3	
20	-	3.6	3.6	-	2	-	-	2	2	-	4	
18	-	7	-	5	10	7	10	-	-	5	6	
16	-	10	-	7	13	10	15	-	-	7	8	
14	-	15	-	15	18	15	20	-	-	-	17	
12	-	20	-	20	25	20	25	-	-	-	23	
10	-	-	-	25	30	25	-	-	-	-	28	
8	-	-	-	35	40	35	-	-	-	-	40	
6	-	-	-	45	55	45	-	-	-	-	55	
4	-	-	-	60	70	60	-	-	-	-	70	
3	-	-	-	-	-	-	-	-	-	-	80	
2	-	-	-	80	95	80	-	-	-	-	95	
1	-	-	-	-	-	-	-	-	-	-	110	