Electrical Safety Procedure

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Office of the Chief Risk Officer

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Contents

Version Control Table

Version Number	Owner	Approver	Change Summary	Status
1	OCRO	OCRO	New	N/A

1. Document Background

Purpose and scope of document

The Electrical Safety Procedure (hereafter "the procedure") outlines the University of Ottawa (also known as "uOttawa"') procedure for anyone working with electrical equipment within uOttawa premises.

The procedure applies to uOttawa employees and is intended to serve as a reference for stakeholders at uOttawa.

The procedure does not outline all the independent requirements and potential risks or challenges specific to any projects, workspaces, or situations, but rather is intended to serve as a framework for building a fit-for-purpose approach to managing the applicable risks.

Terms and definitions

Refer to the OHS Glossary for the OHS terms and definitions that apply to the documents within the management system.

Additional terms and definitions specific to this procedure are listed below.

"Electrical/electronic work" – any labour or material used in installing, altering, or maintaining:

- An electrical wiring system
- Appurtenances, apparatus, or equipment used in connection with the use of electrical energy in, on, outside, or attached to a building, residence, structure, property, or premises

"Flash hazard" or **"arc flash" –** a dangerous conditions in which energy is released through an electric arc, producing thermal energy that may be hazardous

This document provides 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, to ensure that it is safe to operate and meets current regulations, codes or standards.

Responsibilities

The responsibilities of individuals in a variety of roles, including supervisor and worker, are detailed in Administrative Procedure 14-1 (Internal Responsibility Procedure for Health and Safety Issues).

In addition to the roles and responsibilities outlined in Procedure 14-1, additional responsibilities applicable to this procedure include:

Workers

- Employees who repair, modify, or maintain equipment shall be qualified to conduct such work or be under the direct supervision of a qualified individual familiar with the provisions of the legal requirements, codes, any associated hazards, safe operating procedures, and emergency measures

Reference documents

- Hazard Identification and Risk Assessment (HIRA) Procedure

2. Procedure

Procedural Steps

The following procedural steps **must be followed** when planning for or performing electrical work:

1. Perform hazard identification and risk assessment
2. Plan and prepare for electrical work, equipment, and training
3. Execute work using precautionary measures for electrical hazards
4. Maintain and store equipment and tools

Additional steps may be required based on the project or work scope.

STEP 1 Perform hazard identification and risk assessment (HIRA)

Key activities

- Conduct preliminary qualitative survey of workspace to identify energized systems, equipment, or tools
- Identify the work hazards present, including a review of existing hazard identification and risk assessments (HIRA) and standard procedures in place
- If the hazard(s) of the specific work have not been previously assessed through the completion of a HIRA or equipment/activity specific procedure (that includes the outcome of a HIRA), conduct a HIRA with reference to the Hazard Identification and Risk Assessment Procedure
- Identify manufacturer and legislative requirements for operating electrical systems, tools, and equipment
- Define appropriate measures to effectively eliminate or mitigate identified hazards and risks using the appropriate methodology

Contextual Details

Supervisors of projects and workspaces within uOttawa premises shall identify and evaluate current and potential energized equipment and electrical hazards at the site through a preliminary qualitative survey. The survey shall consult workers and relevant committee(s) to identify additional hazards that may be present.

The survey shall include the identification of electrical workspace hazards including, but not limited to:

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

    - Existence of additional arcing or fire hazards such as metal ladders, overhead wires, presence of electrical conductors, electrical cords over a heat source, or overloaded electrical outlets
- Condition of the electrical equipment in use
    - Presence and integrity of grounding system
    - State and age of equipment
    - Presence of internal safety mechanisms
    - The actual operating voltage
    - The electrical wiring and loads incurred
    - Certification by regulatory authorities (refer to Appendix 2 for regulatory references)
- Electrical hazards (with reference to IHSA), such as:
    - Hidden power supplies
    - Operating equipment near energized power lines
    - Flash hazard (arc flash)
    - Electric shock

A list of general precautionary measures for electrical hazards is available in Appendix 1.

Based on the findings of the preliminary hazard survey, identified electrical hazards shall be addressed using the following:

1. Identify an existing assessment of the work hazard(s), reviewing the HIRA and associated standard procedure to mitigate the hazard risks.
2. If an assessment or standard procedure do not exist already, a HIRA must be conducted, utilizing the HIRA process outlined in the Hazard Identification and Risk Assessment Procedure

Electrical safety deficiencies identified through initial and ongoing assessments shall be prioritized and appropriately addressed.

Electrical safety requirements identified during the assessment shall be documented and communicated to the appropriate parties. Documentation shall meet the requirements outlined in the General OHS Program Manual.

STEP 2 Plan and prepare for electrical work, equipment and training

Key activities

- Use the hierarchy of controls to determine the type of electrical protection systems and devices needed
- Obtain appropriate personal protective equipment (PPE) and inspect before use; examples may include head, foot, eye/face PPE, protective clothing, etc.
- Ensure proof of training/certification is available through documentation and included within the HIRA

Contextual Details

Electrical Protection Systems

Refer to the hierarchy of controls within the Hazard Identification and Risk Assessment Procedure for guidance on determining the appropriate electrical protection systems and devices.

Refer to the General OHS Program Manual for general PPE requirements and inspection protocols.

Electrical equipment at the University of Ottawa that does not have the approved certification markings must undergo an inspection to be certified by an approved inspection authority in Ontario. A list of recognized certifications and evaluation agencies is maintained by the Ontario Electrical Safety Authority.

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:

- Being certified by a recognized testing agency
- Arranging to have the product "field approved" by a recognized field approval agency

Any supervisor or worker who is unsure of the proper approval for products shall contact an approved inspection agency, as listed by the Ontario Electrical Safety Authority or the Faculty of Science, Electronics Shop, as needed. The Electronics Shop has the authority to pre-inspect and assess the equipment to ensure it meets 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.

Specific Electrical Training and Certification

No worker shall connect, maintain, or modify electrical equipment or installations unless the worker holds a valid certificate of qualification issued under the Ontario *College of Trades and Apprenticeship Act*, in the trade of electrician, or is otherwise permitted to connect, maintain, or modify electrical equipment by the Act. Refer to Appendix 2 for regulatory references.

Questions or concerns regarding electrical work involving infrastructure should be directed towards Facilities and uOttawa electrical personnel.

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

- Canadian Standards Association (CSA); or
- Electrical Safety Authority (ESA); or
- 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 3 is permitted.

STEP 3 Execute work while applying precautionary measures for electrical hazards

Key activities

- Isolate electrical energy sources before starting work
- Execute electrical work (or work using electrical tools/equipment)
- Re-energize systems after completion of work, removing any locks in place

Contextual Details

Isolation Activities

As stated in the Industrial Establishments Regulation (O.Reg.851), "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."

The practice of Lock out/tag out (LOTO) is performed to de-energize equipment and remove any residual energy that may exist (i.e., pneumatics, hydraulics, etc.) prior to working on the equipment. Correctly executed LOTO ensures that the equipment cannot be activated by anyone while work is ongoing. The process involves locking the power source/breaker before beginning work. Keys to the lock are with the individual performing the work. The University of Ottawa has a formal process for locking out equipment, which is available on the Facilities website.

Work Execution

Execution of safe electrical work, or work using electrical tools/equipment, includes: identifying all hazards; assessing risks, including hazardous energy control and isolation; and remaining aware of electrical risks to workers and other University personnel. Examples of electrical equipment to inspect include:

- Electrical cords and plugs
- Outlets, multiple outlets and power bars
- Breakers
- Electrical circuit panels or disconnects
- Electrical equipment used in wet locations (GFCI)

For additional general electrical hazards and precautionary measures, refer to Appendix 1.

To ensure the safety of personnel not performing the work, a safety zone should be established.

Safety Zone

Whenever electrical work is performed, a safety zone should be established around the workspace to ensure persons not performing the work and/or using equipment are not exposed to electrical hazards.

Once work is complete, electrical connections within the system may be systematically reconnected, including removing any locks that were applied prior to starting work by following proper lock-out/

tag-out procedures. Electrical systems should be tested by a competent individual to ensure proper function after they have been repaired or serviced by a certified electrician. Any additional issues or hazards should be reported immediately to the workplace supervisor or the respective OHS personnel (or OCRO) for major hazards (i.e., hazard with an extreme risk level).

STEP 4 Maintain and store equipment and tools

Key activities

- Document the maintenance and storage of electrical, work-related PPE devices and electrical equipment
- Perform and document the regular inspection of PPE and equipment used for electrical work
- Conduct regular device and system maintenance as necessary

Contextual Details

Both electrical equipment and associated PPE shall be documented for each workplace. A regular maintenance schedule must be established for both electrical equipment and relevant PPE devices / systems to ensure proper and safe operation and no defects.

Inspections

The following important points must be considered when verifying that electrical equipment is in proper working condition:

- Identify equipment: know what it is, where it is, and how it is used
- Identify 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 terminals (i.e., the prongs) are bent
- Ensure that no coloured 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
- Verify that no bare wires are visible other than at the terminals (i.e., the prongs)
- Ensure that the terminal screws are tight
- Verify that there are no signs of internal damage, entry of liquid, dust, or dirt

Used and Donated Equipment and Equipment Certification

When the University receives donated or used equipment, the individual in receipt of the transfer or donation of electrical equipment must ensure that received equipment bears the proper approval markings and will undergo inspection to validate correct and safe operation. Received equipment must follow and comply with the *Ontario Electrical Safety Code* (refer to Appendix 3). Maintenance documentation must meet the requirements outlined in the General OHS Program Manual.

3. Emergency Procedures

For emergencies, all stakeholders shall, at a minimum, refer to and follow the process and guidance provided in the emergency response plan .

Electrical shock or emergency

In situations involving electrical work on uOttawa premises, these steps inform members of the University of the proper procedure:

1. **Contact Protection Services**
   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 assist by dispatching a member and contacting emergency services as necessary. If you are off campus (i.e., at 1100 Polytek, 1 Nicholas, etc.) contact 911 for assistance and report the incident to Protection Services as soon as possible.
2. **Control the energy source, but only if it is safe to do so**
   Attempt to close the breaker or source of energy with a non-conductive material to limit the electricity. Do not interact with the equipment or source of energy if there is any uncertainty about the presence of live electricity or about the proper non-conductive material to use.
3. **Attend to person in need**
   Attempt to separate the person from the energy source **only if it is safe to do so** and move the injured person to a safe area away from the electrical source.
   - Do not attempt to remove the injured person from the electrical source directly; doing so risks that you become part of the circuit and you may be injured in the process. 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**
   - Seek medical treatment immediately. Refer to the AED map for additional emergency support. If you are qualified to do so, administer first aid until further assistance arrives, unless the injured person refuses.

Table 1: Injuries sustained due to 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
10 – 30	Grip paralysis threshold at which the individual cannot detach themself from the energy source despite efforts to do so
30 – 75	Respiratory systems cease to operate
100 – 200	Heart fibrillation begins
200 – 500	Heart clenches tightly
≥ 1,500	Organs and tissues are burnt

Appendix 1: General Precautionary Measures for Electrical Hazards

The following tips provide general information on electrical safety:

- Verify that electrical equipment is “approved” by checking for recognized approval markings to ensure it meets the electrical safety requirements for Ontario
- NEVER handle electrical equipment that is plugged into a power source 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 ground fault circuit interrupter (GFCI)
- Unplug equipment by pulling on the plug, not the cord
- Do not use damaged electrical equipment that constitutes an electrical hazard until it has been properly repaired and/or replaced
- Never connect electrical cords in series (i.e., power bar to power bar, extension cord to extension cord, or a combination thereof)
- Multiple outlets and power bars should have automatic circuit breakers, surge protectors and on/off switches
- Electrical circuit disconnects or panels must be freely accessible (i.e., not blocked); the standard clearance is 1 meter
- Know and understand the manufacturer’s recommended limits on the use of the electrical equipment and follow such recommendations precisely; these limits may be found on written instructions that accompany the electrical equipment
- 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

Specific information on electrical components

Plugs

- Regularly check for loose or damaged plugs/prongs
- Never remove the ground (third) 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, excessive heat 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 equal to or greater than the electrical cord capacity for the tool

- Ensure that the rating on the cord is equal to or greater 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 cord and wire ratings, see Appendix 4
- Extension cords or power bars must not be connected in 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 trip hazards
- For temporary situations, adequately protect electrical and extension cords from foot traffic to avoid a trip hazard
- If you need an extension cord, use only one temporarily (i.e., a few hours) and make sure that it is long enough to avoid stretching it too much
- Should an extension cord be necessary on a longer, you must submit a request to Facilities for the installation of a permanent power source solution
- Electrical and extension cords must not be coiled or looped when in use; cords generate heat, which can damage the insulation
- Store electrical and extension cords above $0^{o}C$ in an interior location to minimize deterioration of the cords over time
- Do not store electrical cords 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 series.
- Multiple-outlet bars and power bars should be used only as short-term power solutions
- Multiple-outlet bars with surge protection, if graded appropriately, can be used for a longer period – for example when used for low demand equipment (e.g., computers)
- If outlets or switches feel warm, shut off the circuit and have them checked by an electrician
- Multiple-outlet surge protectors should be equipped with an automatic circuit breaker. Do not use outlet strips with fuses or without over-current protection
- The cord for multiple-outlet surge protectors should be no longer than six (6) feet and must be plugged directly into a wall receptacle
- Do not expose multiple-outlet surge protectors 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. Do not connect other, higher wattage applications to them, 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, and circuits that won't work when fuses are replaced or breakers reset, often indicate a serious electrical hazard. Discontinue use and immediately report any problems to Facilities.

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 proximity (1.5 meters) 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:

- A GFCI receptacle can be used in place of a standard receptacle
- A portable GFCI, which when plugged into a standard receptacle converts a standard receptacle into a GFCI one
- A GFCI circuit breaker, which when 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 self-testing units (GFCI-ST), which self-test during their lifecycle.

Appendix 2: Regulatory References

Ontario Occupational Health and Safety Act and its regulations:

Ontario Regulation 213/91, section 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*

Industrial Establishments Regulation (Reg. 851)

- Electrical equipment, insulating materials, and conductors shall be,
  a) Suitable for use; and
  b) Certified by,
  i. The Canadian Standards Association, 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 such 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))

Ontario Electrical Safety Code Rule 2-022

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).

Appendix 3: 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.

	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				
Size AWG	Types TPT, TST	Type CXWT, PXWT, TXFW	Type PXT TXF	Type E, EO, ETT, ETP	2 Current-Carrying Conductors	3 Current-Carrying Conductors		Types TXF	Type DRT	Type TXFW	Types GTF, TEW,SEW,REW, TEWN,SEWF,TBS, SIS
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