



ELECTRICAL SAFETY PROGRAM

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ELECTRICAL SAFETY

1.0 Introduction

The danger of injury through electrical shock is present whenever electrical power is used. All electrical equipment should be adequately insulated, grounded or isolated to prevent bodily contact with any source of dangerous potentials. Under certain conditions, people can be injured severely even from relatively low voltages coupled with high current.

The primary effects of electrical shock are due to current actually flowing through the body. Electrical burns occur when the body, or a part of it, completes a circuit connecting the power source with the ground. Although the resistance of dry, unbroken skin to electric current is relatively high, the amount of current necessary to kill a person is small. Therefore, it is easy to exceed lethal levels of current flow, especially if the skin is broken, wet, or damp with sweat.

If your equipment runs erratically or if you feel an electrical “tingle” when you touch it, stop using the tool, tag it, and have it repaired. Whenever the risk of electrocution is high, wear the right protective clothing-insulated gloves, eye protection, boots, headgear, etc. If you are not sure what to wear, ask your supervisor or contact EHS for assistance.

Specific issues regarding electrical safety must currently be covered locally by supervisors on standard operating procedures.

1.1 Objective

The objective of the Towson University Electrical Safety Program is to minimize the risk of the following through appropriate Code and standard enforcement:

1. Injury to faculty, staff, and students.
2. Fire and associated property damage.
3. Interrupted operation.
4. Shortened equipment life.

This program shall conform to the requirements of at least 29 CFR 1910 Subpart S - Electrical, NFPA 70 – The National Electric Code, Standard for Electrical Safety in the Workplace 2004 Edition and any other applicable standards.

1.2 Other Requirements

This document may be supplemented by other code requirements and internal documents, such as:

1. State and local code requirements.
2. Unique location safety requirements
3. Energy conservation requirements
4. Installation and service requirements
5. Special operating requirements
6. [Towson University Lockout/Tagout Program](#)

2.0 General Safety Guidelines

The following outlines electrical safety guidelines:

1. Equipment and handheld tools should have 3-prong plugs and/ or double insulation
2. For any tool/ equipment that generates heat, unplug when not in use
3. Label all circuit box switches
4. All electrical panels shall be unobstructed, have a minimum clearance of 36", and shall be easily accessible.
5. Ensure no energized or circuits/ parts are exposed (i.e., outlet cover plates, electrical panel doors)
6. NEVER repair/ modify electrical wiring unless shop-specific training is provided (Contact Facilities Management Work Control (x4-2481) for assistance)
7. Never modify a plug by bending or removing the prongs. When plug prongs are bent, loose or missing, replace the device.
8. Never unplug an appliance by pulling on the cord, always remove by the plug.
9. Keep dust and lint off electrical panels, receptacles, and appliances.
10. Electrical panel doors should be closed and latched when not in use.
11. Separate all combustible materials away from electrical equipment.
12. Attempt to limit one appliance per outlet. However, if more than one appliance is to be used for each circuit, an approved plug strip with circuit breaker should be used.
13. Always turn off a tool or appliance before disconnecting it to avoid exposure to live electrical parts. (See [Towson University Lockout-Tagout Program](#))
14. Proper illumination shall be provided in all areas where electrical hazards are apt to be encountered and an emergency lighting system should be in place as well.
15. All energized parts of electrical circuits and equipment shall be guarded against accidental contact by approved cabinets or enclosures.
16. Employees who regularly work on or around energized electrical equipment shall be trained in the proper methods of cardio-pulmonary resuscitation (CPR) and Automatic External Defibrillation (AED).
17. Where electrical shock hazards exist, first-line and backup protection shall be provided to prevent access to energized circuits and parts. This protection includes using lockouts, grounding hooks, barriers and rubber mats.
18. In places where electrical hazards exist, there shall be conspicuous visual indications of ON and OFF conditions, the type of hazard and its exact location.
19. Bench tops and bench edges in the immediate work area should be non-conductive and only a minimum of connected equipment should be on the bench tops. Rubber matting of adequate breakdown voltage should be used.
20. Adequate and workable lockout-tag out procedures shall be used. (See [Towson University Lockout-Tagout Program](#))
21. Never work alone on a live circuit - always have an observer.
22. Be acquainted with all electrical hazards that may be encountered in your work area.
23. Notify your supervisor of any potential electrical hazard that may be going unnoticed.
24. Equipment Examination. New equipment or existing equipment that is to be relocated must be examined for recognized hazards when it is installed.

2.1 Damage or Miss-use

1. Immediately report damaged/ malfunctioning items to supervisor and take out of service until repaired by a qualified electrician.

2. Portable electric tools shall not be lifted or lowered by means of the power cord. Ropes shall be used.
3. Avoid overloading electrical outlets.
4. Cord adapters used to defeat the ground connection (i.e. 3-prong to 2-prong adapters) should not be used.
5. Damaged electrical enclosures such as switches receptacles and junction boxes should be reported immediately to Facilities.

3.0 Personnel Protection

3.1. Protection shall be provided:

1. Where service is required with power on and *inadvertent contact* is likely.
2. Where it is necessary to reach over, under, around, or in close proximity to hazards.
3. Where dropped tools could cause shorts and arcing.

3.2. Protection shall be provided by one or more of the following:

1. Shields.
2. Interlocks.
3. Remote or external test points.
4. Insulated potentiometer extensions.
5. Access holes.
6. Separation of low voltage and line voltage terminal blocks and relays.

3.3 Specific Personal Protective Devices

1. When any equipment may produce sparks or arcing during normal operation, safety glasses must be used at all times.
2. Proper personal protective equipment, such as a hard hat, safety glasses, arm mats and gloves should be worn when maintaining any electrical equipment.
3. When using tools near electrical hazards, all tools must have a double insulated casing to prevent contact with energized parts.

3.4 Labels

3.4.1. Warning Signs. Warning signs are needed to identify and locate potential hazards. The need for such warnings is particularly significant:

1. Where the hazard may not be immediately apparent.
2. Where personnel may assume there is no hazard when, in fact, one exists.
3. Where the hazard may exist only under a certain set of conditions and not otherwise.

3.5 Hazard Warning

Non-service personnel shall be warned of the presence of possible hazards in service areas. A sign mounted on a structural member of the machine reading *Hazardous Area - Trained Service Personnel Only* shall be used when there is exposure to chemical, electrical, thermal or mechanical hazards. Excessive use of this sign shall be avoided.

3.6 Hazardous Potential Warning.

Hazardous potentials (other than line voltage) above 250 VAC or DC must be identified by a prominent sign located near energized parts. The sign applicable to the highest voltage present shall be used.

3.7 Main Control Enclosure.

A label indicating the following information shall be installed near the supply circuit disconnecting means:

1. Voltage (V)
2. Amperage (A)
3. Phase (Ph)
4. Frequency (Hz)

3.8 Circuit Protection Devices. The rated current (in amperes) of the circuit protection devices shall be visibly indicated near the device. Special fuses must also indicate type.

3.9 Emergency Off (EMO). EMO devices shall be engraved or have a red legend plate or label with white letters stating "EMERGENCY OFF."

3.10 Components (Devices). Shall be identified to (not on) the component with the same designation as shown on the diagram.

4.0 Nominal Voltages

Nominal voltages for circuits are 24 V AC or DC, 120 / 208 VAC and 480 VAC.

Table 1 is provided as a guide for determining equipment power requirements.

Equipment Power (kW) Requirements	Recommended Voltage (V) & Phase (Ph)	Approx. Amperage Range (A)
0 kW - 3 kW	120 V , 1 Ph	0 A - 25 A
0 kW - 5 kW	208 V , 1 Ph	0 A - 25 A
3 kW - 30 kW	208 V , 3 Ph	10 A - 80 A
15 kW & over	480 V , 3 Ph	20 A & over

5.0 High Voltage Safety

In addition to the recommendations for general electrical safety, there are more stringent rules that apply to high voltage operations. High voltage pertains to electrical equipment that is operating at more than 600 volts in terminal to terminal operation or at more than 300 volts in

voltage to ground operation. In addition, low voltage, high current AC or DC power supplies are also considered to be high voltage applications.

All switches, circuit breakers and other control devices that are in high voltage equipment shall be labeled as such.

For a more comprehensive listing of proper high voltage maintenance and operation, check the National Electrical Code available in the Department of Environmental Health & Safety.

5.1 Hazards of Working with High Voltage

1. Care must be taken to ensure that unknown parties do not come in contact with energized parts. This can occur when there is a remote on/off switch relative to the energized conduits.
2. Ensure that terminal voltage ratings can withstand any surges that may occur due to electrical faults or switching transients.
3. Overload or improper cooling can cause excessive temperature rises, resulting in equipment damage.
4. Be aware of output circuits even after input power is turned off to the system. Parallel power sources and energy storage devices such as capacitors can cause damage.
5. When power supplies serve more than one experiment, switching errors can result in energizing the wrong equipment or load, creating possible hazards for nearby personnel.
6. Over-current protective devices such as fuses and circuit breakers may not adequately limit or interrupt the total inductive energy and fault currents in highly inductive DC systems.

5.2 Safe Operating Procedures

1. Prior to operation, inspect the power supply and check all protective devices.
2. Employees shall be prohibited from working alone on energized lines or equipment over 600 volts.
3. Before entering power supply or associated equipment enclosure, take the following precautions:
 - De-energize the equipment.
 - Open and lockout the main input power circuit breaker.
 - Check for auxiliary power circuits which could still be energized.
 - Inspect automatic shorting devices to verify proper operation.
 - Short the power supply from terminal-to-terminal, and terminal- to-ground with grounding hooks.
4. Label equipment to identify input power sources; and label input power sources to identify their connected power supply loads.
5. Equipment that is remotely controlled or unattended while energized should be labeled with emergency shutdown instructions and identification of personnel to contact in case of emergency.

6.0 Receptacles

Receptacles shall comply with the following.

1. Voltage and current ratings shall not be less than that of the supply circuit.
2. When installed for convenience use, shall be rated at not less than 15 A at 125 V.
3. When installed for power distribution, shall not have a connected load exceeding 80% of rating.
4. Shall be grounding type specification grade receptacles.
5. Receptacles should be mounted firmly in their enclosures and should not move when the plug is inserted. Loose receptacles can cause short circuits.
6. Shall be enclosed.
7. Shall be securely mounted to a vertical surface or may be mounted to a horizontal surface with faceplate down.
8. Shall be accessible to service personnel.
9. Shall be accessible without removing covers or opening doors when installed as convenience outlet for operator use.
10. Faceplates shall be flush with the outer edges of the box.
11. Faceplate screws or faceplate screw holes shall not be used for receptacle mounting unless other provisions are made to counteract the plug insertion pressure.
12. All receptacles and any electrical conductors must be sufficiently grounded, and if uncertain whether or not this is true, call Facilities for assistance.
13. If plug prongs break off and remain in the receptacle slots after insertion or withdrawal, do not attempt to remove them. Call Facilities for assistance.

6.1 Ground Fault Circuit Interrupters (GFCIs)

1. Keep the floor in your workplace completely dry
2. Keep all electrical equipment away from any source of water unless the appliance is rated for use around water, such as a wet-dry shop vacuum.
3. Ground fault circuit interrupters (GFCI's) should be used as much as possible. In any wet, damp or moist environment, GFCI's are required.
4. Receptacles shall be protected by ground fault circuit interrupter (GFCI) when installed in a damp or wet location, e.g., hose wash down area.

If anyone discovers loose receptacles or other faulty electrical equipment, it should be removed from service or tagged out until a qualified electrician from Facilities can make repairs.

7.0 Extension Cords

1. Extension cords should be used only when necessary and only on a temporary basis (>90Days). Extension cords should not be used in place of permanent or fixed wiring.
2. Do not "daisy chain" extension cords and/ or power strips
3. Prevent damage to the cord and plugs (i.e., avoid placing in walkways/ driveways, never staple, nail or otherwise attach extension cords to a surface.) * Keep all electrical cords away from areas where they may be pinched, such as off the floor, out of walkways, and out of doorways. Where possible, move the electrical appliance closer to the outlet.
4. Only use extension cords rated for the equipment power needs.
5. Make sure all extension cords are the right size or rating for the tool you're using.
EXAMPLE: The diameter of the extension cord being used should be equal to or greater than the cord of the appliance being used.

6. Do not use any appliance or extension cord that exhibits signs of wear, such as frayed insulation or exposed wiring. To insure safe operation, all electrical equipment should be visually inspected before use.

Appendix A

OSHA ELECTRICAL SAFETY STANDARDS

[1910 Subpart S - Electrical](#)

[1910.301 - Introduction.](#)

[1910.302 - Electric utilization systems.](#)

[1910.303 - General requirements.](#)

[1910.304 - Wiring design and protection.](#)

[1910.305 - Wiring methods, components, and equipment for general use.](#)

[1910.306 - Specific purpose equipment and installations.](#)

[1910.307 - Hazardous \(classified\) locations.](#)

[1910.308 - Special systems.](#)

[1910.331 - Scope](#)

[1910.332 - Training](#)

[1910.333 - Selection and use of work practices](#)

[1910.334 - Use of equipment.](#)

[1910.335 - Safeguards for personnel protection.](#)

[1910.399 - Definitions applicable to this subpart.](#)

[1910 Subpart S App A - Reference Documents](#)

[1910 Subpart S App B - Explanatory Data](#)

[1910 Subpart S App C - Tables, Notes, and Charts](#)

Appendix B

DEFINITIONS

Accessible.

Admitting close approach; not guarded by locked doors, elevation, or other effective means.

Ampacity.

Current carrying capacity expressed in amperes.

Approved.

Acceptable to the authority having jurisdiction.

Approved for Purpose.

Approved for a specific purpose, environment, or application by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation.

Attachment Plug (Cap).

A device which, when installed on a flexible cord and inserted into a receptacle, establishes an electrical connection of the conductors in the flexible cord for those in the receptacle.

Black Box.

Any unit or subassembly installed in equipment that is packaged for ease of removal for ready maintenance.

Bonded.

Securely and mechanically connected by screws, copper braid, or other means.

Captive Screw.

Screw type fastener retained in some manner so that when unscrewed it can not be easily separated from the part it secures.

Circuit Breaker.

A thermal and / or magnetic device providing overcurrent and short-circuit protection.

Circuit Protector (Interrupter).

A thermal and / or magnetic device providing overcurrent protection only.

Commercial Equipment.

Off-the-shelf equipment that is purchased without modification.

Component.

The smallest field replaceable part that serves to form, compose, or make up a unit. Components are assigned part numbers and are identified in materials and spare parts lists.

Conductor.

A substance or body capable of transmitting electricity, e.g., wires.

Conductor, Bare.

Not covered by electrical insulation.

Conductor, Insulated.

Conductor encased within material recognized as insulation by the National Electrical Code, Article 310.

Control Circuit.

The circuit that carries the electrical signals which direct the performance of the components that control the power circuit.

Daisy-Chain Connections.

Connections made so that the removal of one component connection causes the interruption of the circuit to another component.

DC Common.

A reference for DC output voltages.

Dead Front.

Without live parts exposed to the person on the operating side of the equipment.

Device. A component which is intended to carry but not use electrical energy.

Disconnecting Means.

A device which disconnects the conductors of a circuit from their supply.

Double Insulation.

Insulation comprised of basic and secondary insulation.

Electrical Control Enclosure.

A compartment (box) designed for supporting and enclosing electrical components and devices which have hazardous potentials or hazardous energy levels.

Emergency Off (EMO).

A name applied to an equipment control switch or circuit switch which, when operated, will stop the operation of the associated equipment and will shut off all hazardous potentials and energy levels outside of the associated main power control enclosure.

Emergency Power Off (EPO).

A name applied to a facilities control switch or circuit which, when operated, will shut off power to all if the equipment in the room / area that it controls.

Emergency Return.

A name applied to an equipment control switch or circuit which, when operated, will stop the operation of associated equipment and will return the machine elements to the start "home" position.

Emergency Stop (EMS).

A name applied to an equipment control switch or circuit which, when operated, will stop the operation of associated equipment and will bring all moving parts to a stop.

Fail-Safe.

An electrical system so designed that a failure of any component in the system will prevent unsafe operation of the system.

Ferroresonant Regulator.

A magnetic device usually consisting of a primary winding, secondary windings, and an auxiliary winding connected to a capacitor. The device is used to maintain a constant voltage output during line variations.

Fixed Equipment.

Equipment which is fastened or otherwise secured at a specific location.

Ground.

The conducting mass of the earth having zero potential.

Ground Conductor.

A circuit conductor that is intentionally grounded.

Grounding Conductor (EARTH).

A conductor used to connect conductive metal parts and grounded circuit conductors to ground.

Guard (Shield).

A part or attachment to protect personnel from accidentally contacting a potentially hazardous area.

Hazardous Energy Level.

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

Hazardous Potential.

A voltage exceeding 42.4 V peak, 30 VRMS, 60 VDC or, in wet areas, 10 VAC or DC.

Inadvertent Contact.

Where it is necessary to reach over, under, around, or in close proximity to any hazards.

Interrupt Current.

The maximum current at rated voltages that a device is intended to interrupt.

Isolation Transformer.

A transformer in which the primary winding(s) are isolated from the other windings such that a insulation breakdown either is unlikely or will not cause a hazardous condition.

Large Equipment.

Multiphase equipment and equipment operating at 120 V with 2 kVA or more main protection.

May.

A recommendation of this document.

Movable Equipment.

Equipment which is:

- under 18 kg (40 lb.) in mass, and not fixed.
- equipped with wheels, casters, or other means to facilitate movement by the operator as required to perform its intended use.

Multioutlet Assembly.

A type of raceway that is designed to hold conductors and receptacles. It must be securely fastened in place.

Multiphase Circuit.

A circuit containing two or more ungrounded conductors.

Multiphase Component.

A component with two or more windings.

Must.

A requirement of this document.

Neutral Conductor.

A circuit conductor used to carry the unbalanced current from the other circuit conductors.

Operator Access Area.

An area to which the operator is given deliberate access or which under normal operating conditions can be accessed without the use of a tool.

Overcurrent.

Any current in excess of the rated current of the equipment.

Portable Equipment.

Equipment which is:

- moved while in operation.
- easily moved from one place to another while plugged into its power source.

Raceways.

A tube or channel used for routing wires, cables, or busbars.

Rated Current.

The input current as specified by the manufacturer.

Rated Voltage.

The input voltage as specified by the manufacturer.

Readily Accessible.

Capable of being easily reached for operation, renewal, or inspections without having to climb over or move obstacles.

Receptacle.

A contact device installed for the connection of a single attachment plug.

Service Area.

All areas of the machine or system to which trained personnel must gain access for service, maintenance, or inspection.

Shall.

A requirement of this document.

Should.

A recommendation of this document, other methods of compliance are acceptable providing they meet the intent of the recommendation.

Signal.

A detectable, physical quantity or impulse by which messages or information can be transmitted.

Single-Phase Circuit.

A circuit containing one grounded conductor and one ungrounded conductor.

Single-Phase Component.

A component containing only one winding.

Note: A 208 V single-phase (one winding) motor is installed in a multiphase circuit (two ungrounded conductors).

Small Equipment.

Single-phase equipment operating at 120 V or less with up to 2 kVA main protection.

Stationary Equipment.

Denotes either a fixed machine or a machine whose mass exceeds 18 kg (40 lb.) or a machine which can not easily be moved from one place to another.

Strain Relief.

A means to hold a cord or cable securely so that strain is not placed on the electrical terminations.

Subassembly.

An assembly of electrical or electronic components mounted on a panel or chassis which forms a functional unit by itself.

Supply Disconnect (MAIN).

A means of removing all voltages from the machine circuits.

System.

Two or more units that are electrically or mechanically interconnected.

Temporary Power Tap.

A portable assembly consisting of a connector, a length of flexible cord and an enclosure with one or more receptacles. It shall not incorporate any means for permanent mounting.

Thermal Protection.

A protective device which, when properly applied, protects a motor against overheating.

Trip Free.

A design such that a circuit protection device would open a circuit even if the handle mechanism were held closed.

Undervoltage.

Any reduction, interruption or failure of voltage that may cause equipment to stop or cycle incorrectly.

Unit.

A unit is a portion of a system to which an identification type number is applied. It is supported by a frame or frames and is self-enclosed or designed to be attached to another device. Normally a machine is considered to be a unit.

Utilization Equipment.

Equipment which uses electrical energy for mechanical, chemical, heating, lighting, etc.

Ventilated.

Provided with a means to circulate air.

Voltage, AC.

Unless specifically defined as peak, AC voltages are expressed in RMS (Root Mean Square). To convert peak to RMS, multiply by 0.707.

Voltage, Nominal.

A voltage assigned to a circuit or system that serves as a convenient designation of its voltage class, e.g., 24 V AC or DC, 120 / 208 VAC, and 277 / 480 V AC.

Wet Area.

Any area where liquids are visible on the floor.

Wireway.

Sheet metal trough with hinged or removable cover for housing and protecting electric wires and cables.

Wiring Duct.

Plastic trough with removable cover for housing and protecting electric wires and cables.

Within Sight.

Visible and not more than 50 feet distant.

Working Voltage.

Denotes the voltage to which the part under consideration is subjected when the machine is operating at its rated voltage under the conditions of normal use.