GEORGIA INSTITUTE OF TECHNOLOGY

ENVIRONMENTAL HEALTH AND SAFETY

ELECTRICAL SAFETY GUIDELINES

PURPOSE

To ensure that Georgia Tech employees, students and visitors health and safety are protected during any electrical work activity or exposure.

SCOPE

These guidelines apply to all Georgia Tech personnel and projects involving electrical work activity or exposure.

RESPONSIBILITIES

Supervisor Responsibilities

- Maintain a safe work environment and to assist in verifying that electrical equipment is installed in accordance with applicable codes.
- Ensure the safety of their employees and mitigate hazards within their area of responsibility.
- Provide awareness training to all employees and to observe their work practices.

Environmental, Health and Safety

- Assist in the coordination of the appropriate training for qualified and unqualified workers.
- To provide electrical safety guidelines that is necessary for the practical safeguarding of employees in their workplaces.
- Conduct periodic inspections of work sites to assure that electrical safety guidelines are being followed and provide assistance with corrective actions that may be necessary.

Employee Responsibility

- Test electrical equipment when de-energized.
- Understand and follow the Standard Operating Procedures (SOP), regulatory codes and standards prior to performing electrical work.
- Be aware of potential electrical hazards.
- Use non-conducting or insulated tools and the proper personal protective equipment when working around electricity.
- Stay at least 10 feet away from overhead power lines.
- Never use damaged power tools/electrical cords.
- Do not touch wet electric tools, equipment, or cords.
- Have knowledge and understand the emergency procedures.
- Immediately report any work-related injury/illness.

DEFINITION

Arcing – a type of continuous electric discharge, giving intense light and heat, formed between two electrodes in a gas at low pressure or in open air.

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Authorized Lockout/Tagout Employee - A person who has completed the required hazardous energy control (LOTO) training and is authorized to lockout or tagout a specific machine or equipment to perform service or maintenance.

Confined space - An enclosed space which has limited egress and access, and has an atmospheric hazard.

De-energized electrical work - Electrical work that is performed on equipment that has been previously energized and is now free from any electrical connection.

Disconnecting/Isolating switch - A device designed to close and/or open an electric circuit.

Energized Electrical Work - Repair, maintenance, troubleshooting, or testing on electrical circuits, components, or systems while energized/live.

Energy Source - Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Exposed Electrical Parts - Energized parts that can be inadvertently touched or approached nearer than a safe distance by a person. Parts not suitably guarded, isolated, or insulated. (i.e. terminal contacts/lugs, bare wiring, etc.).

Ground Fault Circuit Interrupt (GFCI) - A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds a predetermined value that is less than that's required to operate the over-current protective device of the supply circuit.

Ground - A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth. Or, to some conducting body that serves in place of the earth.

Hazardous location - An area in which an airborne flammable dust, vapor or gas may be present and would represent a hazard if a source of ignition were present (see National Fire Protection Association (NFPA) Class I & II and Division 1 & 2).

High voltage - Circuits with a nominal voltage more than 600 volts.

Interlock - An electrical, mechanical, or key-locked device intended to prevent an undesired sequence of operations.

Isolating power system – A system comprising an isolating transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors.

Life safety equipment - Equipment that provides critical protection for safety, in the event of an emergency or other serious hazard.

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Lockout - The placement of a lock on an energy-isolating device according to procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout/ Tagout - A standard, that covers the servicing and maintenance of machines and equipment in which the unexpected re-energization of the equipment or release of stored energy could cause injury to employees. **Tagout -** The placement of a tagout device on an energy-isolating device according to procedure to indicate that the equipment may not be operated until the tagout device is removed.

Low voltage - Circuits with a nominal voltage less than or equal to 600 volts.

Switching devices - Devices designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts.

Outlet – A point of the wiring system at which current is taken to supply utilization equipment.

Over-current – Any current in excess of the rated current of equipment of the capacity of a conductor. It may result from overload, short circuit, or ground fault.

Personal Protective Equipment
Employees who work directly with electricity should use the personal protective equipment required for the jobs they perform. This equipment may include rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets designed to reduce electric shock hazard.

Qualified person: One who has received training in and has demonstrated skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.
Note 1: A worker can be considered qualified with regard to certain equipment in the workplace, but "unqualified" as to other equipment. Note 2: An employee who in undergoing on-the-job training and who, in the course of such training , has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

Remote-Control Circuit - Any electric circuit, that controls any other circuit through a relay or an equivalent device.

Service - The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

Service Equipment - The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the entrance of supply conductors to the building and intended to constitute the main control and means of cutoff of the supply.

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Voltage– The difference of electrical potential between two points of an electrical or electronic circuit, expressed in volts. It is the measurement of the potential for an electric field to cause an electric current in an electrical conductor.

Voltage, nominal - An approximate value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240 volts, 480/277 volts, 600 volts). The actual voltage at which a circuit operates can vary from the nominal with a range that permits satisfactory operation of equipment.

GENERAL REQUIREMENTS

Grounding

Grounding a tool or electrical system means intentionally creating a low-resistance path that connects to the earth. This prevents the buildup of voltages that could cause and electrical accident.

A service or system ground is designed primarily to protect machines, tools, and insulation against damage.

An equipment ground helps protect the equipment operator. It furnishes a second path for the current to pass through from the tool or machine to the ground. This additional ground safeguards the operator if a malfunction causes the tool's metal frame to become energized.

Guarding

Guarding involves locating or enclosing electric equipment to make sure people don't accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where it is accessible only to authorized people qualified to work in it.

Equipment of 50 volts or more shall be guarded against accidental contact by approved cabinets or other enclosure of or other means such as;

- By location in a room
- By suitable permanent, substantial partition or screen
- By placement
- By elevation of 8 feet or greater
- Entrances with exposed parts, shall be marked:" Danger", "Warning" or "Caution" Electrical Equipment – Approved Entrant Only"

Equipment over 600volts:

- Installation accessible to qualified persons only
- Working spaces must be according to there minimum clearances

Entrances must be locked at all times

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Entrances must have warning signs: " Danger", "Warning" or "Caution", and beneath that, appropriate concise wording that alerts people to the hazard or gives an instruction, such as "Danger/High Voltage/Keep Out".

Circuit Protection Devises

Circuit protection devices limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. (i.e. fuses, circuit breakers, ground-fault circuit interrupters, and arc-fault circuit interrupters).

Fuses and Circuit Breakers open or break the circuit automatically from too much current flow. Typically, a fuse then melts and a circuit breaker trips the circuit open. Fuses and circuit breakers are designed to protect conductors and equipment. They prevent wires and other components from overheating and open the circuit when there is a risk of a ground fault.

Ground-fault circuit interrupters

GFCIs, are used in wet locations, construction sites, and other high-risk areas. These devices interrupt the flow of electricity within as little as $1/40^{th}$ of a second to prevent electrocution. GFCIs compare the amount of current going into electric equipment with the amount of current returning from it along the circuit conductors. If the difference exceeds 5 milliamperes, the device automatically shuts off the electric power.

Arc-fault device

Arc-fault devices provide protection from the effects of arc-faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc-fault is detected.

PROTECTION

Protection against Electrical Hazards

Safe work practices is a protection, some include:

- De-energizing electric equipment before inspection or repair
- Keeping electric tools properly maintained
- Exercising caution when working near energized line
- Using appropriate protective equipment

Protection against metal parts that become energized

A break in an electric tools or machine insulation can cause its metal parts to become hot or energized, meaning that they conduct electricity. Touching these energized parts can result in an electrical shock, burn, or electrocution. The protection when using electrical tools or machines is to establish a low resistant wire that directs unwanted current directly to the ground.

Protection against unexpected equipment startup

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Proper lockout/tagout procedures protect you from the dangers of the accidental/unexpected startup of electrical equipment. Securing tagging the switch or controls of the machine or equipment being locked out of service is an identification mark that the equipment or circuits are being inspected or repaired. Note: One individual lock and key should be issued to each worker authorized to lock out and tag the equipment. All employees who repair a given piece of equipment should lock out its switch with an individual lock. Only authorized workers should be permitted to remove it. (See Georgia Tech EHS – General Safety Lockout Tagout Procedure)

Protection from overhead power lines

Maintain a safe distance to the overhead power lines and for very high-voltage lines. Ground any equipment such as cranes that can become energized.

Employees unqualified to work with electricity, as well as mechanical equipment, should remain at least 10 feet away from the overhead power lines. If the voltage is more than 50,000 volts, the clearance increases by 4 inches for each additional 10,000 volts.

Tool Safety

Tools must be maintained regularly to protect workers against electric hazards. Check each tool before using it. If you find a defect, immediately remove it from service and tag it so no one will use it until it has been repaired or replaced.

When using a tool to handle energized conductors, check to make sure it is designed and constructed to withstand the voltages and stresses to which it has been exposed.

Basic Electrical Safety Guide

- □ Personal Protective Equipment (PPE) must be tested prior to its use. (i.e. glove must be tested to confirm no tears or pin holes).
- □ Use protective shields, barriers, or insulating materials when working near exposed energized parts.
- □ Ensure all wiring and electrical equipment conforms to all the applicable codes, laws, regulations, and good practices.
- □ Unused openings in cabinets, boxes and fittings shall be effectively closed for systems over 6oo volts:
- □ Covers for boxes shall be permanently marked "High Voltage".
- □ Unless specifically permitted, flexible cords and cables may not be used for the following:
  - As a substitute for fixed wiring
  - Run through holes in wall, ceilings or floors
  - Run through doorway, window or similar areas
  - Attached to buildings surfaces
  - Concealed behind building walls, ceiling or floor
- □ Install electrical equipment in accordance with area restrictions based on real or potential hazards (for example, explosion-proof fixtures, hazardous location classifications, size, voltage, type, etc.).

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☐ Ensure grounding of all electrical equipment, including powered hand tools. Equip all electrical equipment with a ground fault circuit interrupter (GFCI).

☐ Use extension cords only on a temporary basis where fixed wiring is not available. Ensure that they are free from defects, use only in dry areas. Note: Do not present a tripping hazard.

☐ Do not use extension cords to lift or pull equipment. Never tie extension cords or knot them together as this increases the rated resistance and places undue stress upon the insulation and or insulators.

☐ Label electrical equipment.
- All circuitry must be accurately and clearly labeled.
- Mark all disconnecting means, circuitry and/or over-current devices to indicate their purpose.
- Electrical panels, main switches, and transformers must be labeled as to their voltage, current, wattage or other ratings as necessary.
- 600 volt equipment or greater must have controlled access for qualified personnel only.

☐ Guard and secure live electrical equipment.

☐ Guard live parts of electrical equipment operating at fifty volts or more against accidental contact by the use of approved cabinets or other methods of isolation to which only qualified persons have access.

☐ Do not work on live equipment unless a specific procedure is developed to ensure employee protection.

☐ Hazardous locations must be marked as such and clearly state that entry is restricted to qualified individuals.

☐ Maintain electrical equipment and systems.

☐ Inspect electrical equipment on a periodic basis.

☐ Repair or replace exposed wires, frayed cords, and deteriorated insulation.

☐ Keep junction boxes, outlets, switches, and fittings covered.

☐ Ensure cord and plug-connected equipment has grounded connections (for example, electrical appliances, vacuums, blowers, etc.).

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- □ Ensure portable electric hand tools are either double insulated or grounded. Do not remove the third grounding prong or use adapters that do not connect.

- □ Only qualified workers can test instruments and equipment.

Electrical Hazards:

Inadequate wiring	Ungrounded electrical systems and tools	Wires with bad insulation
Exposed electrical parts	Overloaded circuits	Damaged power tools and equipment
Using the wrong PPE and tools	Overhead power lines	Working with electricity in wet/damp environments

Protective Measures

Proper grounding	Using GFCIs
Use of fuses and circuit breakers	Guarding live parts
Proper use of flexible cords	Training

EMERGENCY ACTION

If a person is "frozen" to a live electrical contact, shut off the current immediately. If this is not possible, use boards, poles, or sticks made of **wood or any other non-conducting materials** and safely push or pull the person away from the contact. It is important to act quickly, while remembering to avoid electrocution or shock.

Note: Report all incidents to the immediate supervisor and the Georgia Tech Emergency Line (dial 911/ 404-894-2500)

TRAINING AND COMMUNICATION

Georgia Tech employees involved with electrical work/activity of any sort are at risk and shall be trained in general electrical safety, work practices and procedures.

Qualified persons shall at a minimum be trained in and familiar with exposed live parts, have skills necessary to determine the nominal voltage of exposed live pars; and know the clearance distances and the corresponding voltages to which the qualified person will be exposed.

Employees in the following occupations are at risk and are required to be trained:

- Direct supervisors
- Electrical Engineers
- Electrical Equipment Assemblers
- Electrical technicians
- Electricians
- Industrial machine operators
- Material handling equipment operators
- Mechanics and Repairers
- Painters
- HVAC Mechanics
- Welders
- Maintenance Workers

REFERENCES

External - American National Standards Institute (ANSI) Standards Z89.1; Z87.1; Z41
External - American Standards for Testing of Materials (ASTM) for Electrical Protective Equipment
External - OSHA Regulations, Subpart S - 1910.301
External - National Fire Protection Association (NFPA) Article 70
Internal - Georgia Tech – Lock Out/ Tag Out Procedure