ARIZONA STATE UNIVERSITY

Environmental Health & Safety

Electrical Work Safety Program
October 2016

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INTRODUCTION:

The mission of Environmental Health and Safety Department is to:

Assist individuals and departments in achieving compliance to all health and safety standards by establishing safe work practices through education, training and the hazard review process resulting in a safe and healthy work environment for every member of the university community; In addition, act as liaison with external regulatory agencies and monitor university compliance to mandatory health and safety regulations.

Purpose

The primary purpose of this program is to prevent electrical shock and injury. This program meets the requirements of EHS 118: Electrical Safe Work Practices http://www.asu.edu/aad/manuals/ehs/ehs118.html. Whenever possible ASU employees will de-energize systems as the primary method of hazard control and use appropriate "Lockout and Tag out" procedures. If an electrical system cannot be de-energized, then only qualified personnel as specified under 29CFR1910, Subpart S will work on the system using the appropriate personal protective equipment as specified in this program and under NFPA 70E.

Employees who face a risk of electrical shock or related injuries must be trained in appropriate electrical safety work practices. In addition, employees that work around, but not on electrical systems must also be trained in the hazards associated with electricity.

Application

This program applies to all ASU campuses, all work performed on the university campus, and to any work performed by ASU employees regardless of jobsite location. All employees who face a risk of electrical shock, burns or related injuries must be trained in electrical safe work practices. These work practices must always be followed. In addition, employees that work around, but not on electrical systems must be trained in the inherent danger of electricity. This Electrical Safety Program describes work practices for both *qualified* and *unqualified* persons. This program also covers academic and research activities requiring work on or diagnosis of any energized electrical systems.

Scope

Each department that performs work covered by this program must designate one or more employee(s) to assist in coordination of the requirements of this program at the departmental levels. Furthermore, it is recommended that each work unit supervisor that oversees work covered by this program be designated to coordinate this program in their work area. These program coordinators will assist ASU EH&S with identifying training departmental members that work on or near electrical systems and they will review and verify the skills and competency of their co-workers. Work practices covered by this program include persons working on or near;

Electrical Distribution System or Energized Equipment: Installation, repair, servicing and diagnostic work on power transmission or distribution systems, panels, outlets, breakers and such items associated with power supply systems and all mechanical energized equipment, including;

Premises wiring: Installations of electric conductors and equipment in or on buildings or other structures, and in other areas such as yards, parking and other lots, and industrial substations.

Wiring for connection to supply sources.

Installation of conductors that connect to the supply of electricity.

Other wiring: Installation of other outside conductors on the premises.

Optical fiber cable: Installation of optical fiber cable near or with electric wiring.

Equipment and Related Systems: Any and all installations involving machinery, energized systems and equipment.

Work practices covered by this program also includes work performed by *unqualified* persons near or with electric power generation, transmission, and distribution installations and communications installations.

This program does not apply to:

Work performed by qualified persons on or directly associated with electric power generation, transmission, and distribution, including the repair of overhead or underground distribution lines, line clearance tree trimming and utility pole replacement.

Work in a generating plant where the electric circuits are commingled with power generation equipment or circuits and where there is exposure to high voltage or lack of over-current protection.

Definitions

Accessible - (Readily Accessible) Capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc.

Arc Rating – The maximum incident energy resistance demonstrated by a material (or layered system of materials) prior to break open or at the onset of a second-degree skin burn. Arc rating is normally expressed in cal/cm^2.

Break open – is a material response evidenced by the formation of one or more holes in the innermost layer of flame-resistant material that would allow flame to pass through the material.

Deenergized – Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential difference from that of the earth.

Disconnecting Means - A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

Electrical Hazard – A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn or blast.

Energized - Electrically connected to or having a source of voltage.

Feeder - All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit over-current device.

Flash Hazard – A dangerous condition associated with the release of energy caused by an electric arc.

Flash Hazard Analysis – A study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of PPE.

Flash Protection Boundary – An approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur.

Ground - Connected to earth or to some conducting body that serves in place of the earth.

Grounded, Effectively - Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazards to connected equipment or to persons.

High Voltage - Voltage exceeds 600 volts.

Isolated - (as applied to location). Not readily accessible to persons unless special means for access are used.

Low Voltage - Subject to or capable of operating under relative low voltage, for the purposes of this program 0 to 50 volts.

On-The-Job-Training (OJT) - An employee undergoing on-the-job training who has demonstrated the 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 purpose of those duties.

Prohibited Approach Boundary – An approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part.

Qualified Persons **–** are those who have received specific training and have demonstrated the skills necessary to work safely on or near exposed energized parts. A person may be qualified to work, for example, on circuits up to 600 volts, but may be unqualified to work on higher voltages. Only qualified persons, who have also successfully completed the ASU LOTO Program, may place or remove locks and tags on energized electrical systems.

Unqualified Persons – are those with little or no such training or limited experience.

Responsibilities

Environmental Health & Safety (EH&S)

ASU EH&S is responsible for developing, implementing, and administering the Electrical Safety Program for the University. This involves;

- Training supervisors and designated departmental program coordinators and their employees on this program. (specific electrical training will be obtained from nationally recognized resources or equipment manufacturer's or trade schools)
- Maintaining centralized records of training, energy control procedures and inspection data and reports.
- Providing technical assistance to university personnel and departments.
- Developing and maintaining the written program, training programs and other training resources that can be used by university personnel.
- Evaluating the overall effectiveness of the Electrical Safety Program on a periodic basis and making the necessary changes.

The effectiveness of the electrical safety program will be periodically reviewed by ASU EH&S. If deficiencies are found, with the program or employee training, the program will be modified to address these deficiencies by ASU EH&S on an as needed basis or every three (3) years.

Departmental Responsibilities

Departments are expected to maintain a safe and healthy working environment for their faculty, staff, students and visitors to our campus. Departments are expected to assure that all employees are thoroughly familiar with their safety responsibilities and that safety practices are followed at all times. Departmental worksites should be inspected on a frequent basis to identify and correct hazards. Employees are expected to comply with all safety requirements and act proactively to prevent accidents and injuries by communicating hazards to supervisors or reporting concerns directly to ASU EH&S offices.

Contractors

Contractors must comply with all local, state, and federal safety requirements and assure that all of their employees and sub-contractors performing work on ASU property have been suitably trained. Contractors must comply with the requirements under Arizona Department of Occupational Safety and Health (ADOSH) for General and Construction Industry Standards.

Training

Employees who face a risk of electrical hazards that are not reduced to a safe level by the electrical installation must be trained per the requirements of this program. Employees in the following occupations must be trained:

Any employee who faces a risk of injury due to electric shock or electrical hazards.
Supervisors of employees performing work around or on electrical systems
Electricians
Material handling equipment operators
Mechanics and repairers
HVAC Technicians
Painters

Electrical and electronic engineers
Industrial machine operators
Electrical/ electronic equipment assemblers
Welders
Electrical and electronic technicians
Researchers
Instructors & Student Workers
Engineers
Project Managers
Custodial

Note: Employees in these groups do not require training if their work does not bring them close enough to exposed parts of electric circuits operating at or above 50 volts.

Qualified persons working on or near exposed energized parts must receive training in the following:

- The skills and techniques necessary to distinguish exposed live parts from other parts of electrical equipment;
- The skills and techniques necessary to determine the nominal voltage of exposed live parts; and
- The clearance distances specified for working on or near exposed energized parts and the corresponding voltages to which the qualified person will be exposed.
- Appropriate safety equipment and tools necessary to safely perform work in accordance with OSHA and NFPA 70E.

Qualified persons whose work on energized equipment involves either direct contact with or contact by means of tools or materials must be trained on how to work safely on energized circuits. These employees must be familiar with proper precautionary work practices, personal protective equipment, insulating, shielding materials and the use of insulated tools. The training for both qualified and unqualified employees will involve both classroom and on-the-job training. This training will be coordinated between ASU EH&S and the work unit supervisor, and customized to reflect the scope of work performed within that work unit. The work unit supervisor will coordinate the review of the work performed by each employee to assure that they demonstrate the skills and techniques needed to perform their work safely on an annual basis.

- Training must be performed before the employee is assigned duties involving work around or on electrical systems.
- Retraining will be performed whenever inspections performed by ASU EH&S or the employee's supervisor indicates that an employee does not have the necessary knowledge or skills to safely work on or around electrical systems. Retraining will also be performed when policies or procedures change and/or new equipment or systems are introduced into the work area.
- Refresher training once every two to three years is recommended to maintain safe work practices skills and knowledge.

Electrical Installation Requirements

Recognized Hazards

Electrical equipment must be free from recognized hazards that are likely to cause death or serious physical harm. Equipment must be suitable for the installation and use, and must be installed and maintained in accordance with the manufacturer instructions, the National Electrical Code (NEC) and OSHA. "*Suitable*" means that the equipment is listed or labeled for the intended use by a nationally recognized testing laboratory such as Factory Mutual (FM) or Underwriters Laboratory (UL). Personnel working on energized electrical systems must be aware of the Hazard Risk Category of electrical systems and equipment within the flash protection boundaries. Table 1 below can assist in identifying the hazard class and risk associated with recognized electrical hazards associated with varies voltages and work classifications.

Table 1 Hazard Risk Category Classification (within flash protection boundary, source NFPA 70E)

For low-voltage tasks (600 volts and below), this table applies only when there is an available short-circuit capacity of 25 kA or less, and when the fault clearing time is 0.03 seconds (2 cycles) or less. For 600-volt-class motor control centers, a short-circuit current capacity of 65 kA or less and fault-clearing time of 0.33 seconds (20 cycles) is allowed. For 600-volt-class switchgear, you need a short-circuit current capacity of 65 kA or less and fault-clearing time of 1 second (60 cycles). For tasks not covered in this table and tasks involving equipment with larger short-circuit current capacities or longer fault-clearing times, a qualified person must conduct a flash hazard analysis (see section 2-1.3.3, Part II, NFPA 70E).

		Hazard/Risk Category	Voltage-Rated Gloves	Tools
Opening Doors and Covers				
Opening hinged covers (to expose bare, energized parts)				
	240 volts or less	0	N	N
	600-volt-class motor control centers	1	N	N
	600-volt-class lighting or small power transformers	1	N	N
	600-volt-class switchgear (with power circuit breakers or fused switches)	2	N	N
	NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	3	N	N
	1 kV and over (metal clad switchgear)	3	N	N
	1 kV and above metal clad load interrupter switches, fused or unfused	3	N	N
Removing bolted covers (to expose bare, energized parts)				
	240 volts or less	1	N	N
	600-volt-class motor control centers or	2*	N	N

	transformers			
	600-volt-class lighting or small power transformers	2*	N	N
	600-volt-class switchgear (with power circuit breakers or fused switches)	3	N	N
	NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	4	N	N
	1 kV and above (metal clad switchgear)	4	N	N
	1 kV and above metal clad load interrupter switches, fused or unfused	4	N	N
Opening transformer compartments for metal clad switchgear 1 kV and above		4	N	N
<u>Installing, Removing or Operating Circuit Breakers (CBs), Fused Switches, Motor Starters or Fused Contactors</u>				
Installing or removing circuit breakers or fused switches, 240 volts or less		1	Y	Y
Inserting or removing (racking) CBs from cubicles, doors closed				
	600-volt-class switchgear (with power circuit breakers or fused switches)	2	N	N
	NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	2	N	N
	1 kV and above metal clad switchgear	2	N	N
Inserting or removing (racking) CBs or starters from cubicles, doors open				
	600-volt-class switchgear (with power circuit breakers or fused switches)	3	N	N
	NEMA E2 (fused contactor) Motor Starters, 2.3 kV through 7.2 kV	3	N	N
	1 kV and above metal clad switchgear	4	N	N
Operating circuit breaker (CB), fused switch, motor starter or fused contactor, covers on/doors closed				
	240 volts or less	0	N	N
	>240-<600 volt panel boards/switchboards (molded case or insulated case CBs)	0	N	N
	600 volt class motor control centers	0	N	N
	600 volt class switchgear (with power circuit breakers or fused switches)	0	N	N
	NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	0	N	N
	1 kV and above (metal clad switchgear)	2	N	N
	1 kV and above metal clad load interrupter switches, fused or unfused	2	N	N

Operating circuit breaker, fused switch, motor starter or fused contactor, covers off/doors open			
240 volts or less	0	N	N
>240-<600 volt panel boards/switchboards (molded case or insulated case CBs)	1	N	N
600 volt class motor control centers	1	N	N
600 volt class switchgear (with power circuit breakers or fused switches)	1	N	N
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	2*	N	N
1 kV and above (metal clad switchgear)	4	N	N

Working on Energized Parts			
Working on energized parts, voltage testing, applying safety grounds			
240 volts or less	1	Y	Y
>240-<600 volt panel boards/switchboards (molded case or insulated case CBs)	2*	Y	Y
600-volt-class motor control centers	2*	Y	Y
600-volt-class switchgear (with power circuit breakers or fused switches)	2*	Y	Y
600-volt-class lighting or small power transformers	2*	Y	Y
600-volt-class revenue meters	2*	Y	Y
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	3	Y	Y
1 kV and above metal clad switchgear	4	Y	Y
1 kV and above metal clad load interrupter switches, fused or unfused	4	Y	Y
Working on control circuits with exposed energized parts, 120 volts or below			
600-volt-class motor control centers	0	Y	Y
600-volt-class switchgear (with power circuit breakers or fused switches	0	Y	Y
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	0	Y	Y
1 kV and above metal clad switchgear	2	Y	Y
Working on control circuits with exposed energized parts, over 120 volts			
600-volt-class Motor Control Centers	2*	Y	Y
600-volt-class switchgear (with power circuit breakers or fused switches)	2*	Y	Y
NEMA E2 (fused contactor) motor starters, 2.3 kV	3	Y	Y

	through 7.2 kV			
	1 kV and above metal clad switchgear	4	Y	Y
Other Tasks				
Reading panel meters while operating meter switches		0	N	N
Metal clad load interrupter switches, fused or unfused, 1 kV and above				
	Outdoor disconnect switch operation (hook stick operated)	3	Y	Y
	Outdoor disconnect switch operation (gang-operated, from grade)	2	N	N
	Insulated cable examination, in open area	2	Y	N
	Insulated cable examination, in manhole or other confined space	4	Y	N
Removing/installing other equipment				
	Starter "buckets" for 600-volt-class motor control centers	3	Y	N
	600-volt-class revenue meters	2*	Y	N
	Covers or cable troughs for 600-volt-class revenue meters	1	N	N

Footnotes:

2* = A double-layer switching hood and hearing protection are required, in addition to the other hazard/risk category 2 requirements of table 3-3.9.2 of Part II of NFPA 70E. *See* tables 3 and 4.

kV = kilovolt

Note: Applying safety grounds after voltage testing does not require voltage-rated tools. Voltage-rated gloves or tools are rated and tested for the maximum line-to-line voltage on which work will be done. The hazard/risk category may be reduced by one number for low-voltage equipment listed here where the short-circuit current available is less than 15 kA (less than 25 kA for 600-volt-class switchgear).

Source: Adapted from table 3-3.9.1, Hazard Risk Category Classifications (*NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces, 2004 edition*.

Labeling of Disconnects

Each disconnecting means—the switch or device used to disconnect the circuit from the power source must be clearly labeled to indicate the circuit's function, unless it is located and arranged so the purpose is evident. Identification should be specific rather than general. For example, a branch circuit serving receptacles in a main office should be labeled as such, not simply labeled "receptacles". All labels and marking must be durable enough to withstand the environment to which they may be exposed.

New Installations – All new installations should be labeled in accordance with NFPA 70E labeling standards.

Existing Installations – All existing installations will be evaluated and labeled accordingly with "Arc Flash" rating and the "Hazard Risk Category". These installations and the arc flash rating will be conducted by an experienced electrical professional in accordance with NFPA 70E.

Guarding of Live Parts

Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact. Proper guarding can be achieved by use of an approved cabinet or other approved enclosure, by location in a room or vault that is accessible to qualified persons only, or by elevating the equipment or controlling the arrangement of the space to prevent contact by *unqualified* persons. If electric equipment is located in an area where it is potentially exposed to physical damage, the enclosure or guard must be of sufficient strength to prevent such damage.

General Wiring Design and Protection

New electrical wiring, and the modification, extension or replacement of existing wiring must conform to the requirements of the NEC, the Uniform Building Code, OSHA and the following:

1. No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.
2. The grounding terminal or grounding-type device on receptacles, cord connector, or attachment plug may not be used for any purpose other than grounding.
3. Conductors and equipment must be protected from over-current above their safe current carrying capacity.
4. All AC systems of 50 to 1,000 volts must normally be grounded as required by the NEC and OSHA. The path to ground from circuits, equipment and enclosures must be permanent and continuous. Existing ungrounded premises wiring do not meet the OSHA requirements and must be replaced or modified as needed to meet this requirement. For information on exceptions to these requirements, please contact ASU EH&S.

- Conductors entering boxes, cabinets or fittings must be protected from abrasion, and openings through which conductors enter must be effectively closed. Unused openings in cabinets, boxes and fixtures must also be effectively closed.
- All pull boxes, junction boxes and fittings must be provided with covers approved for the purpose. If metal covers are used they must be grounded. In completed installations, each outlet box must have a cover, faceplate or fixture canopy. Pull boxes and junction boxes for systems over 600 volts, nominal, must provide complete enclosure, the boxes must be closed by suitable covers securely fastened in place and the cover must be permanently marked "High Voltage".
- Switchboards and panel-boards that have exposed live parts must be located in permanently dry locations and accessible to qualified persons only. Panel-boards must be mounted in cabinets, cutout boxes or other approved enclosure and must be dead

front unless accessible to qualified persons only. Exposed blades of knife switches must be dead when open. Receptacles installed in damp or wet locations must be suitable for the location.

- Cabinets, cutout boxes, fittings, boxes and panel-board enclosures in damp or wet locations must be installed so as to prevent moisture or water from entering and accumulating within the enclosure. In wet locations the enclosures must be weatherproof.
  - Fixtures, lamp holders, lamps, rosettes, and receptacles may have no live parts normally exposed to employee contact.
  - Screw-base light socket adapters do not maintain ground continuity and may not be used.
  - Multi-plug receptacle adapters that may not maintain ground continuity or may overload circuits must not be used. If additional receptacles are needed in a work location, additional circuits and/or receptacles must be installed. Multi-plug power strips with over-current protection are acceptable for use with electronic equipment if they are used to reduce line noise or to provide surge or over-current protection.
  - Electrical equipment, wiring methods and installations of equipment in hazardous classified locations must be intrinsically safe, approved for the location, or safe for the location. Hazardous classified locations are areas where flammable liquids, gases, vapors, or combustible dusts or fibers exist or could exist in sufficient quantities to produce an explosion or fire.

Requirements for Temporary Wiring

Temporary electrical power and lighting installations 600 volts or less, including flexible cords, cables and extension cords may only be used during and for renovation, maintenance, repair or experimental work. Temporary wiring may also be used for decorative lighting for special events and similar purposes for a period not to exceed 90 days. The following additional requirements apply:

Ground-fault protection (e.g., ground-fault circuit interrupters or GFCI) must be provided on all temporary-wiring circuits, including extension cords.

In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded. For information on exceptions to these requirements, please contact ASU EH&S.

Feeders must originate in an approved distribution center, such as a panel board that is rated for the voltages and currents the system is expected to carry.

Branch circuits must originate in an approved power outlet or panel board.

Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.

Receptacles must be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.

Flexible cords and cables must be of an approved type and suitable for the location and intended use. They may only be used for pendants, wiring of fixtures, connection of portable lamps or appliances, elevators, hoists, connection of stationary equipment

where frequently interchanged, prevention of transmission of noise or vibration, data processing cables, or where needed to permit maintenance or repair. They may not be used as a substitute for the fixed wiring, where run through holes in walls, ceilings or floors, where run through doorways, windows or similar openings, where attached to building surfaces, or where concealed behind building walls, ceilings or floors.

Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture or by providing a suitable guard. Hand lamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.

Flexible cords and cables must be protected from accidental damage. Sharp corners and projections are to be avoided. Flexible cords and cables must be protected from damage when they pass through doorways or other pinch points. Temporary cords may not exceed 90 days.

Open Conductors, Clearance from Ground

Open conductors must be located at least 10 feet above any finished grade, sidewalk or projection, 12 feet above areas subject to non-truck traffic, 15 feet above areas subject to truck traffic, and 18 feet above public streets, roads or driveways.

Entrances and Access to Workspace

In any workspace where there is electric equipment operating at over 600 volts, there must be at least one entrance at least 24 inches wide and 6 feet, 6 inches high to permit escape in the event of an emergency. The hazard should not impede the escape route. Any exposed energized conductors operating at any voltage and located near the entrance must be guarded to prevent accidental contact. Any insulated energized conductors operating at over 600 volts and located next to the entrance must also be guarded.

If switches, cutouts, or other equipment operating at 600 volts, nominal, or less, are installed in a room or enclosure where there are exposed live parts or exposed wiring operating at over 600 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen. However, switches or other equipment operating at 600 volts, nominal, or less, and serving only equipment within the high-voltage vault, room, or enclosure may be installed in the high-voltage enclosure, room, or vault if accessible to qualified persons only.

Working Space about Electric Equipment

Sufficient access and working space must be provided and maintained around all electric equipment to allow ready and safe operation or maintenance of the equipment. Working clearances may not be less than 30 inches in front of electric equipment. Except as permitted by OSHA or the NEC, the working space in front of live parts operating at 600 volts or less that requires servicing, inspection or maintenance while

energized may not be less than indicated in Table 2. This working space may not be used for storage.

Table 2 Working Clearances (NEC - Table 110.16(a) & 110.34(a))

Nominal Voltage to Ground	Minimum Clear Distance for Condition (3)		
	A	B	C
0-150	3' (1)	3' (1)	3'
151-600	3' (1)	3-1/2'	4'
601-2,500	3'	4'	5'
2,501-9,000	4'	5'	6'
9,001-25,000	5'	6'	9'
25,001-75 kV (2)	6'	8'	10'
Above 75 kV (2)	8'	10'	12'

Footnotes:

(1) Minimum clear distance may be 2-1/2' for installations built prior to April 16, 1981.

(2) Minimum clear distance in front of electrical equipment with nominal voltage to ground above 25 kV may be the same as for 25 kV under conditions A, B and C for installations built prior to April 16, 1981.

(3) Conditions A, B and C are as follows: (A) Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides are effectively guarded by an insulating material. Insulated wire or insulated bus bars operating at not over 300 volts are not considered live parts. Concrete, brick or tile walls are considered to be grounded. (B) Exposed live parts on one side and grounded parts on the other. (C) Exposed live parts on both sides of the workspace not guarded as per condition (A), with the operator between.

Selection and Use of Work Practices
Working on Electrical Systems

The work practices used by an employee must be sufficient to prevent electric shock or other injuries that could result from either direct or indirect electrical contact. These work practices must be used when work is performed near or on equipment or circuits that are or may be energized. The work practices used must be consistent with the nature and extent of the electrical hazard.

Energized Parts

Only qualified employees are allowed to work on electric parts or equipment that has not been de-energized. Live parts to which an employee may be exposed will be de-energized using approved lockout/tagout procedures before the employee works on or near them, unless:

- De-energizing introduces additional or increased hazards. Examples of "additional or increased" hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of fume hood ventilation systems, or removal of illumination for an area.
- De-energizing is not possible due to equipment design or operational limitations. Examples include testing that can only be performed with the electrical circuit energized, and work on circuits that form an integral part of a continuous process that would need to be completely shut down in order to permit work on one circuit or piece of equipment.
- Live parts operate at less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electric arcs.

If de-energizing exposed live parts can add to or increase the hazard or is not possible, then other approved work practices must be used to protect employees who may be exposed to the electrical hazards. The work practices used must protect employees from contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object. The work practices used must be suitable for the conditions under which the work is performed and for the voltages of exposed electric conductors or circuit parts, Approach boundary distances must be maintained (Table 3).

Table 3 Approach Boundary Distances to Exposed Energized Electrical Conductors/Circuit Parts.

Nominal System Voltage Range	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary
Phase to Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	Includes Standard Inadvertent Movement Adder*	Includes Reduced Inadvertent Movement Adder*
Less than 300 V	10.0 ft.	3.5 ft.	AVOID CONTACT	AVOID CONTACT
300 V to 750 V	10.0 ft.	3.5 ft.	1.0 ft.	1 in.
Over 750 V, to 2000 V	10.0 ft.	4.0 ft.	2.0 ft.	3 in.

NOTE: When assessing distance, include the length of any conductive tools being used to perform work. For SI units: 1 in. = 25.4 mm and 1 ft. = 0.305 m.

De-energized Parts: When employees work on exposed de-energized parts or near enough to them to expose the employee to an electrical hazard, then the following safety-related work practices will be followed.

- Any conductors or parts of electric equipment that have not been properly locked and/or tagged out must be treated as energized even if these systems have been de-energized.
- If the potential exists for an employee to contact parts of fixed electric equipment or circuits that have been de-energized, the circuits energizing the parts must be locked and/or tagged out. Locking and tagging procedures must comply with Arizona State University's Lockout/Tagout Program and the requirements outlined in this program. A copy of this program may be obtained by contacting ASU EH&S at (480) 965-1823 or may be downloaded from http://www.asu.edu/uagc/EHS/documents/lockout_tagout_program.pdf.
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Note: Stored electrical energy may remain in capacitors and battery banks and other components after source or sources have been de-energized. Appropriate care must be taken and the use of "grounding wands" where provided to dissipate any stored charge.

De-energizing Equipment Safe procedures for de-energizing circuits and equipment will be determined by a qualified worker before the circuit or equipment is de-energized.

- Circuits and equipment to be worked on will be disconnected by the worker from all electric energy sources. Control circuit devices, such as push buttons, selector switches, and interlocks will not be used as the sole means for de-energizing circuits or equipment. Interlocks for electric equipment may not be used as a substitute for lockout and tagging procedures unless designed by the manufacturer.
- Stored electrical energy that might endanger personnel must be released prior to the work. This might include, for example, discharging capacitors, short-circuiting and grounding high capacitance elements. If the capacitors or associated equipment are handled during this work, they must be treated as energized.
- Stored non-electrical energy (for example, hydraulic or pneumatic) in devices that could energize electric circuit parts must be blocked or relieved so that circuit parts cannot be accidentally re-energized by the device. Follow ASU Lockout/Tagout procedures.
- A lock and tag must be placed on each disconnecting means used to de-energize circuits and equipment on which work is to be done. The lock must be attached so as to prevent persons from re-energizing the circuit unless they resort to undue force or the use of tools.
- If the system or equipment will remain inoperable for a period of time the lock and tag must be replaced with an "Equipment Down" tag and a secured equipment lock. Locks used for lockout/tagout purposes are only temporary while working on systems.

- Verification of De-energized Condition: The following requirements must be met before any circuit or equipment is considered de-energized or may be worked on as de-energized.
    1. A qualified person must activate the equipment operating controls or use other methods to verify that the equipment cannot be restarted.
    2. A qualified person must use test equipment to ensure that electrical parts and circuit elements are de-energized. The test must confirm there is no energized condition from induced voltage or voltage back feed.
    3. Test equipment and instruments must be visually inspected for external defects or damage before being used to verify that the equipment or circuit is de-energized.
    4. When voltage over 600 volts nominal are tested, the test equipment must be checked for proper operation immediately before and after the test.

Re-energizing Equipment

In addition to the requirements of the Lockout/Tagout Program, the following requirements must be met, in the order given before circuits or equipment are re-energized, even temporarily:

- A qualified person must conduct tests and visual inspections as necessary to verify that all tools, electrical jumpers, shorts, grounds and other such devices have been removed so that circuits and equipment can be safely energized;
- Employees potentially exposed to the hazards of re-energizing of the circuit must be warned to stay clear; and,
- Each employee removes his or her lock(s) and tag(s).

Overhead Power Lines

When work is to be performed near overhead lines, the lines must be de-energized and grounded. Arrangements must be made with the organization (utility) that operates or controls the electric circuits when lines are to be de-energized and grounded. ASU personnel do not perform these operations as part of their routine job functions, special work permit and job safe analysis must be performed before such work can begin. If this is not possible to de-energize and ground overhead lines, then other protective measures, such as guarding, isolating or insulating, must be taken before the work is started. These protective measures must prevent direct contact by the qualified person or indirect contact through conductive materials, tools, or equipment. Only qualified persons from the power distribution company are allowed to install insulating devices on overhead power transmission and distribution lines. All other persons, and any conductive object used by these employees, may not approach closer than the minimum distance specified in Table 1 when working in an elevated location near unguarded, energized overhead lines. Unqualified persons working on the ground are not allowed to bring any conductive object or any insulated object that does not have the proper insulating rating closer to unguarded, energized overhead lines than the distance allowed in Table 4.

TABLE 4 Overhead Power Line Distances (adopted from 1910.269(I) (10) Table R-6**)**

Voltage to Ground	Minimum Approach Distance
50 kV or less	10 feet
Over 50 kV	10 feet + 4 inches for every 10 kV over 50 kV

Qualified employees working in the vicinity of overhead lines, whether in an elevated position or on the ground are not allowed to approach or take any conductive object without an approved insulating handle closer to exposed energized parts than allowed in Table 4 unless:

- The person is insulated from the energized part by using gloves, with sleeves if necessary, rated for the voltage involved; or
- The energized part is insulated from all other conductive objects at a different potential and from the person; or
- The person is insulated from all conductive objects at a potential different from the energized part.

Vehicles and Mechanical Equipment

A minimum clearance of 10 feet must be maintained between energized overhead lines and all vehicles or mechanical equipment capable of having parts or its structure elevated (e.g., cranes, mobile scaffolds, elevating platforms, dump trucks, lift trucks, and flatbed trailer cranes). If the voltage of the overhead line is greater than 50 kV, the clearance must be increased by 6 inches for every 10 kV over 50 kV. A spotter must be used at all times. The clearance requirement may be reduced if:

- The vehicle is in transit with its structure lowered. The clearance may be reduced to 4 feet when near energized lines operating at less than 50 kV, or 4 ft. plus 6 inches for every 10 kV over 50 kV.
- Insulating barriers are installed to prevent contact with the lines and the barriers are rated for the voltage of the line being guarded. The barrier may not be part of an attachment to the vehicle or its raised structure. The clearance may be reduced to the distance allowed by the design of the insulating barrier.
- The equipment is an aerial lift insulated for the voltage involved and the work is performed by a qualified person. The clearance between the un-insulated portion of the lift and the power line may be reduced to the distance given in Table 3.
  NOTE: Persons working on the ground are not allowed to contact the vehicle or mechanical equipment or any of its attachments, unless:

  The person uses protective equipment rated for the voltage; or
  The equipment is located so that no un-insulated part of its structure can provide a conductive path to persons on the ground. Equipment shall not approach

closer to the line than 10 feet for voltages less than 50 kV, or 10 feet plus 6 inches for every 10 kV over 50 kV.

When any vehicle or mechanical equipment is intentionally grounded, persons may not stand near the point of grounding when there is any possibility of contact with overhead energized lines. Additional precautions (e.g., such as the use of barricades or insulation) must be taken as necessary to protect persons from hazardous ground potentials that can develop within a few feet or more outward from the grounding point.

Illumination

Employees may not enter spaces containing exposed energized parts unless there is sufficient illumination for them to perform the work safely. Employees may not perform tasks near exposed energized parts where there is lack of illumination or an obstruction that blocks his or her view of the work to be performed. Do not reach blindly into areas that may contain energized parts.

Confined or Enclosed Work Spaces

Employees working in manholes, vaults or similar confined or enclosed spaces that contain exposed energized parts must be provided with, and must use, protective shields, protective barriers, or insulating materials as needed to prevent inadvertent contact with these energized parts. Doors and hinged panels that could swing into an employee and cause him or her to contact exposed energized parts must be secured before work begins. Work performed within confined or enclosed spaces must comply with ASU's Confined Space Program (EHS 102) or may be downloaded from *http://www.asu.edu/aad/manuals/ehs/ehs102.html*.

Conductive Materials and Equipment

Conductive materials and equipment that are in contact with any part of an employees' body must be handled in a manner that will prevent them from contacting exposed energized conductors or circuit parts. If an employee must handle long conductive objects, such as metal ducts, pipes, or rods, in areas with exposed live parts, then insulation, guarding and/or approved materials handling techniques must be used which will minimize the hazard.

Portable Ladders

A portable ladder used where there is potential for contact with exposed energized parts must have nonconductive side rails.

Conductive Apparel

Employees may not wear conductive articles of jewelry and clothing, such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear, if they might contact exposed energized parts.

Housekeeping

Housekeeping duties may not be performed close to live parts unless adequate safeguards, such as insulating equipment or barriers, are provided. Electrically conductive cleaning materials, including steel wool, metalized cloth and silicon carbide, as well as conductive liquid solutions, may not be used near energized parts unless procedures are followed which prevent electrical contact, typically through de-energization.

Interlocks

Only qualified persons are allowed to bypass electrical safety interlocks, and then only temporarily while working on the equipment. This work must comply with the specified procedures for working on or near exposed energized parts. The interlock system must be returned to its operable condition when the work is completed.

Portable Electrical Equipment and Extension Cords

The following requirements apply to the use of cord and plug connected equipment and flexible cord sets (extension cords):

- Extension cords may only be used to provide temporary power.
- Portable cord and plug connected equipment and extension cords must be visually inspected before use on any shift for external defects such as loose parts, deformed and missing pins, or damage to outer jacket or insulation, and for possible internal damage such as pinched or crushed outer jacket. Any defective cord or cord and plug connected equipment must be removed from service and no person may use it until it is repaired and tested to ensure it is safe for use.
- Extension cords must be of the three-wire type. Extension cords and flexible cords must be designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval must be visible.
- Job-made extension cords may only be built by qualified persons and must be tested and certified prior to use. Job-made extension cords may only be constructed using parts approved for this use. Metal electrical boxes with knockouts, for example, may not be used for job-made extension cords.
- Personnel performing work on renovation or construction sites using extension cords or where work is performed in damp or wet locations must be provided and must use a ground-fault circuit interrupter (GFCI).
- Portable equipment must be handled in a manner that will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.
- Extension cords must be protected from damage. Sharp corners and projections must be avoided. Flexible cords may not be run through windows, doors or walls unless protected from damage, and then only on a temporary basis. Flexible cords may not be run above ceilings or inside or through walls, ceilings or floors, and may

not to be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.

- Cords must be covered by a cord protector or tape when they extend into a walkway or other path of travel to avoid creating a trip hazard.
- Extension cords used with grounding-type equipment must contain an equipment-grounding conductor (i.e., the cord must accept a three-prong, or grounded plug).
- Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.
- Flexible cords may only be plugged into grounded receptacles. The continuity of the ground in a two-prong outlet must be verified before use with a flexible cord, and it is recommended that the receptacle be replaced with a three-prong outlet. Adapters that interrupt the continuity of the equipment grounding connection may not be used.
- All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where employees are likely to contact water or conductive liquids must be approved for those locations.
- Employee's hands must not be wet when plugging and unplugging flexible cords and cord and plug connected equipment, if energized equipment is involved.
- If the connection could provide a conducting path to employees hands (for example, if a cord connector is wet from being immersed in water) the energized plug and receptacle connections must be handled only with insulating protective equipment.
- Locking-type connectors must be properly locked into the connector.
- Lamps for general illumination must be protected from breakage and metal shell sockets must be grounded.
- Temporary lights must not be suspended by their cords unless they have been designed for this purpose.
- Portable lighting used in wet or conductive locations, such as tanks or boilers, must be operated at no more than 12 volts or must be protected by Ground Fault Circuit Interrupters (GFCI's).

NOTE: Extension cords are considered to be temporary wiring, and must also comply with the section on "Requirements for Temporary Wiring" in this program.

Electric Power and Lighting Circuits

Routine Opening and Closing of Circuits

Load rated switches, circuit breakers, or other devices specifically designed as disconnecting means must be used for the opening, reversing or closing of circuits under load conditions. Cable connectors not of the load-breaker type, fuses, terminal lugs and cable splice connections may not be used for opening, reversing or closing circuits under load conditions except in an emergency.

Re-closing Circuits after a Protective Device Operates

After a circuit is de-energized by a circuit protective device (e.g., circuit breaker or similar) the circuit may not be manually re-energized until it has been determined that the equipment and circuit can be safely energized. The manual re-closing of circuit breakers or re-energizing circuits by replacing fuses without verifying that the circuit can be safely energized is prohibited. When it can be determined that the over-current device operated because of an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is re-energized. Over-current protection of circuits and conductors may not be modified even on a temporary basis.

Test Equipment and Instruments

Only qualified persons may perform testing work on electric circuits or equipment. Test instruments and equipment (including all associated test leads, cables, power cords, probes and connectors) must be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item must be tagged out of service. The device may not be returned to service until it has been repaired and tested safe for use. Test instruments, equipment, and their accessories must be rated for the circuits and equipment to which they will be connected and designed for the environment in which they will be used.

Flammable or Ignitable Materials

Where flammable or ignitable materials are present, do not use electric equipment capable of igniting them unless measures are taken to prevent hazardous conditions from developing. Equipment that is intrinsically safe for the hazardous condition may be used.

Safeguards for Personnel Protection

Personal Protective Equipment (PPE)

Employees working in areas where there are potential electrical hazards must be provided with and must use electrical protective equipment that is appropriate for the specific parts of the body to be protected (Table 5) and the work to be performed. The department must provide electrical safety-related personal protective equipment required by this program at no cost to the employee. The requirements for general purpose gloves, respirators, hearing protection, fall protection, and electrical protective headwear and footwear may be found in ASU's Personal Protective Equipment Program (EHS 105), a copy of this program may be obtained from ASU EH&S or downloaded from http://www.asu.edu/aad/manuals/ehs/ehs105.html.

Table 5 Simplified, two-category, flame-resistant clothing system

Applicable tasks	Clothing requirement
ll hazard/risk category 1 and 2 tasks listed in table 2 On systems operating at less than 1000 volts, these tasks include work on all equipment *except* Insertion/removal of low-voltage motor starter "buckets" Insertion/removal of power circuit breakers with the switchgear doors open Removal of bolted covers from switchgear. On systems operating at 1000 volts or more, tasks also include the operation, insertion, or removal of switching devices *with equipment enclosure doors closed.*	**Everyday work clothing** Flame-resistant long-sleeve shirt (minimum ATPV of 5) worn over an untreated cotton T-shirt with FR pants (minimum ATPV of 8) *Or* FR coveralls (minimum ATPV of 5) worn over an untreated cotton T-shirt (or an untreated natural-fiber long-sleeve shirt) with untreated natural-fiber pants.
All hazard/risk category 3 and 4 tasks listed in table 2 On systems operating at 1000 volts or more, these tasks include work on energized parts of all equipment. On systems of less than 1000 volts, tasks include insertion or removal of low-voltage motor-start motor control center "buckets," insertion or removal of power circuit breakers with the switchgear enclosure doors open, and removal of bolted covers from switchgear.	**Electric "switching" clothing** Double-layer FR flash jacket and FR bib overalls worn over either FR coveralls (minimum ATPV of 5) or FR long-sleeve shirt and FR pants (minimum ATPV of 5) worn over untreated natural-fiber long-sleeve shirt and pants worn over an untreated cotton T-shirt *Or* Insulated FR coveralls (minimum ATPV of 25, independent of other layers) worn over untreated natural-fiber long-sleeve shirt with untreated cotton blue jeans ("regular weight," minimum 12 oz./sq. yd. fabric weight), worn over an untreated cotton T-shirt.

FR - flame resistant.
ATPV - arc thermal performance exposure value of the clothing in calories/cm2.
Source: Based on Table F-1 in appendix F of NFPA 70E. 2004.

Table 6 Flame-resistant protective clothing and equipment

Flame-resistant protective clothing and equipment	Protective systems for hazard/risk category (4 = most hazardous)

Hazard/Risk Category Number	**1**	**2**	**3**	**4**
Flash suit jacket (2-layer)				X
Flash suit pants (2-layer)				X
Head protection				
Hardhat	X	X	X	X
Flame-resistant hardhat liner			X	X
Eye protection (safety glasses + side shields or safety goggles)	X	X	X	X
Face protection (double-layer switching hood)		2* tasks	X	X
Hearing protection (ear canal inserts)		2*tasks	X	X
			X	X
Leather gloves or voltage-rated	As needed	X		X
gloves with leather protectors	As needed	X	X	X
Leather work shoes				

Source: Based on personal protective equipment requirements of table 3-3.9.2 of NFPA 70E, 2004.

Workmanship and Finish

Rubber insulating equipment must meet the American Society of Testing and Materials (ASTM) standards D120-87, D178-93, D1048-93, D1049-93, D1050-90 or D1051-87 as applicable. Manufactured equipment which does not indicate compliance with these ASTM standards must be tested using the a-c and d-c proof tests and related procedures as described in these ASTM standards. Blankets, gloves and sleeves must be produced by seamless process. Insulating blankets, matting, covers, lines, hose, gloves, and sleeves made of rubber must be marked to indicate the class of equipment (e.g., Class 0 equipment must be marked Class 0, Class 1, Class 2, and so forth). Non-ozone-resistant equipment other than matting must be marked Type I. Ozone-resistant equipment other than matting shall be marked Type II. Markings must be nonconductive and must be applied in a way that will not damage the insulating qualities. Markings on gloves must be confined to the cuff portion of the glove. Equipment must be free of harmful physical irregularities. Surface irregularities (e.g., indentions, protuberances, or imbedded foreign materials) may be present on rubber goods because of imperfections on forms or molds or because of manufacturing difficulties. These surface irregularities are acceptable under the following conditions:

- The indention or part that sticks out blends into a smooth slope when the material is stretched, or
- The foreign material remains in place when the insulating material is folded and stretches with the insulating material surrounding it.

NOTE: In-service care and use: The department must make certain that electrical protective equipment is maintained in a safe, reliable condition, and that the following requirements are met:

- Maximum use voltages for rubber protective equipment must conform to those listed in Table 7.

TABLE 7 (Adopted from ASTM F 1505)

RUBBER INSULATING EQUIPMENT, MAXIMUM USE VOLTAGE

Class of Equipment	Maximum use voltage[1] a-c --rms
0	1,000
1	7,500
2	17,000
3	26,500
4	36,000

Footnotes:

[1] The maximum use voltage is the ac voltage (rms) classification of the protective equipment that designates the maximum nominal voltage of the energized system that may be safety worked.

The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits. However, the phase-to-ground potential is considered to be the nominal design voltage;

If there is no multiphase exposure in a system area and if the voltage is limited to the phase-to-ground potential, or

If the electrical equipment and devices are insulated or isolated or both so that the multiphase exposure on a grounded wire circuit is removed.

Insulating Equipment Testing

Insulating equipment must be inspected for damage before each day's use and immediately following any incident that could have caused damage.
An air test must be performed on rubber insulating gloves before use.
Insulating equipment with a hole, tear, puncture or cut, ozone cutting or checking, an embedded foreign object, any change in texture including swelling, softening, hardening, or becoming sticky or inelastic, or any other defect that could damage the insulating property must not be used.
All protective equipment must be used and maintained in accordance with the manufacturers' instructions.
Insulating equipment found to have defects that might affect its insulating properties must be removed from service until electrical tests have been performed that indicate it is acceptable for continued use.
Where the insulating capability of protective equipment is subject to damage during use, the insulating material shall be protected by an outer covering of leather or other appropriate material.

Rubber insulating equipment must be tested on a schedule as shown in Table 8.

TABLE 8 - RUBBER INSULATING EQUIPMENT TEST INTERVALS

Type of Equipment	When to Test
Rubber insulating line	Upon indication that the insulating value is suspect
Rubber insulating covers	Upon indication that insulating value is suspect
Rubber insulating blankets	Before first issue and every 12 months thereafter 1
Rubber insulating gloves	Before first issue and every 6 months thereafter 1
Rubber insulating sleeves	Before first issue and every 12 months thereafter 1

NOTE: If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.

Employees must be instructed to clean insulating equipment as needed to remove foreign substances and to store insulating equipment where it is protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage. Employees must be instructed to visually examine their gloves prior to each use and to avoid handling sharp objects.

Protector gloves must be worn over insulating gloves except as follows:

- Protector gloves need not be used with Class 0 gloves, under limited-use conditions, where small equipment and parts manipulation require unusually high finger dexterity.
- Any other class of glove may be used for similar work without protector gloves if is demonstrated that the possibility of physical damage to the gloves is small and if the class of glove is one class higher than that required for the voltage involved.
- Insulating gloves that have been used without protector gloves may not be used at a higher voltage until they have been electrically tested.

The department must ensure that employees do not use insulating equipment that fails to pass visual inspections or electrical tests except as follows:

- Rubber insulating line hose may be used in shorter lengths if the defective portion is cut off.
- Rubber insulating blankets may be repaired with a compatible patch as long as the physical and electrical properties equal or exceed those of the blanket.
- Rubber insulated blankets may be salvaged by cutting and removing the defective area from the undamaged portion of the blanket if the undamaged area remaining is greater than 22 inches by 22 inches for Class 1, 2, 3 and 4 blankets.
    - Rubber insulating gloves and sleeves with minor physical defects, such as small cuts, tears or punctures may be repaired by application of a patch with the same electrical and physical properties as the surrounding material.
    - Rubber insulating gloves and sleeves with minor surface blemishes may be repaired with a compatible liquid compound.

- Repairs to gloves are permitted only in the area between the wrist and reinforced edge of the opening.

Repaired insulating equipment must be retested before it may be returned to service. These tests must be documented in writing, and indicate the type(s) of test(s) performed, equipment tested (specifically by referencing an applied marking, serial number or similar), date, name of tester, and the results of the tests. These test results must be maintained in a permanent log.

General Protective Equipment and Tools

Nonconductive head protection must be worn whenever there is danger of head injury from electric shock or burn due to contact with exposed energized parts.

Protective equipment for the eyes and/or face must be worn whenever there is danger of injury to the eyes or face from electric arcs, flashes or flying objects resulting from electrical explosion.

Insulated tools or handling equipment must be used by employees working near exposed energized conductors or circuit parts if the tools or handling equipment might make contact with such conductors or parts.

If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material must be protected.

Protective shields, protective barriers, or insulating materials must be used to protect each employee from shock, burns, or other electrically related injuries while employees are working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur.

When normally enclosed live parts are exposed for maintenance or repair, they are to be guarded to protect unqualified persons from contact with the live parts.

Fuse handling equipment, insulated for the circuit voltage, must be used to remove or install fuses when the fuse terminals are energized.

Ropes and hand lines used near exposed energized parts must be nonconductive.

Alerting Techniques

The following alerting techniques must be used to warn and protect employees from electrical shock hazards, burns, or failure of electric equipment parts.

Safety Signs and Tags - Safety signs, safety symbols, or accident prevention tags are to be used where necessary to warn employees about electrical hazards that may endanger them.

Barricades – Barricades are used in conjunction with safety signs where necessary to prevent or limit employee access to work areas exposing employees to un-insulated energized conductors or circuit parts. Conductive barricades may not be used where they might cause an electrical contact hazard.

Attendants - If signs and barricades do not provide sufficient warning from electrical hazards, an attendant is to be stationed to warn and protect employees.

Other Safety Hazards

Employees performing work in and around campus buildings may be exposed to other hazards not covered by this program. These include, but are not limited to:

Fall Hazards. Employees that work in elevated locations where there is exposure to an unguarded fall hazard of 4 feet or greater must be provided and use fall protective equipment and must be trained to use this equipment properly.

Confined or Enclosed Spaces. A confined or enclosed space is a space that is large enough for an employee to enter and perform work, that has limited or restricted means for entry or exit, and that is not intended for continuous employee occupancy. Examples include, but are not limited to, sewers, silos, tanks, boilers, tunnels, vaults and manholes. Employees that perform work in confined or enclosed spaces must be trained to perform this work safely and must comply with the requirements of *ASU's Confined Space Entry Program. Available at http://www.asu.edu/uagc/EHS/documents/asu_confined_space_entry_plan.pdf*

Hazardous Materials. If you use or work around chemicals or other hazardous materials, you must be trained on how to read and interpret the Material Safety Data Sheet (MSDS) for the material. You must also be informed of how to gain access to MSDS's, how to safely handle and store these materials and you must comply with the requirements of the University Hazardous Communication and Laboratory Chemical Safety programs. http://uabf.asu.edu/ehs_services

Hot Work Operations. Abrasive grinding, welding, cutting and brazing, torch cutting and similar hot work operations are required to be permitted if performed outside of an approved hot work area. Permits and additional information may be obtained from EH&S. http://uabf.asu.edu/ehs_services

Lockout/Tagout. Work conducted around other types of energized systems (for example, pneumatic, pressurized, spring-actuated and similar) must be addressed using approved lockout/tagout procedures and must comply with ASU's Lockout/Tagout Safety Program. http://uabf.asu.edu/ehs_services

***Asbestos and Lead Materials**. Asbestos is commonly found in mechanical rooms and spaces, and may be present in pipe insulation, ceiling tile, plasters, flooring and electric wire insulation. Lead is commonly found in older paints and coatings. Both materials are potentially serious health hazards. It is a university requirement, therefore, that all maintenance and renovation work that impacts building components, systems or equipment must be reviewed by EH&S or Capitol Programs Management Group (CPMG) authorized representative before the work is performed to determine if asbestos or lead materials are present. See the university's Asbestos and Lead Hazard Control Programs at http://uabf.asu.edu/ehs_occupational_safety.*

Appendix A

Electrical Safety Work Practices Program and General Lockout and Tag out procedures Checklist

The following procedure checklist is intended to aid the department in reviewing work practice controls and energy control procedures that must be followed when de-energizing systems or equipment. This procedure should be used hand-in-hand with the requirements established in *ASU's Lockout/Tag out Program.*

Electrical Safety Training Checklist Form

ELECTRICAL SAFETY WORK PRACTICES PROGRAM GENERAL LOCKOUT AND TAGGING PROCEDURES	☑
• Only trained, authorized employees can perform lockout/tagout (LO/TO).	
• Obtain the LO/TO Procedure for the system or equipment from your departmental supervisor. If a LO/TO procedure is not available for the system or equipment, then:	
• The supervisor, crew supervisor, or other authorized person designated by the supervisor will evaluate and document the procedures on the Lockout/Tagout Procedure form.	
• The supervisor or designated authorized person must identify the name of the machine, equipment or system;	
• The supervisor or designated authorized person must identify all energy sources and their location;	
• The supervisor or designated authorized person must identify the procedure/method required for LO/TO. The general procedures for the various types of energy sources are as follows:	
• **Electrical Control**	
• Isolate the machine or piece of equipment by using an electrical plug lock or by locking and tagging the disconnect switch. A special adaptor may be needed to LO/TO circuit breakers.	
• Ensure that all power sources are locked and tagged out.	
• Bleed any stored electrical energy to a "zero energy state"	
• Use a tester to check that all circuits are deenergized. Employees that must work on or near exposed energized parts, or deenergized electrical parts that have not been LO/TO must be qualified workers as required by ASU's Electrical Safety Work Practices Program.	
• **Pneumatic Control**	
• Release the pressure to reach a "zero energy state"	
• Lockout the energy source using lockout valves and tags	

• **Hydraulic Control**	
• Release the pressure to reach a "zero energy state"	
• Lockout the energy source using lockout valves and tags	
• **Fluids and Gases**	
• Evaluate all hoses and valves connecting to the system or equipment. Determine what type of fluid or gas may be present and, if necessary, obtain and review the Material Safety Data Sheet (MSDS) for the material. Take precautions as needed to protect you from exposure to any hazardous material that may be contained in the system. Contact EHSS as needed for guidance.	
• Close all valves on supply lines, and as necessary, bleed or drain the contents. Contact EHSS as needed for guidance on proper disposal of the material.	
• Insert a blank or blind in the line.	
• Use lockout valves, chains, and locks and tags at the isolating source.	
• **Mechanical Control**	
i) Release or block all stored mechanical energy. Be cautious of springs, tension, elevated mechanical arms or platforms that could lower, and other sources of energy that are not always obvious.	
ii) Restrain energy by using blocks.	
iii) Lockout and tagout all sources of energy.	
iv) Recheck all areas for potential sources of energy.	
• The LO/TO must identify the type/magnitude of energy the equipment or system uses, the specific procedure to be followed for LO/TO, and any precautions that must be taken by the authorized employee during LO/TO.	

ELECTRICAL SAFETY WORK PRACTICES PROGRAM GENERAL LOCKOUT AND TAGGING PROCEDURE	☑
• The energy control procedure must be reviewed and signed by the departmental supervisor or their designee.	
• A copy of the energy control procedure must be maintained on file at the department and copied to EH&S.	
• Review the LO/TO procedure with your supervisor if the procedure, the system, or the equipment is new or unfamiliar.	
• Determine all energy isolating devices that must be locked out/tagged out to ensure the safe and complete control of hazardous energy.	
• Review the type and magnitude of the energy and the required controls.	

• Inform all affected employees and all other employees working in or entering the work area, that lockout/tagout is to be performed. Instruct these employees that they must not attempt to start equipment that has been locked/tagged out, and that locks/tags must not be bypassed or removed.	
• Shutdown the equipment/process/system by following the LO/TO procedure.	
• Locate the necessary energy isolating device(s) for the equipment/process/system and operate them to isolate them from the energy sources. Affix lockout/tagout devices.	
• Relieve all stored or residual energy and take appropriate measures to ensure the energy will not reaccumulate. Affix lockout/tagout devices as necessary.	
• Verify that all sources of energy have been isolated and stored energy relieved after ensuring that employees are not exposed and before beginning work. Activate equipment or system controls to ensure that the equipment or system will not operate, and then deactivate the controls.	
• Perform the servicing or maintenance.	
• Replace all guards and safety devices. Remove all tools and equipment from the work site. Assure that all personnel are clear of the equipment.	
• Notify all affected personnel that the system will be reactivated.	
• Lockout/tagout devices are removed by the authorized employee(s) who installed the devices.	

LOCKOUT/TAGOUT DEVICE REMOVAL BY SUPERVISOR

If it becomes necessary to remove the lockout/tagout device of an employee who is unavailable on site, the removal of this device must be done using the following procedure and per the requirements of the ASU' *Lockout/Tagout Program.*

1. The supervisor must ensure that the employee who applied the lock or tag is not available at the workplace; and
2. The supervisor must make all reasonable efforts to contact the authorized employee to inform him or her that his/her lockout and/or tagout device has been removed; and must contact EH&S prior to removal;
3. The supervisor ensures that the employee is made aware that his or her lock or tag was removed before he or she resumes work at that worksite.

GROUP LOCKOUT/TAGOUT

When a lockout/tagout job involves numerous lockout/tagout devices and many employees, the group lockout procedures contained in *ASU's Lockout/Tagout Program* must be followed.

Appendix B

Electrical Safety Training Checklist Form

The following procedure checklist is intended to aid the department in reviewing work practices and ensuring employees are properly trained.

Electrical Safety Training Checklist Form

TRAINING ITEM
SCOPE AND TRAINING
All employees who work on, near or with premises wiring, wiring for connections to supply, other wiring, and installation of optical fiber cable along with electrical conductors have been trained as either qualified or unqualified workers.
1. Unqualified person have been trained in and are familiar with any electrically related safety practices not covered by this standard but necessary for their safety.
2. Qualified persons trained in and familiar with:
a) Skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.
b) Voltage determination.
c) Clearance distances that must be maintained.
d) Training conducted has been specific to the hazards to which the employee may or will be exposed and their particular job duties.
SELECTION AND USE OF WORK PRACTICES
1. Work practices used to prevent electric shock and other injuries address de-energized parts which may be energized.
2. Work practices used to prevent electric shock and other injuries address exposure to energized parts.
3. Procedure provided for work on or near exposed de-energized parts includes:
a) Written procedures specific to the equipment or worksite.
b) De-energizing equipment.
c) Application of locks and tags.
4. Working on or near exposed energized parts:
a) All employees near enough to be exposed to a hazard have been trained, and are aware of the practices that must be followed to protect them from the hazard.
b) Only qualified employees work on energized parts.
c) Overhead lines de-energized and grounded prior to working near them **or** other protective measures used.

d)	Unqualified persons working near overhead lines are aware that they may not come approach, or use conductive objects closer than, 10 feet for lines up to 50 kV, or 10 feet plus 4 inches for every 10 kV over 50 kV.
e)	Qualified persons are having a working knowledge of the allowable approach distances shown in Table S-2 of this program.
f)	Vehicle and mechanical equipment operators understand that they must maintain:
i)	A clear distance of 10 feet plus 4 inches for every 10 kV over 50 kV while working near energized overhead lines.
ii)	A clear distance of 4 feet plus 4 inches for every 10 kV over 50 kV while in transit.

TRAINING ITEM	
iii)	Insulating barriers are used and installed as required.
iv)	Insulated aerial lift operated by a qualified person must comply with the distances shown in Table S-2.
v)	Employees standing on the ground understand they may not contact the vehicle unless using protective equipment rated for the voltage or the equipment located so no uninsulated part can provide a conductive path to persons on the ground.
g)	Illumination is provided at all worksites to assure safe work.
h)	Protective shields and barriers provided and used for work in confined spaces to prevent contact with exposed energized parts.
i)	All conductive materials such as pipes, rods, etc. are handled so as to prevent contact with exposed energized parts.
j)	Conductive articles of clothing and jewelry such as watches, rings, etc. are not worn if they might contact exposed energized parts unless rendered nonconductive.
k)	Portable ladders with nonconductive side rails are used when working near or on exposed energized conductors.
l)	Housekeeping conducted only when exposed energized parts may not be contacted. Barriers provided and nonconductive cleaning materials used.
m)	Only qualified persons allowed to defeat electrical interlocks on temporary basis while they work on equipment.
USE OF EQUIPMENT	
1. Portable electric equipment such as cord-and-plug connected equipment, including flexible cords:	
a)	Handled in a manner to avoid damage.
b)	Not used to raise or lower equipment.
c)	Not fastened with staples or hung so as to damage insulation.

d)	Visually inspected before each use on each shift.
e)	Defective items removed from service and not used until rendered safe.
f)	Plugs and receptacles mate properly.
g)	Flexible grounding-type cords have a grounding conductor.
h)	Grounding plug not defeated.
i)	Adapters which interrupt grounding continuity not used.
j)	Approved equipment used for work in conductive work locations (e.g. wet locations, etc.).
k)	Locking-type connectors are properly secured after connection.

TRAINING ITEM
ELECTRIC POWER AND LIGHTING CIRCUITS
1. Only load rated switches or circuit breakers used as disconnecting means.
2. Circuits not manually reenergized until it is determined that it is safe to do so.
3. Over-current protection of circuits not modified.
TEST INSTRUMENTS AND EQUIPMENT
1. Used by qualified persons only.
2. Visually inspected before use.
3. If circuit tested is over 600 volts, nominal, test instrument tested for proper operation before and immediately after the test.
4. Test instrument rated for the circuit to be tested and appropriate for the environment.
5. Electrical equipment capable of igniting flammable or ignitable materials not used if present in the worksite.
SAFEGUARDS FOR PERSONNEL PROTECTION
1. Protective equipment used when there is exposure to potential electrical hazards.
2. Protective equipment maintained in safe and reliable condition and tested and inspected as required.
3. Protective equipment protected from damage during use.
4. Approved electrically rated hardhats used as needed to protect head from electric shock or burns.
5. Safety glasses or goggles used as needed to protect eyes or face when there is a danger of arcs, flashes or flying objects.
6. Approved gloves worn that are appropriate for the hazard present
7. Insulated tools or handling equipment used when conductors may be contacted.
8. Insulated fuse handling equipment used to remove or install fuses when terminals are energized.

9. Ropes and hand lines used near energized parts are nonconductive and are protected from moisture.
10. Protective shields, barriers or insulating materials are used to protect employees working near exposed energized parts.
ALERTING TECHNIQUES
• Safety signs and tags used when necessary to warn employees about electrical hazards.
• Barricades used with safety signs when necessary to prevent or limit employee access to work areas with uninsulated energized conductors or parts.
• Attendants stationed as needed to warn when signs or barricades are not sufficient to prevent unauthorized access.
Name of Trainer:
Employee Name:

Appendix C

Energized Electrical Work Permit Form

ARIZONA STATE UNIVERSITY

Department of Environmental Health & Safety, Occupational Health & Safety

ENERGIZED ELECTRICAL WORK PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER: Job/Work Order Number _____

(1) Description of circuit/equipment/job location: _____

_____

_____

(2) Description of work to be done: _____

_____

_____

(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: _____

_____

_____

_____ _____

Requester/Title Date

PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS *DOING* THE WORK:

Check when Complete

(1) Detailed job description procedure to be used in performing the above detailed work: _____ ☐

_____

_____

(2) Description of the Safe Work Practices to be employed: _____ ☐

_____

_____

(3) Results of Shock Hazard Analysis: _____ ☐

_____

_____

(4) Determination of Shock Protection Boundaries: _____ ☐

_____

_____

(5) Results of the Flash Hazard Analysis: _____

_____

_____ ☐

(6) Determination of the Flash Protection Boundary: _____

_____

_____ ☐

(7) Necessary personal protective equipment to safely perform the assigned task: _____

_____

_____ ☐

(8) Means employed to restrict the access of unqualified persons from the work area: __

_____

_____ ☐

(9) Evidence of completion of a Job Briefing including discussion of any job-related hazards: _____

_____

(10) Do you agree the above described work can be done safely? ☐ Yes

☐ No (If *no,* return to requester)

_____ _____

Electrically Qualified Person(s) Date

_____ _____

Electrically Qualified Person(s) Date-··

PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:

Electric Shop Supervisor	Maintenance/Engineering Manager
Safety Manager	Electrically Knowledgeable Person
Facilities Management	Date

Note: Once the work is complete, forward this form to the Facilities Management Safety Manager for review and retention