



Department of the Air Force
HQ AEDC (AFMC)
Arnold AFB, TN 37389

Safety, Health, and Environmental Standard

Title: LOW-VOLTAGE ELECTRICAL SAFETY RELATED WORK PRACTICES

Standard No.: B6

Effective Date: 08/15/2011

The provisions and requirements of this standard are mandatory for use by all AEDC personnel engaged in work tasks necessary to fulfill the AEDC mission. Please contact your safety, industrial health and/or environmental representative for clarification or questions regarding this standard.

Approved:

Contractor /ATA Director
Safety and Health Group

Air Force Functional Chief



Safety, Health, and Environmental Standard

LOW-VOLTAGE ELECTRICAL SAFETY RELATED WORK PRACTICES

1.0 INTRODUCTION/SCOPE/APPLICABILITY

- 1.1 This Safety, Health, and Environmental (SHE) standard outlines the hazards involved, safety equipment required, safety precautions to be observed, and operating procedure requirements when working with low-voltage electricity, i.e. less than or equal to 600 volts.
- 1.2 This standard applies in all situations where exposure to energized or potentially energized electrical equipment is possible due to the nature of the work to be performed. Following this standard will help ensure that electrical work is performed under the safest conditions possible.

2.0 BASIC HAZARDS

- 2.1 Shock: This is caused when a person comes in contact with an energized part, and electrical current travels through the body. Minor shock may cause tingling or discomfort. A serious shock may cause extreme pain, burns, and/or death.
- 2.2 Arc flash: A dangerous condition associated with the release of energy caused by an electric arc. This flash can damage a person's eyes, cause burns up to 3rd degree, and/or death.
- 2.3 Arc blast: An explosive force caused by the rapid expansion of super-heated air and metal vaporized during an electric arc. Arc blasts can damage a person's hearing or cause other internal injuries. Shrapnel from the blast may pierce the skin. Blasts from higher energies may cause death.
- 2.4 Fire: Improper wiring, circuit overloading, and defective tools or equipment can cause sparking, or overheat wires. This could cause a fire and damage property, or injure personnel.

3.0 DEFINITIONS

Automated External Defibrillator (AED) – A device used to administer an electric shock through the chest wall to treat ventricular fibrillation.

Cardiopulmonary Resuscitation (CPR) – An emergency medical procedure, which includes opening and maintaining an airway, providing ventilation through rescue breathing, and providing artificial circulation through the use of external cardiac compression.

De-energized – Free from any electrical connection to a source of potential difference and from electrical charge: not having a potential different from earth. Note; the term is used only with reference to electrical equipment. De-energized does not necessarily describe a safe work condition. The state of being de-energized without consideration of other potential hazards does not constitute an electrically safe work condition.

Diagnostic Work – A category of work that involves the taking readings or measurements of electrical equipment, with approved test equipment which does not require making any physical change to the equipment.

Electrically Safe Work Condition – A state in which the conductors, circuits, and equipment to be worked on has been disconnected or isolated from energized parts, locked/tagged in accordance with established lockout/tagout practices [as detailed in AEDC SHE Standard B2, Lockout/Tagout (LOTO)], tested to ensure the absence of voltage.

Energized – Electrically connected to, or is, a source of voltage.

Energized Electrical Work Permit (EEWP) – A permit approved by supervision or management which authorizes energized repair work on electrical equipment operating at 50 volts or more. The purpose of the

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permit is to ensure that the increased risks posed by this work receive adequate consideration before the work is performed. (Permit Form Annex A of this Document)

Exposed (as applied to live parts) – Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts that are not suitably guarded, isolated, or insulated.

Flash Hazard Boundary - A burn protection boundary surrounding a potentially energized system which, when crossed, requires the use of Flame Resistant (FR) Clothing and other Personal Protective Equipment (PPE) by the person crossing the boundary.

Incident Energy- The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units to measure is calories per centimeter squared (cal/cm²).

Job Safety Analysis (JSA) – A document prepared to help workers and management review the hazards and safety precautions required for each job. (AEDC uses Form GC-1707; see SHE Standard A10, Job Safety Analysis for details.)

Limited Approach Boundary – An approach limit at a distance from an exposed live part within which a shock hazard exists. Non-electrically qualified personnel may not cross this boundary unless escorted by a qualified electrical person.

Personal Protective Equipment (PPE) – Equipment such as voltage-rated rubber gloves, hardhats, face shields, protective arc-flash clothing, hoods, flame resistant (FR) clothing, etc., used to protect a person.

Potentially Energized – Electrical equipment or circuits capable of containing electrical energy that has not been locked out, tagged out, and verified as de-energized by proper testing methods.

Prohibited Approach Boundary – An approach limit or a distance from an exposed live part within which work is considered the same as making contact with the live part. An EEWP is required to cross this boundary.

Qualified Electrical Person – Persons who, by training and demonstration, possess the skills and familiarity with techniques for: (1) distinguishing exposed live parts from other parts of electrical equipment, (2) determining the nominal voltage of exposed live parts, and (3) maintaining minimum clearance distances corresponding to the voltages to which that person will be exposed. A qualified electrical person may be an electrician, electrical technician, electrical engineer, or others, depending on their function and training, and may only be qualified with respect to certain aspects of electrical work.

Reasonable Effort to De-Energize – This is a subjective judgment by both supervision and worker, which produces a risk assessment and considers personnel safety.

Repair Work- A category of work that involves any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

Restricted Approach Boundary – An approach limit at a distance from an exposed live part, within which there is an increased risk of shock due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part.

Qualified Industrial Person – Employees trained in basic industrial safety including but not limited to:

- Lockout Tagout
- Confined Space
- Job Safety Analysis
- Personal Protective Equipment
- Electrical Safety
- Fall Protection
- Master Work Permit

Voltage – The potential difference between any two conductors or between a conductor and ground/earth.

Voltage, Nominal – A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (240/120, 208/120, 480/277, 600, etc.).

Working on Energized Equipment – Coming in contact with energized conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment a person is wearing. This includes diagnostic and repair activities while the equipment is energized. (See Definitions.)

4.0 REQUIREMENTS/RESPONSIBILITIES

4.1 REQUIREMENTS

4.1.1 Electrical Safe Work Practices

- 4.1.1.1 Systems Less than 50 Volts: Energized parts less than 50 volts shall not be required to be de-energized if there is no increased exposure to electrical burns or explosion due to electric arcs.
- 4.1.1.2 Systems 50 Volts or More: All systems of 50 volts or more shall be considered energized until proven otherwise using the appropriately rated test equipment and the correct types and level of PPE. Proper PPE, including arc flash protection, shall be used in accordance with equipment labeling (e.g. Annex B) If no label is present refer to Annex C and Annex D while equipment is considered energized.
 - 4.1.1.2.1 Every reasonable effort shall be made to de-energize and control electrical equipment operating at 50 volts and above per the SHE B2 LOTO Standard prior to being worked on.
 - 4.1.1.2.2 Equipment with Arc Flash Incident Energies above 40 cal/cm² shall be de-energized before any work or local alteration (e. g. breaker operation or racking) may be performed.
 - 4.1.1.2.3 Energized electrical equipment with Arc Flash Incident Energies of 40 cal/cm² or less can be worked only when approval is granted with proper documentation. (JSA and EEWP, when required)
 - 4.1.1.2.4 The correct types and level of PPE is mandatory when performing either repair-type or diagnostic-type work on energized electrical equipment or locally altering the configuration/position of energized electrical equipment, e.g. operating breakers, switches, disconnects; racking breakers, etc. If equipment is not labeled in accordance with Annex B, refer to Annex C and Annex D or NFPA 70E.(Exception: Qualified industrial persons are permitted to operate disconnects for electrically driven equipment such as motors, valves, pumps, etc. for normal operation and maintenance without Arc Flash PPE only when the covers are in place and properly closed.
 - 4.1.1.2.5 Energized conductors/components may be covered and or guarded by blankets, mats, etc., to protect from accidental contact by the qualified worker when within the Limited Approach Boundary.
- 4.1.1.3 Energized Electrical Work Permit (EEWP): Manager or Supervisor approval shall be required before repair-type work is performed on energized electrical equipment operating at 50 to 120 volts nominal or less. Documentation is required on the EEWP. (See Paragraph 4.1.4.3.2 for work on DC systems 140 volts and below.)
 - 4.1.1.3.1 Additionally, Department Director or Deputy Director Approval shall be required before any repair-type work is performed on energized electrical equipment operating at greater than 120 volts nominal. Documentation is required on the EEWP.
 - 4.1.1.3.2 The EEWP shall not be approved when the Arc Flash Incident is greater than 40 cal/cm².
 - 4.1.1.3.3 The EEWP shall not be required for energized diagnostic testing or locally altering the configuration/position of energized electrical equipment, e.g. operating breakers, switches, disconnects; racking breakers, etc.
- 4.1.1.4 Qualified Electrical Person: Only qualified electrical persons shall be permitted to work on energized electrical equipment.
 - 4.1.1.4.1 Only a qualified electrical person shall energize or de-energize any disconnect over 50 volts where the operation could directly or potentially expose personnel to energized electrical circuits.
 - 4.1.1.4.2 A minimum of two qualified electrical persons shall be assigned to any work where the potential exist for direct contact with energized circuits greater than 300 volts nominal.
- 4.1.1.5. A JSA shall be completed for all electrical work, energized or de-energized.
- 4.1.1.6. Circuits automatically tripped by a circuit protective device shall not be reenergized until a qualified electrical person has determined the equipment and circuit can be safely energized. If the fault or overload can be identified and removed on 120/240/208/277 voltages of 30 amps or less, the resetting of a circuit breaker is permitted by non-qualified persons without a JSA or Arc Flash PPE only when the covers are in place and properly closed. Repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses is prohibited.

- 4.1.1.7 Approach Boundaries: The approach boundaries to live (energized) parts for shock protection are tabulated below. Qualified electrical persons shall provide boundaries to prevent unqualified personnel from getting any closer to exposed energized parts than the approach distance shown or the arc flash boundary, whichever is greater.

Approach Boundaries

Nominal System Voltage Phase To Phase	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary
	Exposed Movable Conductor	Exposed Fixed Circuit Part		
Less than 50	Not required	Not required	Not required	Not required
50 to 300	10 ft. 0 in.	3 ft. 6 in.	Avoid contact	Avoid Contact
301 to 600	10 ft. 0 in.	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.

- 4.1.7.1.1 To cross the prohibited approach boundary (shock hazard), the qualified person shall:
- Have specified training to work on exposed live parts.
 - Have a completed/approved JSA and EEWP when required.
 - Use PPE suitable for working near exposed live parts and rated for the voltage and energy level involved as described in Section 4.1.2.
- 4.1.7.1.2 To cross the restricted approach boundary (possible shock from arc over), the qualified person shall:
- Have a completed and approved JSA and EEWP when required.
 - Use PPE suitable for working near exposed live parts and rated for the voltage and energy level involved as described in Section 4.1.2.
 - Be certain that no part of the body enters the prohibited space.
 - Minimize the risk from unintended movement, by keeping as much of the body as possible out of the restricted space; body parts in the restricted space must be protected.
- 4.1.7.1.3 Limited Approach Boundary:
- Is set up by the qualified electrical person. The type of boundary used will depend on the area. In high traffic areas, physical barriers, like stanchions or red danger tape may be used. For remote areas, visually monitoring the area may be appropriate. The distance from the exposed conductor will be the limited approach boundary or the arc flash hazard boundary, whichever is greater. For more information, please see AEDC SHE Standard B3, Control of Hazardous Areas.
 - May only be crossed by non-electrical personnel when accompanied by a qualified electrical person familiar with the current work.
 - Walls or other physical barriers within the boundary, which provide sufficient protection, will suffice for the barrier, provided entrance is limited.
- 4.1.7.1.4 Flash Hazard Boundaries: The distance for the flash hazard boundary will be found on the equipment's arc flash warning decal (see Annex B). For low-voltage equipment without a decal, the flash hazard boundary will be 10 feet. When any part of a person's body is within the arc/flash hazard boundary, the person must:
- Use appropriate PPE and protective equipment in accordance with the Arc Flash Label attached to the equipment or as specified in Annex D of this standard.
 - Ensure that all PPE is in good condition, is locally inspected prior to use, and has been externally inspected as required.
 - Have a completed/approved JSA and EEWP when required
- 4.1.1.7 Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metallicized aprons, cloth with conductive thread, metal headgear, or hair fasteners) shall not be worn when working on energized or potentially energized circuits or equipment.
- 4.1.1.8 No current carrying conductors shall be opened without the use of a properly rated switch in the circuit. Do not cut cables or open connections without first verifying that there is no current flowing. This applies to both maintenance and demolition work.
- 4.1.1.9 When performing demolition work, qualified electrical persons shall positively verify that the cables and circuits are de-energized before cutting conduits, cable trays, supports, and associated wiring for removal.
- 4.1.1.10 No person shall authorize, perform, nor permit alterations or modifications to equipment, circuits, or protective device settings without written authorization from the system engineer. This includes, but is not

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limited to, switchgear modifications, removal or bypass of device contacts from control circuits, and the installation of temporary back feeds.

- 4.1.1.11 Employees shall use insulated tools and/or handling equipment when working inside the limited approach boundary of live parts where tools or handling equipment might make accidental contact. Insulated tools shall be protected from damage to the insulating material. Insulated tools shall be rated for the voltages on which they are used. Insulated tools shall be designed and constructed for the environment to which they will be exposed and the manner in which they are used.
- 4.1.1.12 Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.
- 4.1.1.13 Protective shields, protective barriers, or insulating materials should be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near live parts, which might be accidentally contacted or where dangerous electric heating or arcing might occur.
- 4.1.1.14 Test instruments, equipment and their accessories shall be rated for the circuits and equipment to which they will be connected.
- 4.1.1.15 Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall 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 shall be removed from service, and no employee shall use it until repairs and tests necessary to render the equipment safe have been made.
- 4.1.1.16 Design and installation of electrical circuits and utilization systems and equipment shall be in accordance with the latest edition of National Fire Protection Association (NFPA) 70, The National Electrical Code (NEC). Annex E provides the AEDC Recorded Low-Voltage Wire Color Chart. This document will meet the requirements of Articles 210.5 and 215.12 per the 2008 NEC.
- 4.1.1.17 Safe work practices shall be in compliance with the direction and intent of NFPA 70E, The Standard for Electrical Safety Requirements for Employee Workplaces.
- 4.1.1.18 Specific guidelines apply for work around energized 480 volt or greater electrical equipment. These guidelines are provided in Annex F.

4.1.2 Personal Protective Equipment (PPE)

- 4.1.2.1 Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed. Some equipment will be posted with the PPE requirements in accordance with Annex B. The table in Annex C provides the hazard risk to be followed when PPE requirements are not posted on a piece of equipment. Should any tasks not be covered in Annex C, consult NFPA 70E, Table 130.7(C)(9). Annex D identifies typical PPE requirements.
- 4.1.2.2 Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested in accordance with the requirements specified in AEDC SHE Standard B4.
- 4.1.2.3 All PPE shall be thoroughly inspected prior to use.
- 4.1.2.4 Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burn due to contact with exposed energized parts.

4.1.3 Electrical Equipment

4.1.3.1 Electrical System/Equipment Maintenance

- 4.1.3.1.1 Electrical systems and equipment shall be maintained, in accordance with manufacturers' instructions/recommendations and accepted maintenance practices.
- 4.1.3.1.2 Defective electrical equipment shall be removed from service, then discarded, abandoned, or repaired to operational condition before being returned into service.

4.1.3.2 Labeling of Equipment to Warn of Arc/Flash Hazards

New equipment such as switchboards, panel boards, industrial control panels, and motor control centers 480v and greater that are likely to require examination, adjustment, servicing, or maintenance while

energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

4.1.3.3 480 VAC Electrical Safety Requirements

For all installations requiring 480 VAC receptacle and connectors, material shall meet the guidelines set up in Annex G; 480 VAC extension cord requirements shall meet the guidelines set up in Annex H

4.1.4 Guidance for Work on Energized Systems

4.1.4.1 Before any repair work can be performed on an energized electrical system with voltages that exceeds 120 volts nominal, explicit approval must be granted by a Department Director or Deputy Director.

4.1.4.2 The following routine operations do not require Director/Deputy Director approval, but do require Manager or Supervisor approval, which is indicated by signing the JSA. Craft and working foremen cannot provide this approval.

4.1.4.2.1 Trouble shooting, de-energizing or re-energizing an electrical system,

4.1.4.2.2 Switching, operating disconnects, racking breakers,

4.1.4.2.3 Operating electrical circuit testing or diagnostic equipment,

4.1.4.2.4 Re-lamping by personnel other than a qualified electrical person, no approval is required for a qualified electrical person,

4.1.4.3 The following does require manager or supervisor approval on the JSA and EEWP.

4.1.4.3.1 Repair type work on energized nominal 120 volt (and below) AC systems,

4.1.4.3.2 Working on any 140 volt (and below) DC system (digital systems and instrumentation circuitry – no approval required),

4.2 Responsibilities

4.2.1 Supervisors shall

4.2.1.1 Assume ownership and responsibility for the implementation of this standard.

4.2.1.2 Know and implement applicable safety procedures and take action as required to ensure the safety of the personnel and operations they supervise. This responsibility shall include taking positive action to determine and reduce the hazards associated with their operations, allowing only qualified persons to perform electrical work, and ensuring that employees perform their work safely.

4.2.1.3 Be familiar with the locations where their assigned crews are required to work.

4.2.1.4 Review and sign all JSAs and EEWPs, when required, for work on energized electrical equipment, whether scheduled or emergency, prior to starting work for operations under their supervision.

4.2.1.5 Ensure assigned electrical persons receive refresher training as required.

4.2.1.6 Assess the knowledge and abilities of electrical craft personnel under their supervision to determine where training (retraining) is needed to prevent injuries. A mandatory assessment of training adequacy shall be performed when a qualified electrical person or qualified industrial person has been involved in a mishap or a near miss, or has been observed performing an unsafe act.

4.2.1.7 Ensure that each new or transferred employee is instructed in the safe practices pertaining to his or her work, and schedule employees to receive training in work permits and JSAs, lockout/tagout, and confined space procedures as warranted by the employee's duties.

4.2.2 AEDC Emergency Services shall

4.2.2.1 Maintain competence in site rescue techniques to include elevated, underground and potentially energized situations.

4.2.2.2 Maintain awareness of current tasks/projects being undertaken and prepare response plans for those not already within the scope of Emergency Services capabilities.

4.2.2.3 Provide emergency rescue/triage/transport services as required.

4.3 Investment Projects, Code Compliant Electrical Installations

4.3.1 All electrical equipment shall be installed in compliance with the most recent adopted version of the National Electric Code/NFPA 70, the AEDC SHE Standard D3 and this AEDC SHE Standard B6.

4.3.2 Code compliance should be confirmed and approved by an assessment of the installed equipment during the installation and before completion or energizing the equipment by the assessor.

4.3.3 Assessments shall be done prior to covering or the completion of the electrical work.

4.3.4 Installations or deficiencies that are not approved shall be resolved or corrected prior to the job progressing.

4.3.5 The assessor will be a qualified electrical person selected by the Project Manager to perform this task

5.0 Training and Qualifications

5.1 Employee Training

5.1.1 Qualified electrical persons shall have satisfactorily completed an apprenticeship or other equivalent program that trains them in the skills and techniques necessary to distinguish exposed live parts from other parts of electrical equipment, to safely determine the nominal voltage of exposed live parts, and to determine the safe minimum approach distances corresponding to the voltages to which they are exposed.

5.1.2 Qualified electrical persons shall be trained in the performance of special precautionary techniques, in proper lockout/tagout procedures, and in the proper use and care of PPE, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment.

5.1.3 Qualified electrical persons shall be trained in other aspects of their craft, including, but not limited to, basic electrical formulas, proper installation, support, and termination of power and control wiring, and troubleshooting of electrical circuits and controls. Qualified electrical persons shall be trained to read electrical drawings, including, but not limited to single-line drawings, three-line drawings, control schematics, and wiring diagrams.

5.1.4 Qualified electrical persons shall be trained in rescue techniques for electric shock victims including the proper methods of removing personnel from energized circuits in an emergency situation.

5.1.5 Prior to using an automated external defibrillator (AED), personnel shall be trained in its proper use.

5.1.6 An employee who is 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 direct supervision of a qualified person shall be considered to be a qualified person for the performance of those duties.

5.2 Qualified Industrial Person Training

Employees who will be working in the industrial environment performing limited electrical operations not involving direct exposure to energized electrical circuits (i.e., operating switches, circuit breakers and/or disconnects to control plant equipment, plugging cord and plug type tools and equipment into approved receptacles, etc.) but who are not qualified electrical persons, shall receive training in lockout/tagout and basic electrical safe work practices required for their assigned task(s).

5.3 Supervisors, working foremen, and leads over qualified electrical persons shall be trained in low-voltage safety-related work practices.

6.0 INSPECTION/AUDITS

Contractor Safety may conduct inspections of work activities as directed by contractor management.

7.0 REFERENCES

AEDC Safety, Health, and Environmental Standard A10 – Job Safety Analysis
AEDC Safety, Health, and Environmental Standard B1 – Master Work Permit
AEDC Safety, Health, and Environmental Standard B2 – Lockout/Tagout - LOTO
AEDC Safety, Health, and Environmental Standard B3 – Control of Hazard Areas
AEDC Safety, Health, and Environmental Standard B4 – High Voltage Electrical Work
AEDC Safety, Health, and Environmental Standard B5 – Confined Spaces

Air Force Instruction (AFI) 32-1064 Electrical Safe Practices

ANSI C2 – National Electrical Safety Code (latest revision)

IEEE Standard 1584 – IEEE Guide for Performing Arc-Flash Hazard Calculations

NFPA 70 – National Electrical Code

NFPA 70E – Standard for Electrical Safety in the Workplaces

OSHA 29CFR1910.137 – Electrical Protective Devices

OSHA 29CFR1910.146 – The Control of Hazardous Energy (lockout/tagout)

OSHA 29CFR1910.331 – Scope

OSHA 29CFR1910.332 – Training-Electrical

OSHA 29CFR1910.333 – Selection and Use of Work Practices-Electrical

OSHA 29CFR1910.334 – Use of Equipment

OSHA 29CFR1910.335 – Safeguards for Personnel Protection

8.0 ANNEXES

- A. Energized Electrical Work Permit
- B. Example Labeling of Electrical Equipment to Warn of Possible Arc/Flash Hazards
- C. PPE Requirements for Common Low-Voltage Tasks
- D. Protective Clothing and Personal Protective Equipment (PPE) Matrix
- E. New Installation- Color Codes for Electrical Systems (<600 V)
- F. Guidelines for Work around 480 VAC or Greater Electrical Equipment
- G. 480 VAC Receptacles and Connectors
- H. 480 VAC Extension Cords

ANNEX A

AEDC ENERGIZED ELECTRICAL WORK PERMIT

Job/Work Order Number _____

1. Location of work to be performed: Include the Building, Panel Name/Number, Equipment being worked, etc.

2. Justification why the work must be performed while energized. _____

3. Detailed description of work to be performed. _____

4. Arc Flash Incident Energy from Arc Flash Label or Hazard Risk Class from Annex _____

5. PPE Requirements (Taken from Arc Flash Label or Annex D.) (Check all that apply.)

<input type="checkbox"/> Non-melting Long Sleeved Shirt	<input type="checkbox"/> Arc-rated Shirt and Pants or Coveralls, (4 cal minimum)
<input type="checkbox"/> Non-melting Long Pants	<input type="checkbox"/> Arc-Rated Shirt and Pants or Coveralls, (8 cal minimum)
<input type="checkbox"/> Safety Glasses or Goggles	<input type="checkbox"/> Arc-Rated Face Shield (flash suit hood can be used)
<input type="checkbox"/> Hearing Protection (ear canal inserts)	<input type="checkbox"/> Arc-Rated Face Shield and Balaclava (flash suit hood can be used)
<input type="checkbox"/> Hard Hat	<input type="checkbox"/> Arc-Rated Hard Hat Liner
<input type="checkbox"/> Leather Gloves	<input type="checkbox"/> Arc-Rated Flash Suit Hood
<input type="checkbox"/> Leather Shoes	<input type="checkbox"/> Arc-Rated Foul Weather Gear (jacket, parka, coveralls, rainwear, etc.)
<input type="checkbox"/> Arc-Rated Gloves	
<input type="checkbox"/> Arc-Rated Shirt and Pants and/or Coveralls and/or Arc Flash Suit (minimum combined clothing rating :) _____	

6. Shock Hazard Boundary Determination:

Voltage – Phase To Phase	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary	Check Correct Box
	Exposed Movable Conductor	Exposed Fixed Circuit Part			
50 to 300	10 ft. 0 in.	3 ft. 6 in.	Avoid contact	Avoid Contact	
301 to 600	10 ft. 0 in.	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.	

7. Arc Flash Protection Boundary Distance (Taken from Arc Flash Label or if there is no label, use 10 feet) _____

8. Method to restrict the access of unqualified persons from the work area (e.g. Barrier Set with Danger Tape etc.). _____

9. Evidence of completion of a Job Briefing including discussion of any job-related hazards and emergency egress plan. _____

10. By signing below, you agree the work described above can be done safely:

_____	_____	_____	_____
(1 of 2 Required)	Date	(2 of 2 Required)	Date
Qualified Electrical Person		Qualified Electrical Person	

11. Approval of Work:

_____	_____	_____	_____
50 to 120 Volts	Date	Greater than 120 Volts	Date
Manager or Supervisor		Director or Deputy Director	

ANNEX B

EXAMPLE LABELING OF ELECTRICAL EQUIPMENT TO WARN OF POSSIBLE ARC/FLASH HAZARDS

 WARNING	 WARNING																								
<p align="center">Arc Flash and Shock Hazard Appropriate PPE Required</p>	<p align="center">Arc Flash and Shock Hazard Appropriate PPE Required</p>																								
<p>None Flash Protection Boundary 0.8 cal/cm² flash hazard at 18 inches</p> <p>Arc Flash PPE Requirements: No Arc Flash PPE Required</p>	<p>5 feet Flash Protection Boundary 1.7 cal/cm² flash hazard at 36 inches</p> <p>Arc Flash PPE Requirements: AR Clothing, AR Face Shield, AR Balaclava, Safety Glasses, Hearing Protection, Heavy Duty Leather or AR Gloves</p>																								
<table border="1"> <tr> <td>480 VAC</td> <td>Glove Class 00</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">0.8 cal/cm² <small>29-Jul-10</small></td> </tr> <tr> <td colspan="2">Shock Hazard Boundaries:</td> </tr> <tr> <td>42 inches</td> <td>Limited Approach</td> </tr> <tr> <td>12 inches</td> <td>Restricted Approach</td> </tr> <tr> <td>1 inch</td> <td>Prohibited Approach</td> <td></td> </tr> </table>	480 VAC	Glove Class 00	0.8 cal/cm ² <small>29-Jul-10</small>	Shock Hazard Boundaries:		42 inches	Limited Approach	12 inches	Restricted Approach	1 inch	Prohibited Approach		<table border="1"> <tr> <td>13800 VAC</td> <td>Glove Class 2</td> <td>PPE Level 2</td> </tr> <tr> <td colspan="2">Shock Hazard Boundaries:</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">1.7 cal/cm² <small>28-Feb-11</small></td> </tr> <tr> <td>60 inches</td> <td>Limited Approach</td> </tr> <tr> <td>26 inches</td> <td>Restricted Approach</td> </tr> <tr> <td>7 inches</td> <td>Prohibited Approach</td> </tr> </table>	13800 VAC	Glove Class 2	PPE Level 2	Shock Hazard Boundaries:		1.7 cal/cm ² <small>28-Feb-11</small>	60 inches	Limited Approach	26 inches	Restricted Approach	7 inches	Prohibited Approach
480 VAC	Glove Class 00	0.8 cal/cm ² <small>29-Jul-10</small>																							
Shock Hazard Boundaries:																									
42 inches	Limited Approach																								
12 inches	Restricted Approach																								
1 inch	Prohibited Approach																								
13800 VAC	Glove Class 2	PPE Level 2																							
Shock Hazard Boundaries:		1.7 cal/cm ² <small>28-Feb-11</small>																							
60 inches	Limited Approach																								
26 inches	Restricted Approach																								
7 inches	Prohibited Approach																								
<p>DC-ELEV-Q DS Prot. Device: J6-MCC10-ICE</p>	<p>APTU HV 23 (C3D3) Prot. Device: 23 50/51</p>																								
 WARNING	 DANGER																								
<p align="center">Arc Flash and Shock Hazard Appropriate PPE Required</p>	<p align="center">ENERGIZED WORK PROHIBITED</p>																								
<p>6 feet Flash Protection Boundary 9.5 cal/cm² flash hazard at 18 inches</p> <p>Arc Flash PPE Requirements: AR Flash Suit, AR Flash Suit Hood, Safety Glasses, Hearing Protection, AR Gloves</p>	<p>33 feet Flash Protection Boundary 73.2 cal/cm² flash hazard at 24 inches</p> <p>Arc Flash PPE Requirements: ENERGIZED WORK PROHIBITED</p>																								
<table border="1"> <tr> <td>480 VAC</td> <td>Glove Class 00</td> <td>PPE Level 4</td> </tr> <tr> <td colspan="2">Shock Hazard Boundaries:</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">9.5 cal/cm² <small>28-Feb-11</small></td> </tr> <tr> <td>42 inches</td> <td>Limited Approach</td> </tr> <tr> <td>12 inches</td> <td>Restricted Approach</td> </tr> <tr> <td>1 inch</td> <td>Prohibited Approach</td> </tr> </table>	480 VAC	Glove Class 00	PPE Level 4	Shock Hazard Boundaries:		9.5 cal/cm ² <small>28-Feb-11</small>	42 inches	Limited Approach	12 inches	Restricted Approach	1 inch	Prohibited Approach	<table border="1"> <tr> <td>480 VAC</td> <td>Glove Class 00</td> <td>Dangerous</td> </tr> <tr> <td colspan="2">Shock Hazard Boundaries:</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">73.2 cal/cm² <small>29-Jul-10</small></td> </tr> <tr> <td>42 inches</td> <td>Limited Approach</td> </tr> <tr> <td>12 inches</td> <td>Restricted Approach</td> </tr> <tr> <td>1 inch</td> <td>Prohibited Approach</td> </tr> </table>	480 VAC	Glove Class 00	Dangerous	Shock Hazard Boundaries:		73.2 cal/cm ² <small>29-Jul-10</small>	42 inches	Limited Approach	12 inches	Restricted Approach	1 inch	Prohibited Approach
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<p>APTU PP-4 Prot. Device: APTU_US1-C4</p>	<p>APTU UnitSub 1 Prot. Device: APTU US 1 Main</p>																								

NO ARC FLASH PPE REQUIRED	⚠ WARNING	
	ARC FLASH PPE LEVEL 2	AF PROTECTION BOUNDARY (ft) 5
⚠ WARNING		⚠ DANGER
ARC FLASH PPE LEVEL 4	AF PROTECTION BOUNDARY (ft) 6	ENERGIZED WORK PROHIBITED

Categories:

- **No Arc Flash PPE Required**

- $<1.2 \text{ cal/cm}^2$ calculated arc flash hazard
- Color: Green
- No Arc Flash PPE Required - No Arc Flash Boundary requirement

- **Level 2**

- 1.2 through 8 cal/cm^2 calculated arc flash hazard
- Color: Yellow
- Minimum Arc Flash PPE Requirements:
 - Arc-rated (AR) long-sleeve shirt with Arc-rated pants ($\geq 8 \text{ cal/cm}^2$ rating) or Arc-rated coveralls ($\geq 8 \text{ cal/cm}^2$ rating)
 - Arc-rated face shield ($\geq 8 \text{ cal/cm}^2$ rating) and AR Balaclava ($\geq 8 \text{ cal/cm}^2$ rating) or arc flash suit hood
 - Any optional clothing worn with AR PPE must be non-melting
 - Hard hat, Safety glasses/goggles, hearing protection, heavy duty leather or AR gloves, leather work shoes

- **Level 4**

- $>8 \text{ cal/cm}^2$ up to 40 cal/cm^2 calculated arc flash hazard
- Color: Orange
- Minimum Arc Flash PPE Requirements:
 - Arc-rated arc flash suit jacket, arc flash suit pants, and arc flash suit hood ($\geq 40 \text{ cal/cm}^2$ rating)
 - Any optional clothing worn with AR PPE must be non-melting
 - Hard hat, Safety glasses/goggles, hearing protection, rubber insulated gloves with AR Gloves, leather work shoes

NOTE: Non-AR clothing shall not be worn over AR clothing.

- **Energized Work Prohibited**

- $>40 \text{ cal/cm}^2$
- Color: Red
- No PPE can protect against the non-thermal hazards for energies above 40 cal/cm^2

ANNEX C

PPE REQUIREMENTS FOR COMMON LOW-VOLTAGE TASKS

Task (Assumes equipment is energized and work is done within flash hazard boundary)	Hazard/ Risk Class	V-Rated Gloves	V-Rated Tools
Panelboard or Equipment 250 Volts or below			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation (Covers on or off)	0	N	N
Work on energized parts includes voltage testing	2	Y	Y
Remove/install CBs or fused switches	2	Y	Y
Removal of bolted covers to expose bare energized parts	2	N	N
Opening hinged covers to expose bare energized parts	0	N	N
Work on energized conductors and circuits parts of equipment fed directly by a branch circuit of the panelboard	2	Y	Y
Panelboard or Equipment 250 -600 Volts			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
Circuit breaker or fused switch with cover on	0	N	N
Circuit breaker or fused switch with cover off	2	Y	N
Work on energized parts including voltage testing	2	Y	Y
Work on energized conductors and circuit parts of equipment fed directly by a branch circuit of the panelboard	2	Y	Y
600 Volt Class Motor Control Centers (MCC)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
Circuit breaker, fused switch or starter operation with enclosure door closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Circuit breaker, fused switch or starter operation with enclosure door open	2	N	N
Work on energized parts including voltage testing	2	Y	Y
Work on control circuits with energized conductors and circuit parts 120 volts or less and exposed	0	Y	Y
Work on control circuits with energized conductors and circuit parts above 120 volts and exposed	2	Y	Y
Insertion or removal of individual starter “buckets” from MCC	4	Y	N
Application of safety grounds, after voltage test	2	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts	4	N	N
Open hinged covers to expose bare, energized parts	2	N	N
Work on energized conductors and circuit parts of equipment fed directly by a branch circuit of the panelboard	2	Y	Y

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Task (Assumes equipment is energized and work is done within flash hazard boundary)	Hazard/ Risk Class	V-Rated Gloves	V-Rated Tools
600 Volt Class Switchgear (with power circuit breakers or fuses)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
Circuit breaker, or fused switch operation with enclosure door closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Circuit breaker, or fused switch operation with enclosure door open	2	N	N
Work on energized parts including voltage testing	2	Y	Y
Work on control circuits with energized conductors and circuit parts 120 volts or less and exposed	0	Y	Y
Work on control circuits with energized conductors and circuit parts above 120 volts and exposed	2	Y	Y
Insertion or removal (racking) circuit breakers from cubicles with door opened or closed	4	N	N
Application of safety grounds, after voltage test	2	Y	N
Remove bolted covers to expose bare, energized parts	4	N	N
Open hinged covers to expose bare, energized parts	2	N	N
Other 600 Volt Class Equipment (277-600 Volt)			
Lighting or Small Power Transformer, Remove bolted covers to expose bare, energized parts	2	N	N
Lighting or Small Power Transformer, Open hinged covers to expose bare, energized parts	2	N	N
Lighting or Small Power Transformer, Work on energized parts including voltage testing	2	Y	Y
Lighting or Small Power Transformer, Application of safety grounds, after voltage test	2	Y	N
Miscellaneous equipment cover removal or installation (Cable trough, tray, ect covers)	2	N	N
Work on energized electrical components including voltage testing	2	Y	N
Application of Safety Grounds after voltage test	2	Y	N
Insertion or removal of plug-in devices into or from busways	2	Y	N

ANNEX D

PROTECTIVE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT (PPE) MATRIX
PPE requirements in SHE Standard F2 must be complied with in addition to the requirements below

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 0	
Protective Clothing, Non-melting (according to ASTM F-1506-00) or untreated Natural Fiber	Shirt (long sleeve) Pants (long)
Protective Equipment	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 2	
Arc-rated Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeved shirt Arc-rated pants Arc-rated coverall (Note 3) Arc-rated arc flash suit hood (Note 4) Arc-rated jacket, parka, or rainwear (AN)
Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy Duty Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 4	
Arc-rated Clothing, Minimum Arc Rating of 40 (Note 1)	Arc-rated arc flash suit jacket AR Arc-rated flash suit pants AR Arc-rated arc flash suit hood Arc-rated jacket, parka, or rainwear (AN)
Protective Equipment	Hard hat Arc-rated hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes
<p>AN = As needed (Optional) AR = As required SR = Selection required</p>	
<p>Notes:</p> <ol style="list-style-type: none"> 1. See NFPA 70E Table 130.7(C)(11). Arc rating for a garment or system of garments is expressed in cal/cm². 2. If rubber insulating gloves with leather protectors are required, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement. 3. Alternate is to use FR coveralls (minimum arc rating of 8) instead of FR shirt and FR pants. 4. Alternate is to use face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 which covers the face, head, and neck except for the eye and nose areas. 	

Additional Arc Flash PPE Required

	Hazard Risk Class		
	0	2	4
Safety Glasses or Goggles	X	X	X
Hard Hat	X	X	X
FR Hard Hat Liner	-	-	X
Hearing Protection	X	X	X
Leather Gloves	AN	X	
Arc-Rated Gloves			X-Note
Leather Shoes	-	X	X
Arc-Rated Face Shield	-	X	
Balaclava	-	X	
Flash Suit Hood	-	Alternative to FS & Balaclava	X

AN- As Needed

NOTE: If voltage-rated gloves are required per Annex B or Annex C additional leather or arc-rated gloves are not required. The combination of voltage and leather gloves satisfies the arc flash protection requirement.

Glove/Class#/Color of Identification Label	Maximum Usage Voltage AC	Test Voltage
00 / Beige	500	2,500 V
0 / Red	1,000	5,000 V
1 / White	7,500	10,000 V
2 / Yellow	17000	20,000 V
3 / Green	26,500	30,000 V
4 / Orange	36,000	40,000 V

ANNEX E

NEW INSTALLATIONS - COLOR CODES FOR ELECTRICAL SYSTEMS (<600 V)

Voltage (AC) 3-Phase	Phase 1	Phase 2	Phase 3	Ground (Safety or Power)
480 VAC	Brown	Orange	Yellow	Green or Bare
208 VAC	Black	Red	Blue	Green or Bare
Voltage (AC) Single-Phase	Hot	Neutral		
120 VAC	Black	White		Green or Bare
120 VAC, multi-wire	Black, Red or Blue	White		Green or Bare
277 VAC	Brown, Orange, or Yellow	Gray		Green or Bare
Voltage (DC)	Positive (+)	Negative (-)		Ground (Safety or Power)
24 VDC Power Feeders	Blue	Gray or White/Blue ¹		Green or Bare (if required)
24 VDC System ²	Red	Black		
125 VDC Feeder	Red	Black		
125 VDC System	Red	Black		
5 VDC	Red	Black		
+/-15VDC	+15V Red	-15V White		Black
Instrumentation Ground, Signal Reference Ground, and Isolated Ground³				Green/Yellow ¹
All Uninterruptible Power Supply (UPS) receptacle and panel covers should be painted yellow.				

NOTES:

1. Color 1/Color 2 denotes that the primary color of the insulation is Color 1 and there is a tracer of Color 2.
2. This color code is a change for designing 24 VDC systems in ETF.
3. 120VAC Isolated Ground receptacles are signified with an orange marking.
4. NFPA70/NEC, Articles 200.6 and 250.118 shall be observed and followed.
5. Identification shall be the correct colored insulation, marking tape, or other approved means.

This chart satisfies the requirement of documentation that is readily available and removes the requirement to post each panel board. Colors designated in this chart are the basic industry standards. Most of these colors have been and are currently being used throughout the facility.

NOTE: (NFPA 70/NEC 2008: Articles 210.5 and 215.12 presently requires all branch circuits and feeders to be properly identified where a premises is supplied by more than one voltage system. The identification scheme shall be documented in a manner that is readily available or shall be posted at each panelboard or at the distribution equipment.)

ANNEX F

GUIDELINES FOR WORK AROUND ENERGIZED 480VAC OR GREATER ELECTRICAL EQUIPMENT

In general, energized static (no moving parts) electrical equipment, that has all covers and doors properly closed, is safe to be around. The real concern is when some part of the electrical system is changing, i.e. breaker opening/closing or being inserted/removed (racked). This is because the risk of having an arc flash event goes up considerably when parts are moving. Please note the potential for an arc flash event is still extremely low, even with moving parts. It's just that the likelihood is greater when the parts are moving.

Because of this, the following guidelines are to be followed. Note that the term "energized" references the primary switchgear voltage and not the control voltage. These guidelines apply to all medium voltage (>600V) and (<600V) switchgear. For the purposes of this guideline, switchgear consists of all medium voltage line-ups, breakers and disconnects; and low-voltage unit substations, draw-out breaker MCCs, and remote starters. Note that if the equipment has an arc flash label, the PPE requirements of that label are applicable here. If the equipment does not have a label, the requirements of Annexes C and D are to be followed.

1. Only opening (no touching or device manipulation) a hinged front door on an energized switchgear (energized parts not exposed) is allowed if the following conditions are met.
 - a. There is no existing or potential for a standing close or trip signal
 - b. Level 1 PPE is being worn.
2. Opening hinged front door on energized switchgear (energized parts not exposed) to touch or manipulate a device is allowed if the following conditions are met.
 - a. Where the breaker is removed from the connected position and the shutters are closed and remain that way
AND
 - b. Level 1 PPE is being worn.
OR
 - a. Where the breaker is in the connected position and the dc control power is removed such that a breaker operation cannot occur AND
 - b. Level 1 PPE is being worn.
OR
 - a. Where the breaker is in the connected position AND
 - b. The appropriate PPE is being worn to protect against an arc fault. This assumes that the incident energy is less than or equal to 40 cal/cm².
3. Opening/closing or racking a breaker on energized switchgear while standing in the flash hazard boundary is allowed if the appropriate PPE is being worn to protect against an arc fault. This assumes that the incident energy is less than or equal to 40 cal/cm².

ANNEX G

480 VAC RECEPTACLES AND CONNECTORS

1. All 480 VAC receptacle/disconnects shall be installed by qualified electrical persons.
2. Receptacles shall be of the interlocking disconnecting type.
The disconnect enclosure cannot be opened unless the disconnect is "OFF".
Plugs cannot be inserted or removed unless the disconnect is "OFF".
The disconnect shall have provisions to lock in the "OFF" position for lockout/tagout requirements.
3. Receptacles and disconnects shall be rated for the intended load (30, 60 or 100 amp).
4. Receptacles and disconnects may be of the fused or non-fused type.
If fused, the rating of the fuses shall be for the intended load.
NFPA-70 requirements shall be met.
5. Receptacles shall be approved for the location to be installed:
 - Indoor (Industrial, general purpose, etc.)
 - Weatherproof
 - Hazard location
 - Etc.
6. Receptacles shall be able to accept Crouse-Hinds Arktite® compatible designed plugs;
e.g. Appleton Powertite®, Hubbell Insulgrip®.

ANNEX H

480 VAC EXTENSION CORDS

1. Extension Cords are only allowed under the following conditions:
 - The need is temporary, and
 - The equipment requiring 480 VAC is too far away from the permanently installed receptacle to properly insert the equipment plug.
2. 480 VAC extension cords shall be rated for the intended load and shall follow manufacturer recommendations for wire size and insulation type.
3. 480 VAC extension cords shall be part of the “Assured Equipment Grounding Conductor Program” and shall be inspected by qualified industrial persons at intervals not exceeding 3 months. (NFPA-70 2008, Article 590.6, B (2))