

**UNIVERSITY OF ROCHESTER  
ENVIRONMENTAL HEALTH & SAFETY**

<b>Policy No.: IH004</b>	<b>Approved by: Mark Cavanaugh</b>
<b>Title: Electrical Safety Program</b>	<b>Date: 3/6/08</b>
<b>Revision No.: New</b>	<b>Page 1 of 30</b>
<b>Prepared by: Gregory J. Devlin</b>	

**I. PURPOSE**

Electricity is a serious workplace hazard, capable of causing both employee injury and property damage. It is the policy of the **University of Rochester (U of R)**, to protect all employees, students, and all other personnel from potential electrical hazards. This will be accomplished through compliance with the work practices described herein along with effective application of engineering controls, administrative controls, and the use of personal protective equipment.

The **U of R Electrical Safety Program** is founded on the *principle of avoiding and not permitting energized work unless it is absolutely necessary*. Live parts will be de-energized before an employee works on or near them unless one of the following conditions applies:

- 1. De-energizing introduces additional or increased hazards.** Examples of “additional or increased” hazards would include interruption of life support equipment, deactivation of emergency alarm systems, or shutdown of hazardous location ventilation systems.
- 2. De-energizing is not possible due to equipment design or operational limitations.** Examples of this situation would include testing and troubleshooting of electrical circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.
- 3. Live parts are operating at less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electrical arcs.**
- 4. Live parts are to be de-energized in accordance with the U of R Lockout/Tagout Program.** If live parts are not placed in an electrically safe condition, the work practices described in this document must be used to protect employees. Any work on live parts or circuits requires the issuance of a *Live Work Permit*, except as noted in Section V.B.2, Limited Long Term Energized Electrical Work Permit.

Thus, this program has been established in order to:

- 1. Ensure the safety of employees who may work on or near electrical systems.**
- 2. Ensure that university employees understand and comply with safety standards related to electrical work.**

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3. Ensure that uniform practices are followed at the U of R during the completion of electrical work.

## **II. PERSONNEL AFFECTED**

This program applies to all U of R properties, U of R sites, and work performed by university employees regardless of job site location.

## **III. DEFINITIONS**

The following terms are defined in order to allow a better understanding of this program:

1. **Arc rating:** The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to “breaking open” or at the onset of a second-degree skin burn. This rating is assigned to electrical protective clothing and is normally expressed in calories per square centimeter ( $\text{cal}/\text{cm}^2$ ).
2. **Electrically safe work condition:** A state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with U of R policy, tested to ensure the absence of voltage, and grounded if determined necessary.
3. **Energized:** Electrically connected to or having a source of voltage.
4. **Energized Electrical Work Permit:** Used for all non-routine live work.
5. **Exposed (as applied to live parts):** Capable of being inadvertently touched or approached from closer than a safe distance by a person. It is applied to parts that are not suitably guarded, isolated, or insulated.
6. **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 along with appropriate levels of PPE.
7. **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.
8. **Flash suit:** A complete FR clothing and equipment system that covers the entire body, except for the hands and feet. (Such a suit typically includes pants, jacket, and a “bee-keeper” style hood fitted with a face shield).
9. **FR apparel:** Flame-resistant apparel; describes a broad category of clothing designed to protect employees from electrical arc events during completion of energized tasks.
10. **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 used to measure incident energy is calories per square centimeter ( $\text{cal}/\text{cm}^2$ ).
11. **Limited approach boundary:** An approach limit at a distance from an exposed live part within which a shock hazard exists.

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- 12. Limited Long Term Energized Electrical Work Permit:** Allows specified live work to be performed by a qualified individual. The permit is good for up to one year and will be renewed annually, as appropriate. Routine work only.
- 13. Live parts:** Energized conductive components.
- 14. 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.
- 15. PPE:** An acronym for “Personal Protective Equipment”.
- 16. Qualified person:** Has received training and understands the requirements of the U of R Program plus OSHA and NFPA 70E. One who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training on the hazards involved. Has exhibited proficiency for specific procedures, has worked on the specific voltage before, can distinguish exposed live parts from other parts, can determine the nominal voltage of live parts, and understands clearance distances for the voltages he/she will be exposed too. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools.
- 17. 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.
- 18. Unqualified person:** Any person who does not meet the definition of a qualified person.
- 19. Working near (live parts):** Any activity within a Limited Approach Boundary.

#### **IV. RESPONSIBILITIES**

##### **A. DIRECTORS and MANAGERS**

- 1.** Support the general regulatory compliance programs, and assure that Facility/Departmental Policies are followed.
- 2.** Provide resources and personnel necessary to develop, maintain, and annually verify and update this program as a whole, including a database system to maintain written procedures.
- 3.** Provide for resources and personnel to assure all of their employees have received necessary training and instruction regarding their assigned roles and responsibilities to comply with this program.

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**B. ENVIRONMENTAL HEALTH and SAFETY SPECIALIST**

1. Evaluate work being performed to determine compliance with this program.
2. Provide or assist in task specific training for electrical work qualifications.
3. Recordkeeping of all electrical work permits.
4. Periodically review and update this written program.
5. Provide general training for work units on the content of this program.
6. Assist university facility work units in implementing the provisions of this program.
7. Conduct an annual program audit.

**C. OPERATIONS and AREA MANAGERS**

1. Determine the applicability of the electrical safety program to activities conducted within their respective areas of jurisdiction.
2. Designate individuals responsible for the implementation of the electrical safety program within their areas.
3. Actively support this program as part of the University of Rochester overall safety effort.
4. Oversee the Limited Long Term Energized Electrical Work Permit process.

**D. TRADES SUPERVISORS**

1. Ensure employees comply with all provisions of the electrical safety program.
2. Ensure employees receive training appropriate to their assigned electrical tasks and maintain documentation of such training.
3. Develop and maintain a listing of all qualified employees under their supervision.
4. Ensure employees are provided with and use appropriate protective equipment.
5. Identify tasks that require Live/Energized Work Permits.
6. Issue Limited Long Term Energized Electrical Work Permit based on operational needs and route to the area manager and then the Electrical Safety Committee for review and approval.

**E. EMPLOYEES**

1. Follow the work practices described in this document, including the use of appropriate protective equipment and tools.
2. Attend all training required relative to this program.
3. Immediately report any concerns related to electrical safety to supervision.

**F. ELECTRICAL ENGINEERING CONSULTANT**

1. Complete calculations required by this program when needed.
2. Place an emphasis on controlling electrical hazards through the application of engineering and design controls.

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**G. ELECTRICAL SAFETY COMMITTEE**

1. Meet on a quarterly basis to review electrical safety issues at U of R.
2. Review all Live Energized Electrical Work Permits submitted for approval.
3. Promote consistency in how electrical tasks are completed within the various work units at the U of R.

**V. PROCEDURES**

**A. TRAINING**

1. Employees exposed to an electrical hazard that is not reduced to a safe level by that equipment's installation must be trained. Removal of covers and plates, opening of doors and gates, etc. are examples of exposing an electrical hazard.
2. The level of electrical safety training provided is dependent on whether the employee is classified as a "qualified person" or "unqualified person".
3. A "qualified person" shall be trained and knowledgeable in all of the following topics:
  - a. Construction and operation of equipment on which work is assigned.
  - b. Skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.
  - c. Skills and techniques necessary to determine the nominal voltage of exposed live parts.
  - d. The approach distances specified in this document and the corresponding voltages to which the qualified employee will be exposed.
  - e. The process necessary to determine the degree and extent of electrical hazards along with the PPE and job planning necessary to perform the task safely.
4. *A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others. The supervisor shall maintain appropriate documentation.*
5. *An "unqualified person" shall be trained in the inherent hazards of electricity and any related work practices that are necessary for their safety.*
6. The work unit supervisor and Environmental Health and Safety will coordinate training for qualified and unqualified persons. Training will be provided to reflect

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the scope of hazards associated with working on live equipment and include specifics regarding safe work procedures. Training for employees, whether experienced or new to the job, must be provided before duties are assigned that involve work near or on electrical systems.

7. Each U of R work unit shall maintain a record of all electrical training provided to their employees along with a listing of all employees classified as qualified persons. A copy of this record will be provided to EH&S.

**B. WORKING ON OR NEAR LIVE PARTS**

**1. Live/Energized Electrical Work Permit**

- a. Live parts are not placed in an electrically safe condition, work to be performed shall be considered energized electrical work and will be performed by written permit only, unless the work is authorized by that person's *Limited Long Term Energized Electrical Work Permit*
- b. A copy of the "*U of R Energized Electrical Work Permit*" can be found in Appendix A of this document. The intent of this permit is to ensure that all appropriate safety precautions are taken prior to starting energized electrical work.
- c. The permit is to be originated by the individual requesting that the energized work be completed. (This will normally be the supervisor of the employees who will be completing the work). The requestor is responsible for completing Section I of the permit.
- d. The qualified persons completing the task are responsible for completing Section II of the permit.
- e. All Energized Work Permits should be initiated and reviewed by the Trades Supervisor, who then reviews it with the area manager followed by at least two members of the Electrical Safety Committee reviewing and approving the permit prior to the work beginning. The two members of the Electrical Safety Committee must be other than the individual performing the work.
- f. In the event of an emergency condition requiring an Energized Work permit where sufficient members of the electrical safety committee are not available, the on-call supervisor and/or the on call manager can review the work plan and provide verbal authority to conduct work. In the MC, the on-call supervisor reviews the plan and then reviews it with the on-call manager for approval. In either event, the Energized Work Permit application shall be filled out the next business day for review by the committee.

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- g. The permit must be posted in the area where the energized work is taking place for the duration of the task.
- h. Copies of all energized electrical work permits must be provided to Environmental Health and Safety upon completion of the task.
- i. Work related to testing, troubleshooting, and voltage measuring may be completed without a permit provided appropriate safe work practices and PPE are used. The individual performing such work must have a Limited Long Term Energized Electrical Work Permit on file (see next section).

**2. Limited Long Term Energized Electrical Work Permit (see Appendix H)**

- a. Allows specified live work to be performed by a qualified individual.
- b. It includes the performance of routine tasks including testing, troubleshooting, voltage measuring and repair provided appropriate safe work practices and PPE are used, and falls under the Hazard Risk Category.
- c. The permit is good for up to one year.

**3. Approach Boundaries to Live Parts**

- a. Observing a safe approach distance from exposed energized parts is an effective means of maintaining electrical safety. As the distance between an individual and live parts increases, the potential for an electrical injury decreases.
- b. Safe approach distances will be determined for all tasks in which approaching personnel are exposed to live parts.
- c. Safe approach distances to fixed live parts can be determined by referring to **Appendix B**, “*Approach Boundaries to Live Parts for Shock Protection*”. This appendix can be used to identify the Limited, Restricted, and Prohibited Approach Boundaries associated with various system voltages.
- d. Unqualified persons may only cross the Limited Approach Boundary (**Appendix B**) when they are under the direct supervision of a qualified person.
- e. Qualified persons may not cross or take any conductive object closer than the Restricted Approach Boundary unless one of the following conditions apply:
  - i. The qualified person is insulated or guarded from the live parts and no uninsulated part of the qualified person’s body crosses the Prohibited Approach Boundary.
  - ii. The live parts are insulated from the qualified person and from any other conductive object at a different potential.

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- f. Crossing the Prohibited Approach Boundary is considered the same as making contact with energized parts. Qualified persons may only cross this boundary when all of the following precautions have been taken:
  - i. The qualified person has specific training to work on energized parts.
  - ii. The qualified person has obtained an approved Energized Electrical Work Permit.
  - iii. The qualified person uses PPE appropriate for working on energized parts that are rated for the voltage and energy level involved.

**4. Other Precautions for Personnel Activities:**

- a. Lockout/Tagout shall be implemented whenever and wherever possible in order to minimize the amount of live work that gets performed.
- b. Employees shall not reach blindly into areas that might contain exposed live parts.
- c. Employees shall not enter spaces containing live parts unless illumination is provided and permits to perform live work have been issued that allow the work to be performed safely.
- d. Conductive articles of PPE, jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses, etc.) shall not be worn whenever and wherever work is performed on electrical equipment or circuits.
- e. Conductive materials, tools, and equipment that are in contact with any part of an employee's body shall be handled in a manner that prevents accidental contact with live parts. Such materials and equipment include, but are not limited to, long conductive objects such as ducts, pipes, tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, and chains.
- f. When an employee works in a confined space or enclosed space (such as a manhole or vault) that contains exposed live parts, the employee shall use protective shields, barriers, or insulating materials as necessary to avoid contact with these parts. Doors, hinged panels, and the like shall be secured to prevent them from swinging into employees.
- g. When working in a confined space, the U of R Confined Space Program shall be adhered to.
- h. Only properly rated and approved tools shall be used. It is dangerous to use non-approved tools, such as 4in1 screwdrivers. See *Appendix K* for approved tools.

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**C. PERSONAL PROTECTIVE EQUIPMENT**

**5. General Requirements**

- a. Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment (Arc Flash Gear) that is designed and constructed for the specific body part to be protected and for the work to be performed.
- b. U of R will provide electrical protective equipment (Arc Flash Gear) required by this program at no cost to employees. Such equipment shall include 11 calorie, and 40 calorie rated Arc Flash apparel, eye protection, head protection, hearing protection, hand protection, insulated footwear, and face shields where necessary. *The U of R is not responsible for providing under layers, but the employee must wear compatible under layers.*
- c. The employee to whom it is issued shall maintain all protective equipment in a safe, reliable condition.
- d. Employees shall wear nonconductive head protection whenever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion.
- e. Employees shall wear nonconductive protection for the face, neck, and chin whenever there is danger of injury from exposure to electric arcs or flashes or from flying objects resulting from an electrical explosion.
- f. Employees shall wear nonconductive protective equipment for the eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion.
- g. Employees shall wear hearing protection whenever performing live work.
- h. Employees shall wear rubber-insulating gloves where there is danger of hand and arm injury due to contact with live parts or possible exposure to arc flash burn.
- i. Where insulated footwear is used as protection against step and touch potential, electrically rated insulated boots or dielectric overshoes shall be required. Insulated soles shall not be used as primary electrical protection. Shoes shall be leather.
- j. Face shields without an arc rating will not be used for electrical work. Safety glasses or goggles must always be worn underneath face shields.
- k. Additional illumination may be needed when using tinted face shields as protection during electrical work.

**6. Flash Protection Boundary**

- a. Personal protective equipment shall be provided to and used by all employees working within the "Flash Protection Boundary".

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- b. For systems that are 600 volts or less, the Flash Protection Boundary shall be a minimum of four feet. *The formula in **Appendix C** can be used to determine the exact Flash Protection Boundary for systems under 600 volts.*
- c. For systems that are above 600 volts, the Flash Protection Boundary shall be determined through engineering analysis.
- d. The specific protective equipment to be worn within the Flash Protection Boundary can be determined by either of the following two methods:
  - i. Complete a detailed flash hazard analysis under engineering supervision that determines the incident exposure energy of each employee. Appropriate protective clothing can then be selected based on the calculated exposure level. Criteria for completing such an analysis can be obtained from **Environmental Health and Safety**.
  - ii. All new buildings and installations are to have an arc flash study performed and documented. Determine the hazard level of the task by referring to NFPA 70E Table 130.7 (C) (9) (a), “Hazard/Risk Category Classifications” (**Appendix D** of this document). This table also indicates whether voltage-rated gloves and/or voltage-rated tools need to be used. Once the hazard level of the task has been determined, the required PPE can then be ascertained from NFPA 70E Table 130.7 (C) (10), “Protective Clothing and PPE Matrix”. (**Appendix E** of this document).
- e. U of R work units shall develop and maintain a listing of the specific PPE requirements for each energized electrical task conducted by their employees using the form found in **Appendix F** of this document.

**7. Flame-Resistant (FR) Apparel & Under layers**

- a. FR apparel (See **Appendix I** of this document) shall be visually inspected before each use. FR apparel that is contaminated or damaged shall not be used. Protective items that become contaminated with grease, oil, flammable liquids, or combustible liquids shall not be used.
- b. The garment manufacturer’s instructions for care and maintenance of FR apparel shall be followed. See **Appendix J** of this document.
- c. When FR apparel is worn to protect an employee, it shall cover all ignitable clothing and allow for movement and visibility.
- d. FR apparel must cover potentially exposed areas as completely as possible. FR shirtsleeves must be fastened and FR shirts/jackets must be closed at the neck.
- e. Non-melting, flammable garments (i.e. cotton, wool, rayon, silk, or blends of these materials) may be used as under layers beneath FR apparel.

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- f. Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric under layers next to the skin. (An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted).
- g. FR garments worn as outer layers over FR apparel (i.e. jackets or rainwear) must also be made from FR material.
- h. Flash suits must permit easy and rapid removal by the user.

**8. Rubber Insulating Equipment**

- a. Rubber insulating equipment includes protective devices such as gloves, sleeves, blankets, and matting.
- b. Insulating equipment must be inspected for damage before each day's use and immediately following any incident that could have caused damage.
- c. An air test must be performed on rubber insulating gloves before each use.
- d. Insulating equipment found to have defects that might affect its insulating properties must be removed from service until testing indicates that it is acceptable for continued use.
- e. Where the insulating capability of protective equipment is subject to damage during use, an outer covering of leather or other appropriate material shall protect the insulating material.
- f. *Rubber insulating equipment must be tested according to the schedule contained in **Appendix G**.*
- g. Rubber insulating equipment must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage.
- h. No repairs to rubber insulating equipment shall be attempted without the approval of a U of R Master Electrician.

**9. Insulated tools and materials (provided by U of R)**

- a. Only insulated tools and equipment shall be used within the Limited Approach Boundary of exposed energized parts.
- b. Insulated tools shall be rated for the voltages on which they are used.
- c. Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- d. Fuse or fuse holder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse.
- e. Ropes and hand lines used near exposed energized parts shall be nonconductive.
- f. Portable ladders used for electrical work shall have nonconductive side rails.

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**10. Test and Inspection Protocol for PPE Equipment**

- a. All PPE clothing and equipment must be visually inspected by the user before each use and taken out of service if any defects are noted.
- b. Equipment, tools, and clothing are all subject to semi-annual or annual inspections. These inspections shall be documented on the **Test and Inspection Protocol** standard form used at the U of R. See *Appendix L*.

**D. ALERTING TECHNIQUES**

1. Barricades shall be used in conjunction with safety signs to prevent or limit access to work areas containing live parts. Conductive barricades shall not be used where they might cause an electrical hazard. Barricades shall be placed no closer than the Limited Approach Boundary.
2. If signs and barricades do not provide sufficient protection, an attendant will be assigned to warn and protect pedestrians. The primary duty of the attendant shall be to keep unqualified persons out of the work area where an electrical hazard exists. The attendant shall remain in the area as long as there is a potential exposure to electrical hazards. The attendant shall remain outside of the Limited Approach Boundary.

**E. CONTRACT EMPLOYEES**

1. Safety programs used by contractors on U of R jobsites must meet or exceed all applicable guidelines of this Safety Program, including the obtaining of an Energized Electrical Work Permit, when applicable. Applicable would mean using or tied into a U of R power source.
2. Contractors will be required to comply with applicable Safety and Health regulations such as OSHA, NFPA, and EPA.
3. Contractors are required to meet the training requirements of NFPA 70E prior to beginning work at the University of Rochester.
4. Contractors are required to submit copies of their Safety Program to **Environmental Health and Safety** upon request.

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**VI. REFERENCES**

1. NFPA 70E, “Standard for Electrical Safety in the Workplace”, 2004 edition
2. OSHA, 29 CFR 1910.331 through 1910.335, “Electrical Safety-Related Work Practices”
3. OSHA, 29 CFR 1910.147, “The Control of Hazardous Energy”
4. OSHA, 29 CFR 1910.132, “Personal Protective Equipment”
4. University of Rochester Lockout/Tagout and Confined Space Programs
5. University of Rochester *Personal Protective Equipment Plan*

**VII. APPENDICES/FORMS**

- Appendix A: Energized Electrical Work Permit**
- Appendix B: Approach Boundaries to Live Parts for Shock Protection**
- Appendix C: Formula for Calculation of Flash Protection Boundary**
- Appendix D: Hazard/Risk Category Classifications**
- Appendix E: Personal Protective Equipment Matrix**
- Appendix F: PPE Requirements for Energized Tasks**
- Appendix G: Inspection Schedule for Rubber Insulating Equipment**
- Appendix H: Limited Long Term Energized Electrical Work Permit**
- Appendix I: Flame Resistant Clothing**
- Appendix J: Flame Resistant Clothing Care and Maintenance**
- Appendix K: Arc Flash PPE and Insulated Tools**
- Appendix L: Test and Inspection Protocol for PPE Equipment**
- Appendix M: Resources**

**VIII. REVISION HISTORY**

Date	Revision No.	Description
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**Appendix B: Approach Boundaries to Live Parts for Shock Protection**

(All dimensions are distance from live part to employee)

(1)	(2)	(3)	(4)	(5)
	Limited Approach Boundary		Restricted Approach Boundary	
Nominal System Voltage Range, Phase to Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	Includes Inadvertent Movement Adder	Prohibited Approach Boundary
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.05 m (10 ft 0 in)	1.07 m (3 ft 6 in)	Avoid contact	Avoid contact
301 to 750	3.05 m (10 ft 0 in)	1.07 m (3 ft 6 in)	304.8 mm (1 ft 0 in)	25.4 mm (0 ft 1 in)
751 to 15 kV	3.05 m (10 ft 0 in)	1.53 m (5 ft 0 in)	660.4 mm (2 ft 2 in)	177.8 mm (0 ft 7 in)
15.1 kV to 36 kV	3.05 m (10 ft 0 in)	1.83 m (6 ft 0 in)	787.4 mm (2 ft 7 in)	254 mm (0 ft 10 in)

- **Limited Approach Boundary:** Distance from an exposed live part within which a shock hazard exists. An unqualified person may not cross this boundary unless a qualified person continuously escorts them.
- **Restricted Approach Boundary:** 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. This boundary may only be crossed by a qualified person who is safely insulated or guarded from the live parts.
- **Prohibited Approach Boundary:** Distance from an exposed live part within which work is considered the same as making contact with the live part. This boundary may only be crossed by a qualified person who has specific training to work on energized parts; has obtained an approved Energized Electrical Work Permit; and uses PPE appropriate for working on energized parts which are rated for the voltage and energy level involved. (Note: A permit is not required for work related to testing, troubleshooting, and voltage measuring).
- **Flash Protection Boundary (not listed in table):** Distance from exposed live parts within which a person could receive a second-degree burn if an electrical arc flash were to occur. This boundary may only be crossed by a qualified person wearing the appropriate PPE. For systems that are 600 volts or less, the Flash Protection Boundary shall be a minimum of four feet. An engineering analysis must be performed to determine the Flash Protection Boundary for systems that are above 600 volts.

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**Appendix C: Formula for Calculation of Flash Protection Boundary**

$$D_c = [2.65 \times MVA_{bf} \times t]^{1/2}$$

OR

$$D_c = [53 \times MVA \times t]^{1/2}$$

Where:

$D_c$  = Distance in feet from an arc source for a second-degree burn

$MVA_{bf}$  = Bolted fault capacity available at point involved (in mega volt-amps)

$MVA$  = Capacity rating of transformer (mega volt-amps). For transformers with  $MVA$  ratings below 0.75 MVA, multiply the transformer  $MVA$  rating by 1.25.

$t$  = Time of arc exposure (in seconds).

**Examples:**

#1 Transformer 1000 kVA = 1.0 mVA, and breaker trip setting instantaneous of 0.1 seconds

$$D_c = (53 \times 1 \times 0.1)^{1/2}$$

$$D_c = (5.3)^{1/2}$$

$$D_c = 2.3 \text{ feet}$$

#2 Transformer 1000kVA = 1.0 mVA, and breaker trip setting at short time delay of 0.5 seconds

$$D_c = (53 \times 1 \times 0.5)^{1/2}$$

$$D_c = (26.5)^{1/2}$$

$$D_c = 5.1 \text{ feet}$$

Flash Protection Boundary increases with breaker trip setting

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**Appendix D: Hazard/Risk Category Classifications**

<b>Task (Assumes equipment is energized, and work is done within the Flash Protection Boundary)</b>	<b>Hazard/Risk Category</b>	<b>V-rated Gloves</b>	<b>V-rated Tools</b>
<b>Panelboards Rated 240 V and Below</b>			
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
<b>Panelboards or Switchboards Rated &gt; 240 V and up to 600 V (with molded case or insulated case circuit breakers)</b>			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2 (*)	Y	Y

**PPE Requirements can be found in Appendix E  
Additional Information:**

- V-rated Gloves are gloves rated and tested for the maximum line-to-line voltage upon which work will be done.
- V-rated Tools are tools that are rated and tested for the maximum line-to-line voltage upon which work will be done.
- 2(\*) means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category requirements of *Appendix E*.
- Y = Yes (required)
- N = No (not required)

**Notes:**

- (1) 25kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
- (2) For < 10kZ short circuit current available, the hazard/risk category required may be reduced by one number.

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**Appendix E: Personal Protective Equipment Matrix**

Protective Clothing and Equipment	Protective Systems for Hazard/Risk Category					
	Hazard/Risk Category Number	- 1 <sup>(3)</sup>	0	1	2	3
<b>Non-melting (according to ASTM F 1506-00) or Untreated Natural Fiber</b>						
a. T-shirt (short-sleeve)	X			X	X	X
b. Shirt (long-sleeve)		X				
c. Pants (long)	X	X	X	X <sup>(6)</sup>	X	X
<b>FR Clothing<sup>(1)</sup></b>						
a. Long-sleeve shirt			X	X	X <sup>(9)</sup>	X
b. Pants			X	X <sup>(6)</sup>	X <sup>(9)</sup>	X
c. Coverall			<sup>(5)</sup>	<sup>(7)</sup>	X <sup>(9)</sup>	<sup>(5)</sup>
d. Jacket, parka, or rainwear			AN	AN	AN	AN
<b>FR Protective Equipment</b>						
a. Flash suit jacket (multilayer)						X
b. Flash suit pants (multilayer)						X
c. Head protection						
1. Hard hat			X	X	X	X
2. FR hard hat liner					AR	AR
d. Eye protection						
1. Safety glasses	X	X	X	AL	AL	AL
2. Safety goggles				AL	AL	AL
e. Face and head area protection						
1. Arc-rated face shield, or flash suit hood				X <sup>(8)</sup>		
2. Flash suit hood					X	X
3. Hearing protection (ear canal inserts)				X <sup>(8)</sup>	X	X
f. Hand protection						
Leather gloves			AN	X	X	X
g. Foot protection						
Leather work shoes			AN	X	X	X
<b>PPE Arc Flash Gear Required</b>	<b>N/R</b>	<b>N/R</b>	<b>4cal</b>	<b>8cal</b>	<b>25cal</b>	<b>40cal</b>

**Hazard categories up to 2 U of R will require 11 calorie protection.  
Hazard categories over 2 U of R will require 40 calorie protection.**

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AN = As needed AR = As required AL = Select one in group X = Minimum required

**Notes:**

- (1) See Table 130.7 (C) (11). Arc rating for a garment is expressed in cal/cm<sup>2</sup>.
- (2) If voltage-rated gloves are required, the leather protectors worn external to the rubber gloves satisfy this requirement.
- (3) Hazard/Risk Category Number “-1” is only defined if determined by Notes 3 or 6 of Table 130.7 (C) (9) (a).
- (4) Space Reserved.
- (5) Alternate is to use FR coveralls (minimum arc rating of 11 cal) instead of FR shirt and FR pants.
- (6) If the FR pants have a minimum arc rating of 11 cal, long pants of non-melting or untreated fiber are not required beneath the FR pants.
- (7) Alternate is to use FR coveralls (minimum arc rating of 11 cal) over non-melting or untreated natural fiber pants and T-shirt.
- (8) A face shield with a minimum arc rating of 11cal, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or alternatively, a flash suit hood), is required.
- (9) Alternate is to use two sets of FR coveralls (the inner with a minimum arc rating of 4cal and outer coverall with a minimum arc rating of 5) over non-melting or untreated natural fiber clothing, instead of FR coveralls over FR shirt and FR pants over non-melting or untreated natural fiber clothing.



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**Appendix G: Inspection Schedule for Rubber Insulating Equipment**

<b>Type of Equipment</b>	<b>When to Test</b>
Rubber insulating line hose	Upon indication that 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 (*)
Rubber insulating gloves	Before first issue and every 6 months thereafter (*)
Rubber insulating sleeves	Before first issue and every 12 months thereafter (*)

(\*) – If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless is has been electrically tested within the previous 12 months.

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**Appendix H: Limited Long Term Energized Electrical Work Permit – Routine Tasks**

<b><u>LIMITED LONG TERM ENERGIZED ELECTRICAL WORK PERMIT – Routine Tasks</u></b>	
<b><u>To Be Updated Annually</u></b>	
QUALIFIED EMPLOYEE: _____	
EMPLOYEE JOB TITLE: _____	
Tasks Qualified for: _____ _____	
Hazard Category Qualified for: _____	
VOLTAGE LEVEL LIMIT: _____	
ANNUAL TRAINING REQUIRED:	NFPA 70E Date Received: _____ Electrical Safety Program Date Received: _____
PPE INSPECTION:	DATE: _____
FR PANTS/SHIRTS: _____	FR HOOD: _____
FR JACKET: _____	VOLTAGE RATED GLOVES: _____
VOLTAGE RATED TOOLS: _____	
(AGREE WITH ABOVE CONDITIONS)	
EMPLOYEE: _____	Date: _____
SUPERVISOR: _____	Date: _____
OPERATIONS/AREA MANAGER: _____	Date: _____
E. H. & S.: _____	Date: _____

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**Appendix I: Fire Resistive Clothing**



**Men's Work Pant**

**Fabric:** Excel-FR™ flame resistant, 9 oz. twill  
100% cotton

- Features:**
- Innerlined waistband w/ button closure
  - Two slack style front pockets, two set in hip pockets, left hip w/button closure

**Protection:** Arc Rating ATPV 11.2 calories/cm<sup>2</sup>

**Care:** Home and Industrial wash



**Women's Work Pant**

**Fabric:** Excel-FR™ flame resistant, 9 oz. twill  
100% cotton

- Features:**
- Innerlined waistband w/ button closure
  - Two slack style front pockets, two set in hip pockets, left hip w/button closure

**Protection:** Arc Rating ATPV 11.2 calories/cm<sup>2</sup>

**Care:** Home and Industrial wash



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### **Button Front Work Shirt**

**Fabric:** EXCEL-FR™ flame resistant, 7 oz. 100% cotton

- Features:**
- Two-piece, lined collar
  - One-piece lined cuff w/ button closures
  - Hemmed front w/ button closure
  - Sleeve vent

**Protection: Arc Rating ATPV 7.7  
calories/cm<sup>2</sup>**

**Care:** Home and Industrial wash



### **9oz. Deluxe Coverall**

**Fabric:** Excel-FR™ ComforTouch™ flame resistant, 9 oz. twill, 88% cotton / 12% nylon

- Features:**
- Two-way concealed NOMEX® taped brass breakaway zipper, concealed snap at top of zipper and at neck
  - Mandarin style, stand up, two-way safety collar
  - Concealed snap closure on cuff
  - Elastic waist inserts
  - Two front swing pockets, two patch chest pockets w/ flaps and concealed snap closure, two patch hip pockets, left sleeve tool pocket, rule pocket
  - Deep pleated action back
  - Side vent openings w/ snap closure

**Protection: Arc Rating ATPV 12.2  
calories/cm<sup>2</sup>**

**Care:** Home and Industrial wash



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**Appendix J: Fire Resistive Clothing Care and Maintenance**

- Machine wash with like colors
- Tumble dry and remove promptly
- No chlorine bleach
- No starch
- No fabric softeners
- No products containing hydrogen peroxide

**Note:** Failure to launder these garments properly could affect the flame resistance.

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**Appendix K: Arc Flash PPE and Insulated Tools**

**Face Shield, Hard Hat, Hood, and Safety Glasses**

The AS1000HAT Kit contains an AS1000HAT, a 10 cal/cm<sup>2</sup> ATPV rated AFHOOD, safety glasses and an ASBAG.  
The AS1000HAT has an ATPV rating of 10 cal/cm<sup>2</sup>.  
The lens provides a 7.5" x 20" viewing area with an extra light tint.  
The SKA10 is to be used with the HRC 2 uniform (work shirt and work pants) or HRC 2 coveralls.



**Glove Kits**

Insulating rubber gloves are necessary for every electrical worker's complete safety. To insure safety, leather protectors provide needed protection from cuts, abrasions, and punctures. To keep these safety items in top condition, proper storage is very important. Proper storage extends the service life of gloves. Folds and creases strain natural rubber and cause it to cut from ozone prematurely. By storing rubber gloves in the right size bag and never forcing more than one pair into each bag, equipment will lie flat and last longer.



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**TEN-FOUR™ Glove Dust**

A cooling, frictionless powder that absorbs moisture and perspiration when wearing rubber gloves. It is available in the shop.

**Basic Electrician's Kit**

**Insulated Hand Tools**

Rated for exposure up to 1000VAC and dielectrically tested at 10,000VAC. These tools meet or exceed current ASTM F1505-01 and IEC 900 Standards for Insulated Hand Tools. These tools will help you to be compliant with OSHA 29 CFR 1910 Subpart S, and NFPA 70E 2004.

The insulating material used is impact resistant and flame retardant. Two-color insulation makes inspection easier, which adds to the overall safety. If the yellow under layer is showing, the tool may no longer be insulated properly and should be considered for electrical retesting.



Kit, as pictured: 9PCS. INCLUDES: 3/16 X 4", 3/16 X 6", 1/4 X 6" SLOTTED SCREWDRIVERS; #1 X 3", #2 X 4" PHILLIPS SCREWDRIVER; 7" NEEDLE NOSE PLIER; 7-1/2" DIAGONAL CUTTING PLIER; 9" LINESMAN'S PLIER; AND COMBINATION STRIPPER / CRIMPER PLIER. IN A ROLL.

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**Appendix L: Test and Inspection Protocol for PPE Equipment**

**FR Clothing:**

Shirts, Workpants, and Coveralls:

- Rips and Tears
- Holes
- Threadbare
- Worn spots
- Missing or loose fasteners
- Shirts and Coveralls have the Meliora logo on chest and Bulwark triangle on the sleeve.

**Gloves:**

- Electrically tested before first use and every 6 months thereafter.
- Visual inspection for damage or wear before each use.
- Perform an air test on rubber insulating gloves before each use.

**Hardhats:**

- Support mechanism properly adjusted and in good repair
- Support mechanism mounted correctly so the brim is forward.
- Hat has no cracks or notable scratches.
- Hat has no decals or painting other than prescribed identifiers.
- Hat is pliable. Test by pressing in on the sides to ensure some flex.
- Hat is no more than 5 years old. See manufacture date on underside of brim.

**Face Shield:**

- Support mechanism is in good repair and fits the hard hat properly.
- Shield is certified for HRC-2.
- Shield has no cracks or notable scratches.
- Shield has no decals applied.

**NEVER USE ANY EQUIPMENT THAT DOES NOT PASS INSPECTION.  
MARK AS DEFECTIVE AND DISCARD. SEE SUPERVISOR OR MANAGER  
FOR REPLACEMENT.**

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**Appendix M: Resources**

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Mike Rink	UF&S MC Operations	275-4810
Jim Edmondson	UF&S MC Operations	273-2783
Richard Bassney	MCFO	273-4567
Mark Englerth	UF&S RC Operations	273-2100
Levi Olsen	UF&S RC Operations	273-2106
Scott Attili	U&E Mgmt UF&S	273-4609
Kevin Gibson	Facilities ESM	274-1170
Walt Poteat	UF&S MC Operations	273-1457
Mike Morsch	UF&S MC Operations	275-5179
Maggie Thomas	UF&S MC Operations	275-9761

**ELECTRICAL SAFETY PPE COMMITTEE**

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Maggie Thomas	UF&S MC Operations	275-9761
Jim Edmondson	UF&S MC Operations	273-2783
Richard Bassney	MCFO	273-4567
Mark Englerth	UF&S RC Operations	273-2100
Steve Teugeman	UF&S MC Operations	273-2880
Scott Attili	U&E Mgmt UF&S	273-4609
Norm Rhow	UF&S RC Operations	273-5810
John Nastasi	U&E Mgmt UF&S	275-6058
John Redhead	UF&S RC Operations	273-5810

**ELECTRICAL SAFETY TRAINING COMMITTEE**

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Maggie Thomas	UF&S MC Operations	275-9761
Mark Englerth	UF&S RC Operations	273-2100

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**PANEL WARNINGS/ARC FLASH STUDIES TEAM**

Gregory J. Devlin, Chair	EH&S	275-8414
Mike Morsch	UF&S MC Operations	275-5179
Maggie Thomas	UF&S MC Operations	275-9761
Mark Englerth	UF&S RC Operations	273-2100
Mike Rink	UF&S MC Operations	275-4810
Jim Edmondson	UF&S MC Operations	273-2783