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1.0 INTRODUCTION

1.1 Purpose & Scope

This manual establishes safe work practices for all designated personnel required to work on or around any energized electrical equipment at Ameren Missouri Generation facilities. This manual applies to electrical operations 50 nominal volts ac/dc or greater unless otherwise specifically discussed in this manual

2.0 INFORMATION

2.1 Terms and Definitions

2.1.1 **Ameren Hazardous Risk Categories (AHRC):** A standardized set of electrical PPE used for worker protection based upon varying levels of arc flash and shock exposure.

2.1.2 Approach Boundaries:

2.1.2.1 **Arc Flash Boundary (AFB):** When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash would occur. This is a PPE boundary (See Attachment 1, Limits of Approach).

2.1.2.2 **Limited Approach Boundary (LAB):** When a shock hazard exists, an approach limit at a distance from an exposed energized electrical conductor or circuit part, within which a shock hazard exists. This is a qualification-only boundary (See Attachment 1, Limits of Approach and Attachment 2, Approach Boundaries).

2.1.2.3 **Restricted Approach Boundary (RAB):** An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of shock, due to an electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part. The RAB is the inner boundary classified as ***“working on”*** an exposed energized and unguarded electrical conductor or circuit part. All tools used within the RAB shall be voltage-rated. This is a PPE boundary (See Attachment 1, Limits of Approach and Attachment 2, Approach Boundaries).

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- 2.1.3 **Arc Flash (AF) Hazard:** A dangerous condition associated with the possible release of energy caused by an electric arc.
- 2.1.4 **Arc Rated PPE:** Flame resistant and electric arc resistant clothing.
- 2.1.5 **Control Voltages:** Work on control circuits with exposed energized electrical conductors and circuit parts, 130 volts or below without any other exposed energized equipment over 130 V including opening of hinged covers to gain access
- 2.1.6 **Dead Front:** An electrical device in which the front part is insulated from voltage and can be touched without receiving an electric shock.
- 2.1.7 **De-energized:** Free from any electrical connection to a source of potential and from electrical charge (proven and verified by testing).
- 2.1.8 **Energized:** Electrically connected to, or is, a source of voltage (equipment must be considered energized until proven otherwise).
- 2.1.9 **Electrical Safety Plan:** Plan which must be developed for “**work on**” exposed energized electrical conductors greater than 50 volts including applying or removing grounds. Other work including live-dead-live testing, taking voltage readings with insulated test meters, breaker racking, breaker switching, removing or installing fuses for the purpose of WPA/LOTO do not require a safety plan.
- 2.1.10 **Electrically safe work condition:** A state in which electrical conductors or circuit parts have been disconnected from energized parts, locked or tagged in accordance with WPA procedures, tested to ensure the absence of voltage, and grounded if determined necessary.
- 2.1.11 **Exposed (as applied to energized electrical conductors or circuit parts):** Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated. Less than a ½ inch opening is considered finger-safe.
- 2.1.12 **Guarded:** Covered, fenced, enclosed, finger safe or otherwise protected, by means of suitable covers, casings, barriers rails, screens, mats, or platforms, designed to minimize the possibility, under normal conditions, of dangerous approach or inadvertent contact by persons or objects.
- 2.1.13 **High Voltage:** The effective potential difference between two conductors or between a conductor and ground that is equal to or exceeds 480 volts.
- 2.1.14 **Incident Energy:** The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event.

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One of the units used to measure incident energy is calories per centimeter squared (cal./cm²).

2.1.15 Live-Dead-Live (LDL): The Live-Dead-Live method is testing with voltage test equipment (Multi-meter, Wiggins, Proximity Tester, etc.) on a known energized source, then the circuit being checked de-energized and return to the known energized source. The energized source does not need to be of the same voltage as the designed voltage for the circuit being checked de-energized as long as the test equipment is designed for both, and both are in the selected feature (range, etc.) of the test equipment. At times, further checks are needed to determine static, capacitive, or induced voltage in addition to the Live-Dead-Live check (for example, induced DC in buried cables).

2.1.16 Lockout/Tagout (LOTO): Procedure used to de-energize an electric energy source by identifying and disconnecting the source, then preventing the disconnecting means from accidental closure through the use of appropriate tags and lockout devices.

2.1.17 Personal Protective Grounds (PPG): Cable connected to de-energized lines and equipment by jumpering and bonding with appropriate clamps, to limit the voltage difference between accessible points at a worksite to safe values if the lines or equipment are accidentally re-energized. Grounds that are used whenever workers perform tasks on electrical circuits or components that may become re-energized for some reason, possibly by the reclosing of switches or circuit breakers. Personal protective grounds are required in the following situations:

- When two forms of physical electrical breaks, or one physical break and a blocking device installed cannot be achieved.
- When the possibility of being energized from multiple electrical energy sources exists concurrent with any single source of isolation.

2.1.18 Qualified person: One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved.

2.1.18.1 Electrically Basic (B) qualified persons: Those persons who have received some Ameren basic electrical safety training. They are familiar with the electrical safety-related practices that are necessary to work safely around energized equipment or overhead lines. Class (B) qualified persons are those workers who must **“work around”** exposed energized electrical conductors. Class (B) qualified persons are those workers who can enter the LAB and areas classified as AHRC 0, but cannot

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cross the AFB or RAB unless escorted by a Class (E) qualified person.

2.1.18.2 **Electrically (E) qualified persons:** Those persons who are trained to be exposed to unguarded, uninsulated, energized lines or equipment parts operating at greater than 50 volts. Class (E) qualified persons are trained to a greater proficiency level as part of their job classification because they work on or near energized equipment or overhead lines on such a regular basis that additional personal protective measures beyond simple awareness are required. Not all Class (E) qualified employees can perform the same tasks. As an example, electricians (due to their extensive training) can perform a wider array of Class (E) work than other Class (E) designations. Qualified (E) workers are those who are required to ***“work on or around”*** exposed energized electrical conductors.

2.1.19 **Nonqualified (N) person:** An individual who is not properly trained and experienced to work on or near ***exposed*** energized circuits of greater than 50 volts. This does not exclude personnel from plugging in and using common 120V appliances. Nonqualified (N) employees are required to be escorted by a Class (E) qualified person anytime they are within a Limited Approach Boundary or Arc Flash Boundary. Nonqualified (N) employees can also be escorted by a Class (B) qualified person anytime they are within a Limited Approach Boundary. Those workers whose duties do not require them to work on or around exposed energized electrical conductors.

2.1.20 **Shock Hazard:** A dangerous condition associated with the possible release of energy caused by contact or approach to energized electrical conductors or circuit parts.

2.1.21 **Troubleshooting:** A systematic approach to analyzing a circuit and determining what is wrong. Any activity that involves inspecting, testing or adjusting of the equipment.

2.1.22 **Workers Protection Assurance (WPA):** Name given to the process used by Ameren Missouri to ensure the safety of those who perform work on the generation and transmission system equipment.

2.1.23 **Work/Working around (exposed energized electrical conductors):** Any activity between the AFB or LAB, and the RAB.

2.1.24 **Work/Working on (exposed energized electrical conductors):** Intentionally coming in contact with energized electrical conductors or circuit parts with hands, feet or other body parts with tools, probes or with test equipment,

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regardless of the PPE a person is wearing. Work inside the RAB is considered working on.

3.0 RESPONSIBILITIES

3.1 Ameren Missouri Generation Facilities

- 3.1.1 Generation facilities should either properly label electrical equipment or maintain documentation which will include, but is not necessarily limited to, equipment examined in the Arc Flash Study (See Attachment 3, Heat Energy Incident Table Example). Labels or documentation shall include voltage levels, incident energy levels, and hazard boundary information.
- 3.1.2 Generation facilities shall provide the following for electrical hazards:
 - Suitable work practices to mitigate the hazard.
 - PPE appropriate for the incident energy levels of the task being performed.

3.2 Supervisor (or designee)

- 3.2.1 Supervisors (or designee) shall be responsible for taking the necessary measures to ensure employees wear the appropriate PPE.
- 3.2.2 Supervisors (or designee) shall be responsible for ensuring availability of appropriate PPE for employees.
- 3.2.3 Supervisors (or designee) will be responsible for ensuring safety plan is complete and implemented.

3.3 Safety Person

- 3.3.1 Shall be required when working on 600 volts or greater, or when required by the Energy Center.
- 3.3.2 Shall be a Class E Qualified Worker.
- 3.3.3 Additional requirements will be identified in the following attachments:
 - Non-nuclear Energy Centers: AUE-ADM-5002
 - Nuclear Energy Centers: Addendum No. 2

3.4 Employees

- 3.4.1 Each employee shall follow the requirements of the ESWPM.

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- 3.4.2 Each employee shall verify that they have appropriate PPE for the task.
- 3.4.3 Each employee shall inspect their PPE for good condition before using and ensure they wear their PPE.
- 3.4.4 Each employee shall understand and adhere to the conditions of the safety plan.

4.0 PROCEDURE

4.1 Governing Principles

4.1.1 Governing Safety Principles of Electrical Work

An effective electrical safety program is based on rules that are derived from a group of governing principles. The principles that form the basis for the Ameren Missouri Generation Electrical Safe Work Practices Manual (ESWPM) are listed below.

- 4.1.1.1 Installed electrical conductor or circuit part is considered energized until proven otherwise.
- 4.1.1.2 Energy sensing test devices themselves must be tested before and after use to have confidence in their readings (Live-Dead-Live method).
- 4.1.1.3 Removing all possible sources of electrical energy is the only sure means of rendering a circuit de-energized and safe to work on. The use of grounding for circuits greater than 480 VAC helps ensure the sources of electrical energy are dissipated from the circuit. Control voltages (such as PLC and DCS) are exempt from source energy.
- 4.1.1.4 Electrical circuits and equipment should be de-energized before allowing work on or around them unless it can be demonstrated that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or limitations. Infeasibility should be determined by the supervisor or designee.
- 4.1.1.5 De-energizing an electrical conductor or circuit part and making it safe to work on is in itself a potentially hazardous task.
- 4.1.1.6 No bare hand contact is to be made with exposed energized electrical conductors or circuit parts above 50 volts to ground.

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4.1.1.7 Wire or cable insulation, to be used for personnel protection, must be both:

- Used per its original design configuration and intended use, and
- Visually inspected to be free of damage by a qualified worker.

4.1.1.8 The use of appropriate PPE does not negate the need to employ safe work practices. PPE is the last line of defense and should not knowingly be challenged. Electrical connections designed to prevent inadvertent contact by personnel are considered to be guarded.

4.1.2 Establishing an Electrically Safe Work Condition

4.1.2.1 An Electrically Safe Work Condition can be achieved when a circuit is verified de-energized using any of the following, as applicable:

- When possible, visually verify that all blades of the disconnecting device are fully open or draw out type circuit breakers are withdrawn to the fully disconnected position.
- Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Before and after each voltage test, determine that the voltage sensing device is working properly by measuring a known energized source.
- Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors of circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors, apply ground connecting devices rated for the available fault current (example: transformers, overhead conductors, etc.).
- If grounds have been installed (refer to Section 4.6).

4.1.2.2 Approach distances (boundaries) apply to any conductive tools, equipment, ladders, cranes, man lifts, etc., that personnel may be using in the course of their work.

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- 4.1.2.3 Check applicable up-to-date drawings, diagrams and identification tags.
- 4.1.2.4 Each facility maintains WPA and facility LOTO procedures.
- 4.1.2.5 Energized parts that operate at less than 50 volts to ground are not required to be de-energized if there will be no increased exposure to electrical burns or explosion due to electric arcs.
- 4.1.2.6 Be aware of the physical environment of the electrical circuit. Identify possible sources of induced voltage, stored energy or static charge.

4.2 General Safe Work Practices

- 4.2.1 Only Class (E) qualified persons may work on energized electrical equipment.
- 4.2.2 Class (B) qualified persons are **not allowed** to work within restricted approach distances (boundaries). Work inside this boundary is considered **working on** live parts. Therefore, *only Class (E) qualified persons are allowed within the restricted approach distance (boundary)*, since they have received additional extensive training.
 - Class (B) qualified persons are allowed to open cubicle doors to observe that a breaker is racked out if it has been verified by WPA procedures.
- 4.2.3 Class (E) and Class (B) qualified personnel are allowed to momentarily open equipment doors for the purpose of visual observations of the cabinets. When opening equipment doors:
 - If there is exposure to energized circuits such as buss bars, rosettes, bare terminals, etc. above the nominal control voltages of 130 volts AC or DC, and entry into the RAB or AFB (If established) cannot be avoided, then appropriate AHRC PPE shall be required.
 - If there is no exposure to energized components (excluding control voltages), a minimum of AHRC 0 PPE shall be utilized.
- 4.2.4 Class (E) qualified persons, or Class (B) qualified persons under supervision of Class (E), may defeat an electrical safety interlock. This may be done only temporarily, while working on the equipment. When the work is completed, the interlock shall be re-instated.
- 4.2.5 Equipment and electrical circuits shall be de-energized prior to performing work, unless de-energizing is infeasible (i.e. troubleshooting, testing). Infeasibility should be determined by the supervisor or designee.

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- 4.2.6 Employees shall not reach blindly into areas which may contain an energized part.
- 4.2.7 Employees shall be protected from arc flash hazards. Protective clothing shall match the specific hazard and be inspected and properly maintained.
- 4.2.8 Ensure all conductive objects (e.g. keys, watches, rings, cell phones and change) are removed from person before entering RAB or AFB, whichever is greater. Rings that cannot be removed can be wrapped with vinyl electrical tape. Lanyards shall be secured by one of the following methods: tucked in shirt or removed.
- 4.2.9 Use of conductive ladders shall comply with Ameren Safety Rules where the employee or ladder could contact exposed energized parts (such as work of an electrical nature).
- 4.2.10 Conductive slings or rigging shall not be used within RAB.
- 4.2.11 Employees may not enter any area containing exposed electrical conductors, unless illumination is adequate to perform the job safely.
- 4.2.12 Ground Fault Circuit Interrupters shall be used with electric tools in wet areas or in areas where specifically required.
- 4.2.13 Ground Fault Circuit Interrupters shall be inspected prior to use for safe operation.
- 4.2.14 Low voltage lighting or a Ground Fault Circuit Interrupter shall be used in confined spaces.
- 4.2.15 Never store or leave items inside a switchgear cubicle.
- 4.2.16 Ensure potentially moving equipment (doors, covers, etc.) is secured to prevent them from swinging into you and causing you to contact exposed parts.
- 4.2.17 When working within RAB, ensure conductive objects will not enter RAB.
- 4.2.18 Settings of overcurrent devices shall not be changed without consulting appropriate supervision.

4.3 Electrical Safety Plan

- 4.3.1 An Electrical Safety Plan is documented and approved by authorized management justifying the need to work on exposed energized electrical conductors greater than 50 volts or applying/removing grounds. Determination of the following information constitutes formulation of the electrical safety plan for work on energized circuits. The electrical safety plan

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must be discussed in the pre-job brief (See Attachment 5, Sample Electrical Safety Plan). The electrical safety plan will include the following at a minimum:

- Means of maintaining the worker's isolation from energized parts.
- Determine if a safety person is necessary and have applicable rescue plans outlined (for example, retrieval devices, communications established between the worker and the safety person).
- The need for additional guards and/or barriers.

4.3.2 LDL, taking voltage readings with insulated test meters, breaker racking, breaker switching, removing or installing fuses for the purpose of WPA/LOTO are excluded.

4.4 Personal Protective Equipment (PPE)

Standard PPE consists of hard hat (if required), safety glasses, and primarily leather safety footwear.

- 4.4.1 Personnel shall check for voltage before contacting any uninsulated conductors. Do not use a proximity voltage detector (PVD) on DC voltage.
- 4.4.2 Check expiration dates on all rubber goods. Do **not** use the equipment if the expiration date has passed.
- 4.4.3 When working on energized circuits, approved insulated tools shall be used. If a flashlight is used, the exposed parts shall be non-conductive (i.e. plastic). When guarding is removed from energized electrical conductors, or when exposed conductors are left unattended, physical barriers shall be installed.
- 4.4.4 Wipe clean and visually inspect each live-line tool every shift it is used. Remove from service if defects are identified.
- 4.4.5 When used, dielectric floor mats shall be properly rated for voltage.
- 4.4.6 When used, insulated sleeves and blankets shall be electrically rated.

4.4.7 ASTM D120-approved, inspected, and tested electrical gloves shall be worn for the maximum rated voltages based upon the following classes:

Glove Class	Maximum Voltage
00	500 Volts
0	1,000 Volts
1	7,500 Volts
2	17,000 Volts
3	26,500 Volts
4	36,000 Volts

4.4.8 Rubber insulating gloves shall be electrically tested before the first issue and every 6 months thereafter. Rubber insulating gloves can be electrically tested up to 12 months prior to the first issue.

4.4.9 Inspect voltage-rated rubber gloves before each use by performing the following:

- Inflation test.
- Visual inspection for holes, UV damage, embrittlement, cracking or other sign of physical damage.
- Class 00 and 0 gloves shall be worn without leather protectors only in conditions where dexterity is required, but caution **MUST** be exercised to avoid damage.
- Visually inspect gloves to verify expiration date, voltage, zone rating, as appropriate.

4.4.10 Do not leave rubber goods (gloves, mats, blankets, etc.) intended for PPE against electrical contact out in the open when not in use. UV radiation will cause the rubber to degrade.

4.4.11 Voltage-rated blankets shall be inspected for signs of physical damage before each use. The blanket must not be used if it is ripped, punctured or abraded. The blanket should also be rejected for use if the material has been stretched to the point of thinning the blanket.

4.4.12 Blankets shall be stored either hanging from a rack or placed in tubes. If stored in tubes, the blankets must be periodically rolled in the opposite direction to prevent stress cracks from forming.

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4.4.13 Rolled sheathing that is voltage-rated only needs to be inspected for physical damage. These are single-use items and should be disposed of after each use.

4.4.14 Arc flash protective gear following AHRC:

Ameren Hazardous Risk Category (PPE by Category)

Note 1: FR garments purchased from a vendor are constructed from flame resistant fabrics and components, resist ignition and will not continue to burn when removed from the ignition source. ATPV, EBT, EBTAS, and HRC are all designated as arc rating values.

Note 2: "Primarily" leather safety footwear means any part of the boot that is not covered by your Ameren approved FR apparel must be leather. This excludes the shoe strings, eyelets, soles, and tongue.

- **AHRC 0 – Non-arc rated PPE**

Appropriate natural fiber shirt with pants or coverall and safety glasses or goggles.

- **AHRC 1 - Minimum Arc Rating of 4 cal./cm²** (As long as business segment's arc rated policy allows)

Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; safety glasses with arc rated face shield or flash hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat; safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).

- **AHRC 2 - Minimum Arc Rating of 8 cal./cm²**

Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat; safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).

Note: 8 cal./cm² arc rated balaclava and arc rated face shield may be used as a substitute for the arc rated flash suit hood.

- **AHRC 3 - Minimum Arc Rating of 25 cal./cm²**

Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit jacket; arc flash suit pants; arc flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat (arc rated liner as required); safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).

- **AHRC 4 - Minimum Arc Rating of 40 cal./cm²**

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Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit jacket; arc flash suit pants; arc flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat (arc rated liner as required); safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).

- **AHRC 5 - Minimum Arc Rating of 100 cal./cm²**

Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit jacket; arc flash suit pants; arc flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat (arc rated liner as required); safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).

- **AHRC 6 (De-Energized Only) - Arc Rating greater than 100 cal./cm²**

4.4.14.1 Each facility shall develop an AHRC table similar to the Heat Energy Incident Table shown in Attachment 3.

4.4.14.2 For equipment **not included** in the Arc Flash study, the following must be used:

- Operating welding receptacles and local disconnects, 480 volts and below with enclosures secured, AHRC 0.
- Operating switches, breakers, using receptacles with no exposure on panels of 480 volts and below, no PPE required.
- 50V-240V exposed circuit breaker operation, racking, or exposure within AFB, AHRC 2.
- 277V-480 V exposed circuit breaker operation, MCC breaker operation, racking, or exposure within AFB, AHRC 4.
- Greater than 480 volt – 15 kV circuit breaker operation, racking, or exposure within AFB, AHRC 4.
- When working on control voltage:
 - AHRC 0 PPE is required.
 - Voltage rated gloves shall be worn if the RAB is violated with body parts or uninsulated tools or equipment.

- Arc Flash Boundary for equipment **not included** in the Arc Flash study:

50V-240V	19 in.
241V-600V	20 ft.
601V-15kV	40 ft.

- 4.4.14.3 Arc rated PPE is designed to protect employees from electrical arc hazards only. Arc rated PPE has no electrical insulating capability and only affords protection against burns for which they are rated, no blast protection or other effects such as light, noise, shrapnel, pressure, etc.
- 4.4.14.4 If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected. (For example, an outer covering of leather is used for the protection of rubber insulating material.)
- 4.4.14.5 Appropriate AHRC PPE shall be utilized within the RAB when any part of the body or tool breaks the plane of the RAB, performing switching or racking.
- 4.4.14.6 Appropriate AHRC PPE shall be utilized within the AFB when any employee or tool breaks the plane of the RAB or interacts with the equipment.

4.5 Fuses

- 4.5.1 Only Class (E) qualified persons shall remove fuses.
- 4.5.2 Approved hot sticks or fuse pulling tools shall be used.

4.6 Grounding

4.6.1 Personal Protective Grounds

Personal protective grounds shall be physically (visually) inspected before each use. Visual inspection of the personal protective grounds shall consist of the following:

- Check the cable for cracks or broken insulation.
- Check for broken cable strands, particularly in the area of the ferrule.

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- Check the clamps for sharp edges, cracks, splits, or other defects.
- Verify the clamps operate smoothly and are free of excessive looseness.
- Verify the connection between the clamp and the ferrule is clean and tight.

4.6.1.1 Personal protective grounds shall be either:

- Purchased from a vendor and be ANSI-approved for the rated voltage, fault current and clearing times.
- Manufactured and assembled in-house in accordance with ANSI Standard F855, and tested on an annual basis.

4.6.1.2 A supervisor (or designee) shall be responsible for:

- Obtaining a WPA or
- Accepting transfer of the WPA if it was not originally obtained.
- Communicating to all employees that all disconnecting means have been opened and tagged.
- Ensuring it is safe to re-energize the circuit before the WPA is released.

4.6.1.3 Obtain proper authority approval before installing or removing grounds.

4.6.1.4 As part of de-energizing equipment, if there are any disconnecting means that is accessible to other employees, it shall be made inoperable (i.e. removing or making inoperable a switch handle to ensure the overhead line or equipment remains de-energized). Additionally, disconnecting means shall also be tagged to indicate employees are at work.

4.6.1.5 Prior to working on de-energized conductors or equipment, all phase conductors shall be tested and grounded. A test for voltage shall be made using an appropriate voltage tester.

4.6.1.6 Only approved and tested protective grounding cables and clamps shall be used.

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- 4.6.1.7 Approved temporary protective grounding cables shall not be used in applications above their rated capacity. The temporary protective grounds must be able to carry the fault current for the amount of time or period necessary for the fault to clear.
- 4.6.1.8 Temporary protective grounding cables shall be installed and removed with ANSI-approved, inspected, and tested live-line tools in all cases except when not physically possible. In these cases appropriate shock protection gloves shall be worn.
- 4.6.1.9 When positioned outside the RAB and using ANSI-approved live-line tools on voltages above 600 volts, leather gloves or equivalent type of glove shall be worn
- 4.6.1.10 Prior to grounding, employees shall ensure a clean, secured connection (free from corrosion and paint) between the temporary protective grounding clamps, copper ground cable/strap or conductors.

4.6.2 Installation of Personal Grounds Inside Switchyards

- 4.6.2.1 Size of personal protective grounds shall be based on fault currents and clearing times. If an analysis has not been completed to determine appropriate size of grounds, the facility shall use double 4/0 grounds. Note: Refer to 2.1.17: Personal Protective Ground requirements do not apply if the only concern is static charge or induced voltage in which 2/0 grounds or above are appropriate.
- 4.6.2.2 Due to potential dangers, a safety plan shall be utilized.
- 4.6.2.3 Grounds shall be placed as close as practical on both sides of the work being performed but never more than 50 feet away. Always connect grounds to a permanent ground.
- 4.6.2.4 Ground tags shall be placed where grounds are installed on overhead lines or equipment.
- 4.6.2.5 Order of steps for installing temporary protective grounding cables are as follows to ensure best protection

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is afforded to employees applying grounds.

- Step 1: Temporary protective grounding cable shall first be connected to a permanent ground.
- Step 2: The other end of the temporary protective grounding cable should then be connected to the closest de-energized conductor or phase.
- Step 3: A second temporary protective grounding cable shall be connected to the first conductor or phase and then to the adjacent conductor or phase.
- Step 4: A third temporary protective grounding cable shall be connected to the second conductor or phase and then to the last or farthest conductor or phase.

4.6.2.6 Alternative method for installing temporary protective grounding cables:

- Step 1: Temporary protective grounding cable shall first be connected to a permanent ground.
- Step 2: The other end of the temporary protective grounding cable should then be connected to the closest de-energized conductor or phase.
- Step 3: A second temporary protective grounding cable shall be connected to the permanent ground and then connected to the second conductor or phase.
- Step 4: A third temporary protective grounding cable shall be connected to the permanent ground and then connected to the third or last conductor or phase.

4.6.3 Grounding of Mobile Aerial Equipment in Switchyards

- 4.6.3.1 When using mobile aerial equipment to perform work on energized equipment or within 20 feet of energized conductors, it shall be grounded.
- 4.6.3.2 Uninsulated mobile aerial equipment shall not be positioned or operated in the RAB.

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- 4.6.3.3 All mobile aerial equipment ground leads shall be 2/0 copper or larger.
- 4.6.3.4 Connections shall be clean, secured and tight.
- 4.6.3.5 Mobile aerial equipment grounds shall not be left coiled while in use.
- 4.6.3.6 Steps for installing temporary protective grounding cables to mobile aerial equipment.
- Step 1: Temporary protective grounding cable shall first be connected to a permanent ground.
 - Step 2: The other end of the temporary protective grounding cable should then be connected to an appropriate ground.
 - Step 3: Insulated mobile aerial equipment working within the RAB shall be barricaded to prevent accessing the equipment.
- 4.6.3.7 When mobile aerial equipment is grounded, workers on the ground shall not come into contact with the mobile aerial equipment until they have:
- Communicated their intent to access or contact the grounded mobile aerial equipment to the operator and
 - The operator ceases operating the mobile aerial equipment until the worker has communicated to the operator that he/she is clear of the mobile equipment.

4.6.4 Spotter

- 4.6.4.1 The spotter shall be a designated person who is knowledgeable to recognize the hazards associated with contacting an electrical distribution system. The designated spotter shall:
- A spotter is required if the aerial equipment is within 20 feet from energized conductors.
 - A spotter can act as a safety person.

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- Remain focused on mobile equipment performing work.
- Maintain a clear line of communication with the operator.
- Give timely warning if any part of the mobile aerial equipment approaches the RAB.

4.6.4.2 The spotter may do other work if the mobile aerial equipment movement ceases or the mobile equipment moves at least 20 feet away from energized conductors.

4.6.4.3 Spotters shall assess hazards related to the installation of grounds and position themselves a safe distance from work being performed with the ability to observe the operations.

4.6.5 Grounding of Power Plant Equipment

4.6.5.1 Due to potential dangers, a safety plan shall be utilized.

4.6.5.2 Equipment to be worked on shall be de-energized and tested for all energy sources. This may require opening switches.

4.6.5.3 Steps shall be taken to remove any stored energy, prior to attaching personal protective grounds.

4.6.5.4 Using an ANSI-approved and tested live-line tool, a ground shall be placed onto the grounding cable or strap. The other end of the ground shall then be placed onto the leads or bushing of the de-energized equipment.

4.6.5.5 A protective tag shall be installed onto the equipment or as near as possible to the location of the ground to identify personal protective ground(s) are in place.

4.6.5.6 Personal protective grounds shall be placed on exposed terminals or bushings where work is being performed or as close as feasible to the work.

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4.6.5.7 When grounds are placed, they shall be placed such that they can be visibly verified.

4.7 Removal of Grounds

The reverse procedure shall be followed when removing temporary protective grounding cables.

4.7.1 Temporary protective grounding cables shall be removed with ANSI approved, inspected, and tested live-line tools.

4.7.2 Prior to removing temporary protective grounds, the supervisor (or designee) shall communicate to all workers that the work has been completed and grounds will be removed.

4.7.3 All employees shall stand clear of the lines and equipment.

4.7.4 Steps for removing temporary protective grounding cables.

- Step 1: Protective tags shall be removed.
- Step 2: The temporary protective grounding cable shall be removed from the most remote conductor or phase first.
- Step 3: The temporary protective grounding cable that was removed from the most remote conductor or phase shall then be removed from the second conductor or phase, if applicable.
- Step 4: The second temporary protective grounding cable shall then be removed from the second conductor or phases and the other end removed from the first conductor or phase, if applicable.
- Step 5: The remaining temporary protective grounding cable shall be removed from the conductor or phase, if applicable.
- Step 6: Lastly, the temporary protective grounding cable shall be removed from the permanent ground.

4.7.5 Steps for removing temporary protective grounding cables using the Alternative method.

- Step 1: Protective tags shall be removed.
- Step 2: The temporary protective grounding cable shall be removed from the most remote conductor or phase.

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- Step 3: The other end of the temporary protective grounding cable that was removed from the most remote conductor or phase shall then be removed from the permanent ground.
- Step 4: The second temporary protective grounding cable shall then be removed from the second conductor or phase. The other end of the temporary ground shall then be removed from the permanent ground, if applicable.
- Step 5: The remaining temporary protective grounding cable shall be removed from the conductor or phase. Afterwards, the other end of the grounding cable shall be removed from the permanent ground, if applicable.

4.8 Barricades

- 4.8.1 The AFB or LAB, whichever is greater, must be barricaded to warn personnel who may be in the vicinity of the electrically energized hazard. The AFB or LAB can be guarded by the workers performing the work or it can be marked using barricade tape at the perimeter. A sign or tag must be posted on the barricade tape, which provides the following information or equivalent.

Warning: Flash or Shock Boundary

Only electrically qualified personnel may proceed past this point.

Flash and/or Shock Hazard present.

Hazard _____

Contact person: _____ Phone#: _____

- 4.8.2 A temporary barrier typically does not offer appropriate protection to prevent arc flash or shock. Under specific conditions a temporary barrier that is constructed to withstand arc flash or shock hazards can be utilized upon completion of an engineering analysis.

4.9 Exposed De-Energized Electrical Conductors

When guarding is removed from exposed de-energized electrical conductors and left unattended, workers performing the work will guard the area with barricade tape and appropriate signage. Post a sign with the following information or equivalent:

- Circuit verified De-energized
- No Electrical Hazard Present
- Contact person _____ Phone # _____

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4.10 Switchyard Activities

- 4.10.1 Class (N) employees shall be escorted by a Class (B) or Class (E) qualified person.
- 4.10.2 When grounding, operating disconnects or local operation of breakers and within the RAB, appropriate AHRC PPE shall be worn.
- 4.10.3 When positioned outside the RAB and using an ANSI-approved live-line tool on voltages above 600 volts, leather gloves or equivalent type of glove shall be worn
- 4.10.4 Activities that are not related to electrical work in the switchyard only require the use of a spotter for equipment movement and escort by Class (E).

4.11 Main Generator Brush Inspection

- 4.11.1 Generator doghouse will be visually inspected for signs of arcing through viewing window prior to entry.
- 4.11.2 Brush inspections will be AHRC 0.

4.12 Battery Rooms

- 4.12.1 Battery rooms have exposed energized conductors. An engineering analysis shall be conducted to determine short circuit current for the appropriate size and number of batteries being worked on.
- If the hazard can be mitigated to prevent short circuiting, such as placing properly rated rubber blankets or mats over one output terminal, AHRC PPE 0 can be worn.
 - If taking voltage reading across the battery and the use of insulated leads are being used, AHRC PPE 0 can be worn.
 - If the hazard can't be mitigated, the following chart shall be used to identify the arc flash PPE and boundaries:

Battery Room Maintenance

Arc-Flash Hazard PPE Categories & Arc-Flash Boundary

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources Voltage < 100 V	0	Not Applicable
Storage batteries, dc switchboards, and other dc supply sources 100 V > Voltage < 250 V		

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Parameters: Voltage: 250 V Maximum arc duration and working distance: 2 sec @ (18 in.)		
Short-circuit current < 4 kA	1	3 ft.
4 kA ≤ short-circuit current < 7 kA	2	4 ft.
7 kA ≤ short-circuit current < 15 kA	3	6 ft.
Short-circuit current > 15 kA	4	8 ft.
Storage batteries, dc switchboards, and other dc supply sources 250 V ≤ Voltage ≤ 600 V Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 sec @ (18 in.)		
Short-circuit current 1.5 kA	1	3 ft.
1.5 kA ≤ short-circuit current < 3 kA	2	4 ft.
3 kA ≤ short-circuit current < 7 kA	3	6 ft.
7 kA ≤ short-circuit current < 10 kA	4	8 ft.

4.12.2 Chemical protective clothing may be worn over FR clothing.

4.13 Underground Work

Work being done underground where energized electrical equipment is located includes electrical manholes and vaults.

4.13.1 Underground entry shall be in accordance with *Confined Space Entry Procedures*.

4.13.2 Attendants are required for underground installation entry containing energized equipment.

4.13.3 When working underground, first aid and CPR-trained personnel must be near the area and able to render assistance within 4 minutes. Attendants must remain on the underground installation jobsite, ready to render assistance in an emergency.

4.13.4 Ladders or other climbing devices will be used for entry and exit to all underground installations over 4 feet in depth. Never use cables or cable hangers as a climbing device.

4.13.5 Perform pre-use inspection on all equipment used to lower tools or other equipment into underground installations.

4.13.6 PPE for working in underground installations shall include standard PPE in addition to the appropriate level of arc rated protection.

4.13.7 Utmost care must be taken during cable pulling activities, so as not to disturb adjacent energized cables.

4.13.8 Ensure identification of cables to be disturbed before beginning work.

4.13.9 Inspect adjacent equipment/cable for abnormalities that could lead to a fault.

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4.13.9.1 If an abnormality is identified, that cable must be de-energized prior to performing work.

4.13.9.2 If it is not feasible to de-energize, further evaluation is needed to ensure employees are protected.

4.14 Test Areas

4.14.1 Test Areas (e.g., electrical test areas in maintenance shop):

Test areas shall be guarded or barricaded to prevent unauthorized personnel from entering the test area when electrical testing is being conducted. Barriers should be installed and signs placed indicating that tests are in progress. A door that is closed and appropriately labeled is considered guarded.

Prior to conducting initial testing, inspect test area to ensure:

- All equipment is properly grounded, if required.
- All equipment is in good working order.
- The area is free of clutter and is generally in a safe condition.
- All barriers/guards are in place (Arc Flash or Limited Approach Boundary clearly defined when unattended).
- Test indication is operable.
- Inspect all measuring and test equipment to ensure all leads are free from nicks or abrasions, are in good working order, and no terminals are exposed.
- Do not run any test leads or cables outside test area.
- Ensure all test conductors and equipment are securely restrained and routed to avoid damage or accidental test interruption.
- Do not leave the test area unattended, without being barricaded and signage attached, while tests are in progress.
- Leave the test area in a safe condition while unattended and when testing is complete.

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- Remove temporary barriers/guards when the testing is completed or no longer needed for the protection of employees.

4.14.2 Grounding of Test Equipment

- 4.14.2.1 If accessible to personnel conducting tests, the chassis, instruments and all conductive parts of test vehicles or trailers used to conduct high voltage or high power tests, shall be grounded using an ANSI-approved live-line tool.
- 4.14.2.2 All conductive parts accessible to personnel conducting high voltage tests shall be maintained at ground potential unless it is isolated and guarded.
- 4.14.2.3 All ungrounded terminals of test equipment shall be treated as energized unless tested and verified de-energized.
- 4.14.2.4 High capacitance equipment shall be discharged prior to attaching grounds.
- 4.14.2.5 Test leads shall be applied to the grounded high voltage circuits or equipment to be tested.
- 4.14.2.6 If necessary to complete the test and using an ANSI-approved live-line tool, protective grounds can be removed.
- 4.14.2.7 After tests are complete and prior to working on the equipment, protective grounds shall be re-applied to high voltage circuits or equipment using an ANSI-approved live-line tool.
- 4.14.2.8 After the test leads have been removed, and prior to placing the high voltage circuits or equipment in operation, an ANSI-approved live-line tool shall be used to:
 - Remove the ground from the bushing or equipment, then
 - Remove the ground from the grounding strap, bar or grounding grid.

4.15 Low Power Exposure

- For work on voltages up to 5000 vac/vdc with current output less than or equal to 20 uA, AHRC 0 PPE shall be worn.

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- For work on voltages up to 5000 vac/vdc with current output greater than 20 uA but less than or equal to 100 mA, AHRC 0 PPE plus appropriate rated gloves with leather protectors shall be worn.
- For low power equipment and equipment calibration (such as M&TE test equipment, etc.) not covered within the voltage/current ranges listed above or where they are not known but manufacture has provided safety guidance and/or PPE requirements, electrical safety guidelines and PPE provided by the product manufacturer/vendor manual or instruction shall apply.

5.0 TRAINING

Each facility is responsible for establishing qualified person training requirements in their procedures and ensuring adequate training is conducted.

6.0 EQUIPMENT LABELS

6.1 Format

- 6.1.1 If labels are used, they should include AFB, incident energy, voltage class, and AHRC (See Attachment 4, Equipment Label Example).
- 6.1.2 Where labels are not used, AFB, incident energy, voltage class, and AHRC shall be made readily available to personnel.

6.2 Location

For equipment where the arc flash rating is the same for each cubicle or compartment, labels may be limited to one on each end cubicle and one in the center placed at eye level, provided there is no distance greater than 12 feet between labels.

7.0 RECORDS

Training and testing records shall be maintained in accordance with Ameren retention policy.

8.0 REFERENCES

8.1 Source Requirements

- 8.1.1 NFPA 70E (2015)
- 8.1.2 OSHA 29 CFR 1910
- 8.1.3 ANSI

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8.1.4 ASTM

8.1.5 NESC

8.2 Development References

8.2.1 Ameren Generation Facilities Rules to Live By

8.2.2 Power Operations Safe Work Rules Handbook

8.2.3 Ameren Missouri WPA Implementation Manual for the Fossil Fired Energy Centers

8.2.4 Power Operations FR Personal Protective Apparel Policy

8.2.5 Callaway Energy Center Safe Work Practices Manual

8.2.6 Ameren Records Management Procedure

9.0 ATTACHMENTS

9.1 Attachment 1, Limits of Approach

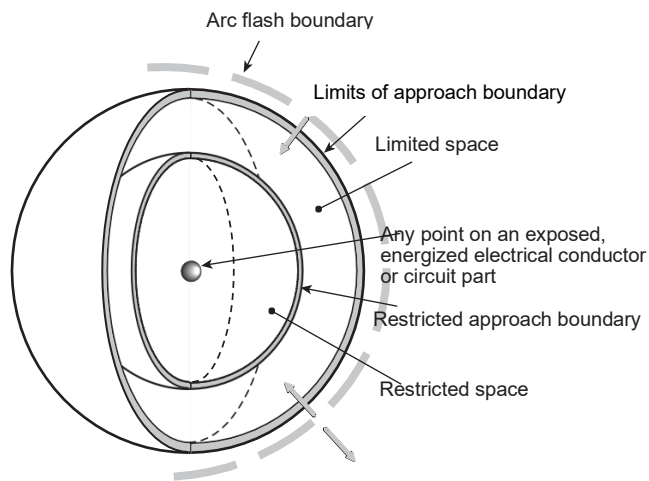
9.2 Attachment 2, Approach Boundaries

9.3 Attachment 3, Heat Energy Incident Table Example

9.4 Attachment 4, Equipment Label Example

9.5 Attachment 5, Sample Electrical Safety Plan

ATTACHMENT 1 – Limits of Approach



Note: All boundaries are spherical in nature, not just single plane.

ATTACHMENT 2 – Approach Boundaries

APPROACH BOUNDARIES

Approach Boundaries to Live Parts for Shock Protection

Nominal System Voltage Range, Phase to Phase	Limited Approach Boundary		Restricted Approach Boundary, Includes Inadvertent Movement Adder
	Exposed Overhead line Conductors	Exposed Fixed Circuit Part	
0 to 50	not specified	not specified	not specified
51 to 300	10ft. 0in.	3ft. 6in.	avoid contact
301 to 750	10ft. 0in.	3ft. 6in.	1ft. 2in.
751 to 15kV	10ft. 0in.	5ft. 0in.	2ft. 2in.
15.1 to 36 kV	10ft. 0in.	6ft. 0in.	2ft. 7in.
36.1 to 46 kV	10ft. 0in.	8ft. 0in.	2ft. 10in.
46.1 to 72.5 kV	10ft. 0in.	8ft. 0in.	3ft. 4in.
72.6 to 121 kV	10ft. 8in.	8ft. 0in.	3ft. 9in.
138 to 145 kV	11ft. 0in.	10ft. 0in.	3ft. 10in.
345 to 362 kV	15ft. 4in.	15ft. 4in.	9ft. 2in.

NOTE: *Exposed overhead conductor* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

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ATTACHMENT 3 – Heat Energy Incident Table (EXAMPLE)

Energy Center - Ameren Hazardous Risk Categories for Arc Flash Exposure - EXAMPLE						
Bus Name	Protective Device Name	Bus kV	Arc Flash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm ²)	Ameren Hazardous Risk Category
4160V BUS 1A (51-1A LineSide)	51-9H	4.16	366	36	124	AHRC 6
4160V BUS 2A	51-2A	4.16	310	36	89	AHRC 5
BUS CAPC-ATS1	NX125	0.480	193	18	40	AHRC 4
CAPC-MCC-1	BOP XFER	0.480	110	18	17	AHRC 3
480V BUS 4C	4C-1	0.48	41	18	4.1	AHRC 2
4APC-MCC-1	MCC4 MAIN	0.480	35	18	3.1	AHRC 1
GEN1 SPACE HTR	MC1-7E	0.480	13	18	0.00	AHRC 0
Ameren Hazard Risk Categories		Arc Flash PPE Legend				
Ameren Hazardous Risk Category		Minimum PPE requirements				
AHRC 0	<1 cal/cm ²	Non-arc rated PPE Appropriate natural fiber shirt with pants or coverall and safety glasses or goggles.				
AHRC 1	1-4 cal/cm ²	Minimum Arc Rating of 4 cal/cm ² Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; safety glasses with arc rated face shield or flash hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat; safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).				
AHRC 2	>4-8 cal/cm ²	Minimum Arc Rating of 8 cal/cm ² Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat; safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts). Note: 8 cal/cm ² arc rated balaclava and arc rated face shield may be used as a substitute for the arc rated flash suit hood.				
AHRC 3	>8-25 cal/cm ²	Minimum Arc Rating of 25 cal/cm ² Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit jacket; arc flash suit pants; arc flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat (arc rated liner as required); safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).				
AHRC 4	>25-40 cal/cm ²	Minimum Arc Rating of 40 cal/cm ² Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit jacket; arc flash suit pants; arc flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat (arc rated liner as required); safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).				
AHRC 5	>40-100 cal/cm ²	Minimum Arc Rating of 100 cal/cm ² Appropriate arc rated long sleeve shirt and pants or coverall; appropriate rated rubber gloves with protectors; arc rated flash suit jacket; arc flash suit pants; arc flash suit hood; arc rated jacket, parka or rainwear as needed; electric rated hard hat (arc rated liner as required); safety glasses or goggles; primarily leather safety footwear; and hearing protection (ear canal inserts).				
AHRC 6	over 100 cal/cm ²	DO NOT WORK ENERGIZED				
NO ASSESSMENT		IF THERE IS NO ASSESSMENT DATA AVAILABLE FOR HEAT ENERGY ON ELECTRICAL EQUIPMENT FOLLOW DIRECTION FROM ELECTRICAL SAFE WORK PRACTICES MANUAL SECTION 4.5.14.2				

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ATTACHMENT 4 – Equipment Label (EXAMPLE)



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ATTACHMENT 5 – Sample Electrical Safety Plan

Part I: TO BE COMPLETED BY THE REQUESTER:

Job Request (JR) Number _____

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

(2) Description of work to be done: _____

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

(4) Will CPR/FA be available within 4 minutes? **YES / NO**

(5) Will a Safety Person be needed? **YES / NO**

Requester/Title

Date

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

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

(2) Shock Hazard Analysis: Voltage Level _____

Approach Boundaries: Limited (LAB) _____ Restricted (RAB) _____

(3) Results of Flash Hazard Analysis: Arc Flash Boundary: _____ (Assumed or Calculated)

Ameren Hazardous Risk Category (AHRC) _____ **OR** Calculated Flash Hazard at 18" _____

(4) Additional PPE beyond AHRC and rescue equipment for worker and safety person, if needed, to safely perform the assigned task: _____

(5) Means employed to restrict the access of unqualified persons (Class N) from the work area, i.e. guarding/barriers: _____

(6) Did the assigned crew member conduct a job briefing: ____ Yes ____ No

(7) Do you agree the above described work can be done safely? **YES / NO** (circle: If *no* return to requester)

Electrically Qualified Person (s)

Date

Electrically Qualified Person (s)

Date

Designated Safety Person(s)

Date

Supervisor (or designee)

Date

Additional Electrically Qualified Person (s) or information can be added to the backside of this form.

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