

Subject Electrical Systems Safe Work Practices	Effective Date February 20, 2014	Initiated Power Systems Branch
	Supersedes May 9, 2003	Approved Associate Director, Engineering and Infrastructure

Applicability

This standard provides safe work practices that shall be used for electrical work on:

- Troubleshooting
- 120/208 Volt panelboards
- 480/277 Volt panelboards
- 480 Volt Motor Control Centers
- 480 Volt Network Protectors
- 480 Volt, 4.16kV & 13.8kV Switchgear
- 26 kV & 138 kV Switchyards at PPPL

Introduction

NFPA 70E, “Standard for Electrical Safety in the Workplace”, 2012 edition, a National Consensus Standard, is referenced in OSHA 29CFR1910 Subpart S, and therefore compliance by PPPL is required. Although NFPA 70E is quite detailed in delineating safe work practices there are some areas that require additional interpretation. Examples of such areas and the corresponding PPPL safe work practices, based on NFPA 70E and accepted industrial practices, follow:

Troubleshooting:

When making voltage measurements, as part of trouble shooting activities, safety glasses (in lieu of an AR rated face shield) and Class 0 rubber gloves (in lieu of, V-rated gloves with leather protectors) may be used for the following circuits when the available short circuit current is below the levels shown:

1. 125 Volt DC control circuits where the available short circuit current is less than 5 kA and the incoming DC feed is fused at the control cabinet. Examples of control cabinets that meet this criterion are as follows:
 - C & D Sites MG control cabinets,
 - 138 kV Switchyard relay house control racks
 - 5 kV & 15 kV Switchgear **control** cubicles

The above cabinets have this in common; they are all at least 50 feet from the Main DC Distribution Cabinet and are fed by #2 wire.

2. 120/208 Volt AC Power & Lighting Cabinets where the available short circuit current is less than 10kA.

NOTE: In situations where the above circuits share an area or cubicle with a high energy circuit that is not in an electrically safe work condition, the level of PPE will be determined on the basis of the high energy circuit.

Basis: Troubleshooting requires good visibility and finger dexterity. An arc-rated (AR) faceshield reduces visibility and the V-rated gloves with leather protectors, reduce finger dexterity. Therefore, additional lighting and use of V-rated gloves without leather protectors may be used as determined by a qualified electrical worker.

If there is any question regarding the available short circuit current for a control cabinet or power panel contact the AC Power Section.

120/208 Volt Panelboards

When the supply circuit breaker of a 120/208 Volt panelboard is located inside the panelboard, normal construction activities such as adding a circuit breaker, installing conduit, pulling cables, etc., may be performed if all of the following conditions are met:

- The panelboard appears to be in good condition both on the outside and inside, i.e., no sign of moisture, corrosion, mechanical damage, etc;
- The room in which the panelboard is located is reasonably dry, i.e., no sign of condensation on room or equipment surfaces;
- The line terminals of the supply circuit breaker have a polycarbonate shield or temporary installed rubber insulating blanket;
- The supply breaker is opened, locked and tagged per ESH-016;
- A zero voltage check has been performed on load side of the supply breaker;
- The appropriate complement of arc-rated (AR) clothing and personal protective equipment (PPE) for the task's Hazard/Risk Category (HRC) for the electrical work is worn. The task's HRC is to be determined by either the panels arc-flash (AF) label or per NFPA 70E tables 130.7(C)(15)(a) and 130.7(C)(16).;
- V-rated gloves with leather protectors are to be worn to protect the hands from inadvertent shock hazard. If good finger dexterity is required to perform a particular task, then the V-rated rubber glove may be used without the leather protector, provided the rubber glove is retested after use.;
- Insulated tools rated for minimum 1000V and non-conductive fish tape must be used to pull cable or wires.;
- A JHA must be performed that lists all of the anticipated hazards and describe the controls that will be used to mitigate the hazards.

If all the conditions specified above are not met, the panelboard must be de-energized and a zero voltage test must be performed.

Basis: The line terminals of a circuit breaker remain energized after the circuit breaker is open. The polycarbonate shield or insulating blanket prevents accidental contact with energized parts either directly or via a conductive object such as a tool. Thus both electric shock and worker initiated arc flash are prevented

480/277 Volt Panelboards

480V panelboards must be de-energized and a zero voltage test must be completed, prior to any normal construction activities or modifications being performed. Some 480V panelboards at PPPL are equipped with permanently mounted illuminated voltage sensors that are designed to sense AC voltage at 50V and above and are directly connected to the 480V panel's line side of the main breaker or its bus. Although these devices are designed to meet the NFPA 70E requirements for visual zero voltage determination, it is still required that the electrical worker must perform a line-to-line and line-to-ground zero voltage tests, with a separate meter, as required by NFPA 70E.

Troubleshooting and voltage measurements on energized 480V panelboards are allowed to be performed by qualified electrical workers without special permit.

Proper PPE must be worn while performing either zero voltage checks or troubleshooting on energized 480V panelboards. The appropriate complement of AR clothing and PPE for the task's Hazard/Risk Category (HRC) for the electrical work is worn. The task's HRC is to be determined by either the panels arc-flash (AF) label or per NFPA 70E tables 130.7(C)(15)(a) and 130.7(C)(16).

480 Volt Motor Control Centers

Maintenance work in an MCC cubicle while the MCC is energized is permitted if all of following conditions are met:

- The MCC and all cubicles appear to be in good condition both on the outside and inside, i.e., no sign of moisture, corrosion, mechanical damage, etc.;
- The room in which the MCC is located is reasonably dry, i.e., no sign of condensation on room walls or equipment surfaces;
- The line terminals of the cubicle supply circuit breaker have a polycarbonate shield or temporary installed rubber insulating blanket;
- The supply breaker is opened, locked and tagged per ESH-016;
- A zero voltage check has been performed on load side of the supply protective device;
- All circuits in the MCC cubicle that derive power externally must be locked and tagged;
- The appropriate complement of arc-rated (AR) clothing and personal protective equipment (PPE) for the task's Hazard/Risk Category (HRC) for the electrical work is worn. The task's HRC is to be determined by either the MCC arc-flash (AF) label or per NFPA 70E, by tables 130.7(C)(15)(a) and 130.7(C)(16).;
- V-rated gloves with leather protectors are to be worn to protect the hands from inadvertent shock hazard. If good finger dexterity is required to perform a particular task, then the V-rated rubber glove may be used without the leather protector, provided the rubber glove is retested after use.;
- A JHA must be performed that lists all of the anticipated hazards and describes the controls that will be used to mitigate the hazards.

If all the conditions specified above are not met, the MCC must be de-energized and a zero voltage test must be performed.

Basis: The line terminals of a circuit breaker remain energized after the circuit breaker is open. The polycarbonate shield or insulating blanket prevents accidental contact with energized parts either directly or via a conductive object such as a tool. Thus both electric shock and worker initiated arc flash are prevented.

Insertion or Removal of Starter Buckets

The normal practice must be to de-energize the MCC and perform a zero voltage test per NFPA 70E, prior to insertion or removal of starter buckets. Starter bucket insertion or removal into an energized MCC is prohibited and **shall not** be performed at PPPL.

480 Volt Network Protectors (NPs)

480-Volt Network Protectors may be manually operated while energized.

The PPPL D-Site NPs have been modified by the manufacturer such that they can be operated, while connected to the ring bus, without the door being opened. However, the recommended approach is to isolate the individual NP from the 480V ring-bus, prior to operating the NP. Isolating the NP will reduce that calculated bolted-fault current at this location from an extremely high, approximately 80 kAIC, to a manageable level of less than 20kAIC. This recommendation greatly reduces the substantial arc-flash / arc-blast hazard for this task.

480 Volt, 4.16 kV & 13.8 kV Switchgear

Racking Power Circuit Breakers: Local –vs.- Remote Racking

- Local racking of a circuit breaker is when the worker is required to be within the arc-flash boundary ($>1.2 \text{ cal/cm}^2$) while racking the breaker.
- Switchgear must be de-energized as a prerequisite for local racking of a circuit breaker. An Energized Work Permit shall be required to rack a circuit breaker with a hot bus. The PPPL Energized Electrical Work Permit can be found in ESHD 5008, Section 2, Chapter 17, Attachment “J”.
- For 4.16kV and 13.8kV switchgear, it is acceptable to use the switchboard bus voltmeter as the means of verifying that the bus is de-energized. The voltages of all three phases must be checked prior to de-energization and the absence of voltage for all three phases after de-energization.
- Racking may be done on an energized bus and without an Energized Electrical Work Permit, if the switchgear is provided with remote racking capability. The person performing the racking operation must stand to the side of the cubicle and outside of the arc-flash boundary. The area must be cleared of all other workers and with additional controls established to prevent pedestrian traffic. HRC for entering the breaker cubicle when the breaker is racked in shall be determined by AC Power per the remote racking procedure for the particular switchgear. Remote racking of a breaker into energized switchgear shall be performed only by qualified personnel under the direction of the Lab’s AC Power Section.

Basis: The failure of a circuit breaker during racking could result in shrapnel travelling at high speeds. Protective clothing and PPE offer no protection against shrapnel.

26 kV & 138 kV Switchyards

Entrance restrictions:

- Only qualified workers are permitted in the 26 kV & 138 kV switchyards.
- A qualified worker must escort unqualified workers in the switchyard.
- Safety ropes and/or danger tape (to define a safe work area) and training may be used, in lieu of, an escort for unqualified workers for a given task.
Basis: OSHA 29CFR1910.269(u)(4).
- A hard hat and safety glasses must be worn in the 26 kV (SE Quad switchyard, SEQUS) and the main 138kV switchyard.
Basis: Standard practice of PSE&G and Philadelphia Electric.

MV and HV Manual Disconnect Switch Operation:

If manual disconnect switch operation is performed (26 kV or 138 kV), a hardhat with arc-rated (AR) faceshield with balaclava or AR flash-hood, safety glasses, hearing protection, AR clothing, Class 2 V-rated gloves and dielectric overshoes must be worn over leather shoes. This task is a hazard risk category 2. Prior to operation of the disconnect switch, the switchyard shall be cleared of all unnecessary personnel to a distance not less than 50 feet from the outdoor disconnect switch.

Basis: NFPA 70E, Table 130.4(C)(a) Approach Boundaries, and Table 130.7(C)(15)(a) Other Equipment 1kV through 38kV, Outdoor disconnect switch operation (gang-operated from grade).

PSE&G standard operating practices

ANSI/IEEE Standard 80-1986 "IEEE Guide for Safety in AC Substation Grounding"

Attachments

None