

Brevard Public Schools



Electrical Safe Work Practices Handbook

Office of Environmental Health & Safety

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CONTENTS

Introduction	3
Definitions	7
Electrically Safe work Condition	9
Energized Work	10
PPE Overview	11
PPE – 50 to 240 Volts	12
PPE – Above 240 to 480 Volts	13
PPE – Above 480 to 600 Volts	14
PPE – Above 600 Volts	15
PPE Inspection and Testing	16
Application Steps for LOTO	17
Steps for Re-Energization of Equipment Following LOTO	18
GFCI Requirements	19
Equipment Requirements	20
Hazard Alerting / Control Requirements	21
Safe work Practices	22

INTRODUCTION

Compliance with the work practices and PPE requirements in this guide are mandatory for all personnel. Carry this guide with you and refer to it often.

Approach distances, PPE requirements, insulated tools and equipment, and work practices apply to all work, not just electrical work.

Did you know that?

- Historically, most electrical incidents involve 277 volts or less.
- Over 1/3 of fatal electrical incidents happen at 120 volts or less.
- Your heart will go into ventricular fibrillation which usually leads to death with currents as little as 75milliamps – that's 30 times less than a small electrical drill.

DEFINITIONS

Exposed – A circuit or component is exposed when:

- Not covered by insulation
- Panel or box is missing knockout plugs, breaker blanks, or gaps allow access inside the panel or box.

Energized – A circuit is energized until it is locked and tagged out and metering has confirmed zero voltage / current.

Electrical Safe Work Condition – A state in which and electrical conductor or circuit part meets all of the following requirements:

- Has been disconnected from energized parts.
- Is locked and tagged out in accordance with the LOTO program.
- Has been tested to ensure the absence of voltage.
- Is grounded (if deemed necessary)

Arc Flash Protection Boundary – The minimum flash protection boundary is 4 feet for voltages between 50 and 600 volts. Arc flash protection is required for any worker within this boundary when work is being performed that could lead to an arc flash. Flash protection boundary at voltages above 600 volts shall be calculated following NFPA 70E on a case-by-case basis using the formula in 130.3 (A) or applying the maximum level of protection recommended in Table 130.7 (C) (9) (a) based on the work being performed.

Limited Approach Boundary – The limited approach boundary is an area around exposed energized hazards of 50 volts or greater where unqualified personnel must be escorted and directly supervised by a qualified individual and insulated voltage-rated ANSI approved tools based on the maximum voltage are required. Limited approach boundaries include the following (refer to NFPA 70E for higher voltages):

- 50 to 750 volts – 3 feet 6 inches
- 751 volts to 15 kV – 5 feet
- 15.1 kV to 36kV – 6 feet
- 36.1 kV to 121 kV – 8 feet

Restricted Approach Boundary – The restricted approach boundary is an area around exposed energized hazards of 50 volts or greater where unqualified personnel are prohibited and insulated voltage-rated ANSI approved tools and full PPE based on the maximum voltage are required. A worker is considered to be working “near” energized systems when any part of the body or tool could approach an energized component closer than the distances below. Restricted approach boundaries include the following (refer to NFPA 70E for higher voltages):

- 50 to 750 volts – 1 foot
- 751 volts to 15kV – 2 feet 2 inches
- 15.1 kV to 36 kV – 2 feet 7 inches
- 36.1 kV to 46 kV – 2 feet 9 inches
- 46.1 kV to 72.5 kV – 3 feet 3 inches
- 72.6 kV to 121 kV – 3 feet 4 inches

Prohibited Approach Boundary – The restricted approach boundary is an area around exposed energized hazards of 50 volts or greater where approach within the boundary is considered working “on” an energized system. A worker is considered to be working “on” energized systems when any part of the body or tool could approach an energized component closer than the distances below. Unqualified workers are prohibited, full PPE based on the maximum voltage is required, insulated voltage rated ANSI approved tools are required. Prohibited approach boundaries include the following (refer to NFPA 70E for higher voltages):

- 50 – 750 volts – 1 inch
- 751 volts to 2 kV – 7 inches
- 2.1 kV to 36kV – 10 inches
- 36.1 kV to 46 kV – 1 foot 5 inches
- 46.1 kV to 72.5 kV – 2 feet 2 inches
- 72.6 kV to 121 kV – 2 feet 9 inches

Working On or Near Energized – Work is considered to be “on” or “near” anytime either of the following 2 conditions occur:

- Any part of the body, regardless of the level of PPE protection, enters or may inadvertently be placed within the Restricted Approach Boundary based on the maximum voltage involved.
- Any tool or piece of equipment (regardless of it is insulated) enters or may inadvertently be placed within the Restricted Approach Boundary based on the maximum potential voltage involved.

NOTE: If you are not qualified in Power Transmission / Distribution you are prohibited from approaching closer than 10 feet to exposed energized High Voltage systems.

ELECTRICALLY SAFE WORK CONDITION

You must make every attempt to establish an electrically safe work condition before performing any type of work, including non-electrical work (other than authorized metering as a part of troubleshooting) within the Limited Approach Boundary. All circuits and equipment are considered energized until an electrically safe work condition has been established and verified.

Performing complete lockout/tagout of all electrical potentials of 50 volts or greater within the cabinet, vault, box, or work area is considered establishing an electrically safe work condition so long as the lock/tagout process accomplishes ALL of the following.

- Every source (including the line) of electrical energy of 50 volts or greater inside the cabinet, vault, or box has been completely eliminated through lockout/tagout.
- Every phase conductor or circuit part is tested with an approved meter (phase-to-phase and phase-to-ground) to verify they are de-energized (meter shall be checked before and after each test to confirm that is operating properly).
- Ground connecting devices are applied to any part or circuit where there is a possibility of induced voltages or stored electrical energy including grounding out of capacitors or similar devices that may hold stored energy.

If both locks and tags cannot be installed, you must employ a second alternative method such as removal of a fuse in addition to the tag. Use of a tag alone is not sufficient. Use of a person to “monitor” is also an unacceptable solution.

If you cannot establish an electrically safe work condition you must follow the minimum electrical safe work practices below:

- If the Restricted Approach Boundary may be breached, work practices shall comply with those required for “work on or near” energized hazards.
- If the Limited Approach Boundary may be breached, a qualified person must be present and directly supervise the work.
- If the Arc Flash Boundary may be breached and any work is performed which has the possibility of causing an arc flash, all personnel within the Arc Flash Boundary shall be protected with appropriate levels of arc flash protection and PPE.

ENERGIZED WORK

The only situations when work on energized equipment may be permitted are:

- When it is impossible or infeasible (due to equipment design or operational limitations) to shut off the equipment or circuit.
- When de-energizing would introduce additional or increased hazards.
- When it must remain energized for testing or as part of the authorized maintenance procedure.

If you work on or near energized circuits or equipment (place any part of your body, a tool or piece of equipment within the Restricted Approach boundary), other than metering for troubleshooting you must:

- Be certified in, and have a second worker certified in First Aid and CPR.
- Use insulated voltage-rated ANSI approved tools.
- Wear PPE outlined in this guide for the maximum potential voltages that may be encountered, including the maximum voltages within the locker, cabinet or vault.

INSULATED TOOLS

You must use insulated voltage-rated ANSI approved tools and/or insulating handling equipment when working near exposed energized conductor or circuit parts. The insulating material on these items must be protected during storage and transportation.

Insulated voltage-rated ANSI approved tools and insulating equipment must be used when:

Breaking the plane (or opening) of an electrical fixture cabinet, vault, panel, etc., when any live voltage of 50 volts or greater remains (including metering for troubleshooting). Cabinet shall be considered as containing live voltage until all sources (including the feed line into the cabinet) of 50 volts or greater have been completely de-energized through lockout/tagout and confirmed to be de-energized through metering.

Any part of the body or a tool or piece of equipment may cross the Limited Approach Boundary for the maximum voltage present.

PPE OVERVIEW

You must wear the PPE outlined in this booklet when any part of the body, a tool, or piece of equipment may be placed within the Restricted Approach Boundary.

You must continue to wear the PPE until all energy sources of 50 volts or greater within the Restricted Approach Boundary have been completely eliminated through lockout/tagout and de-energization has been confirmed through metering.

All equipment used, including PPE, must be rated for the maximum voltage or arc flash that may be encountered.

- Insulated voltage rated ANSI approved tools must be stamped with a double triangle and the maximum rated voltage.
- Clothing and face shields must be marked with a maximum arc flash rating stamped in Cal cm²

NOTE: If tools or PPE lack proper marking they must be replaced.

PPE – 50 TO 240 VOLTS

The following PPE requirements apply to all work including non-electrical work with protection boundaries:

- Eye/Face – Arc flash shield (minimum of 4 Cal cm²) and safety glasses with side shields / goggles.
- Body – Flame retardant long sleeve / long pants (minimum of 4 Cal cm²)
- Hand – EH Gloves (class 00 with leather protectors)
- Foot – EH rated safety footwear.
- Head – Class E hardhat (if overhead hazards are present)

NOTE 1: Removal/installation of non-hinged electrical panel covers (50 to 240 volts) requires minimum PPE above.

NOTE 2: Arc flash face shield is not required for the following:

- Metering to confirm LOTO at wall outlets of less than 240 volts.
- Metering at lighting fixture circuits of 300 volts or less (at the lighting fixture).

PPE – ABOVE 240 TO 480 VOLTS

The following PPE requirements apply to all work including non-electrical work with protection boundaries:

- Eye/Face – Arc flash shield (minimum of 8 Cal cm²), sock hood, and safety glasses with side shields / goggles.
- Body – Flame retardant long sleeve / long pants (minimum of 8 Cal cm²)
- Hand – EH Gloves (class 00 with leather protectors)
- Foot – EH rated safety footwear.
- Head – Class E hardhat (if overhead hazards are present)

NOTE 1: Removal/installation of non-hinged electrical panel covers (above 240 to 480) requires minimum PPE above.

NOTE 2: Arc flash face shield is not required for the following:

- Metering at lighting fixture circuits of 300 volts or less (at the lighting fixture).

PPE – ABOVE 480 to 600 VOLTS

The following PPE requirements apply to all work including non-electrical work with protection boundaries:

- Eye/Face – Arc flash shield (minimum of 8 Cal cm²) and safety glasses with side shields / goggles.
- Body – Flame retardant long sleeve / long pants (minimum of 8 Cal cm²)
- Hand – EH Gloves (class 0 with leather protectors)
- Foot – EH rated safety footwear (carbon fiber recommended)
- Head – Class E hardhat (if overhead hazards are present)

NOTE 1: Removal/installation of non-hinged electrical panel covers (above 240 to 600 volts) requires minimum PPE above.

NOTE 2: Arc flash face shield is not required for the following:

- Work on 600 volt class motor control center, 600 volt class switchgear, and other 600 volt class equipment requires a double layer switching hood. This includes during application of safety grounds after voltage testing and during removal of bolted covers to expose bare energized parts.

PPE – ABOVE 600 VOLTS

The following PPE requirements apply to all work including non-electrical work with protection boundaries:

- Eye/Face – Arc flash hood (minimum of 25 Cal cm²) and safety glasses with side shields / goggles.
- Body – Flame retardant long sleeve / long pants (minimum of 25 Cal cm²)
- Hand – EH Gloves (class 0 or higher with leather protectors)
- Foot – EH rated safety footwear.
- Head – Class E hardhat (if overhead hazards are present)

NOTE 1: Work on metal clad switchgear and other equipment above 1 Kv may require layers of flame retardant clothing and a double layer switching hood with minimum ratings of 40 Cal/cm² depending on arc flash potential (see NFPA 70E)

PPE INSPECTION AND TESTING

Inspect all equipment and PPE before each use. If any of the following defects are found, replace the equipment.

- Holes, tears, punctures, or cuts.
- Embedded foreign objects.
- Texture changes, swelling, softening, or hardening.
- Any other defect that may damage insulating properties.

Inspect rubber equipment before each use and do not use unless it has been tested by a qualified testing agency as listed below (inspection must be documented).

- Insulating line hose & covers – by a qualified testing agency if insulating value is suspect.
- Insulating blankets – every 12 months by a qualified testing agency.
- Insulating gloves & sleeves – every 6 months by a qualified testing agency.

NOTE: If blankets, gloves, sleeves, remain sealed and have not been issued for service, they may not be placed into service unless they have been electrically tested within the past 12 months by a qualified testing agency.

APPLICATION STEPS FOR LOTO

Follow the steps below for LOTO for single energy source (multi-energy sources require additional procedures).

1. Identify equipment to be serviced.
2. Identify the single power source that energizes the equipment.
3. Identify/obtain equipment to apply lock and tag to the energy source.
4. Notify affected personnel that the equipment is to be locked/tagged out.
5. If equipment is running, use the established procedure to shut it down.
6. Bring equipment to zero energy state.
7. Install lock and tag to the single energy source using the tie wrap for tag and placing lock on fixture or hasp that prevents activation of energy source.
8. Confirm all energy is at zero state (meter for electrical, attempt to restart or use other method for non-electrical).
9. If equipment re-start was used to confirm zero energy state, return all valves, levers, and buttons to OFF or neutral position.
10. Equipment is now locked and tagged out and ready to be serviced.

NOTE: Wear required PPE when metering and isolate at the source such as the circuit breaker rather than a light switch.

STEPS FOR RE-ENERGIZATION OF EQUIPMENT FOLLOWING LOTO

Follow the steps below for re-energizing equipment with a single energy source after LOTO (equipment specific procedures are required for multi-energy sources):

1. Place all safeguards back on the equipment.
2. Remove all tools, parts, and other equipment that could cause a potential hazard when the equipment is started.
3. Check the equipment and area to identify anyone that could be affected by the start-up and notify affected personnel that the equipment is to be restarted.
4. Remove the lock, tag, and LOTO equipment and start-up the equipment according to the standard start-up procedure to verify it is working properly.

GFCI REQUIREMENTS

Ground fault circuit interrupters (GFCI) are the standard for protection of personnel from electric shock.

- Make sure you have GFCI protection when using corded portable electric tools and corded portable electrical equipment including portable lights.
- If you use an extension cord make sure it has GFCI protection or plug it into an outlet that has GFCI protection.
- If you use a GFCI protection device with an extension cord make sure it is located between the cord and the electrical outlet into which the cord is plugged.
- Check and test GFCI devices as follows:
 - Portable devices – before each use by pushing the test button.
 - Permanently mounted – monthly by pushing the test button.

NOTE: Although GFCI protection is always required outdoors or in damp or wet locations it is not required for “non-industrial indoor operations” such as computers and janitorial vacuums.

EQUIPMENT REQUIREMENTS

- Portable electric hand tools must be marked as double insulated.
- Cord sets must be three prong and include an equipment ground.
- Wood or fiberglass ladders are required around electrical equipment (metal ladders are forbidden).
- Never pickup electrical equipment with the electrical cord.
- Inspect extension cords and cords on electrical equipment before each use. Do not use equipment or cords with damaged wiring, missing insulation, repairs, or missing or damaged plug prongs including grounding prongs.
- Do not plug extension cords together. Secure the right length cord.
- Do not use extension cords in place of permanent wiring.
- Do not run extension cords through holes in walls, through doors, or attach them to the structure or furniture.
- Do not splice extension cords. Cord repair (replacement plug and outlet) may only be accomplished by a qualified person.

HAZARD ALERTING / CONTROL REQUIREMENTS

- Special precautions are required to protect non-qualified personnel from electrical hazards.
- If knockout plugs, breakers, or breaker blanks are found missing:
 - Submit work order for repair.
 - Place sign on panel limiting access to qualified electricians.
- Assure barricades with warning signs or equally effective methods are used to prevent or limit employee access to work areas containing live parts.
- Never leave exposed energized components unattended or unprotected:
 - If signs or barricades cannot assure protection an attendant shall be stationed to warn unqualified personnel.
 - If an attendant is used they shall remain in the area until the hazard no longer exists or is adequately controlled.
- If equipment is de-energized for work and other equipment in the area remains energized, additional alerting methods such as signs, barricades, or attendants shall be employed to prevent employees from entering or accessing look-alike equipment that is still energized.

SAFE WORK PRACTICES

- Know the voltage and current potential of the circuit and always treat it as live until it has been tested.
- Always wear the minimum PPE defined in this guide when you work on or near energized circuits or equipment.
- Never reach blindly into an area that might contain live circuits or other electrical hazards.
- Make sure there is sufficient light to safely work. Never enter areas with exposed electrical circuits unless there is adequate light.
- Make sure there is proper clearance in front of and around electrical panels. If there isn't, clear the area before starting work.
- Do not wear watches, rings, bracelets, key chains, necklaces, or wire rimmed eyeglasses if contact with exposed electrical could occur.
- Know where wiring is located before penetrating walls, floors, ceilings, or other blind areas.
- Make sure all tools and equipment used for electrical work is an ANSI approved insulated tool and the equipment is rated for the highest potential voltage involved.
- Do not use extension cords to power high current draw equipment such as microwaves, refrigerators, toasters, ovens, or coffee pots.
- Do not use power strips in place of permanent wiring – surge protector type strips are allowed for low current draw items such as computers and office type products that require surge protection.
- If you install or repair electrical circuits make sure your work conforms to the latest version of the National Electric Code (NEC) (or the local code as applicable).
- Equipment setup for thermography and non-contact inspections shall be performed by qualified personnel wearing appropriate PPE and following safe work practices for the potential voltages and approach distances involved.
- Once equipment is setup. Personnel performing thermography and other non-contact inspections shall still wear the minimum PPE based on maximum voltages and approach distances contained in this guide.
- Never endanger yourself or others by attempting to pull a shock victim off a circuit – de-energize the circuit and then seek help. Electrical shocks are medically serious; therefore the victim needs to be seen by a qualified health care professional regardless of symptoms or level of injury.

- To work within 10 feet of exposed energized power transmission and distribution equipment or within the perimeter fence of a high voltage substation you must be trained in the special safe work practices required around this hazardous equipment or be under the direct supervision of a person that is qualified.