



Proof of Training

Print name: _____ Signature: _____ Date: _____

NFPA 70e Electrical Safety and Arc Flash Prevention/Protection

Summary

Unger Construction's NFPA 70e program is closely linked and integrated with our Electrical Safety Program. In fact much of the information is the same. You need to have read, understood and demonstrated competency with the requirements of those programs to Unger Construction's Superintendent and the Safety Director before you will be authorized to work on electrical systems.

Purpose

The purpose of this program is to ensure the protection of employees and subcontractors from the hazards associated with electrical systems.

Scope

This policy will apply to all work performed by employees and subcontractors including, but not limited to the following activities: construction, installation, demolition, remodeling, relocation, refurbishment, testing, and servicing or maintenance of equipment or machines and at other times when electrical systems are required.

Responsibilities

Management (Board of Directors and Project Managers)

Management is responsible for ensuring that the materials (e.g., tools, equipment, personal protective equipment) and other resources (i.e., worker training materials) required to fully implement and maintain this program are readily available where and when they are required. Additionally, management will monitor the effectiveness of the program, provide technical assistance as needed, and review the program bi-annually.

Program Manager

Dave Simpson is responsible for the development, documentation, training and administration of the program. This position carries the responsibility of insuring this program is adhered to and that proper reporting is executed.

Supervisors (Superintendents and Foreman)

Supervisors are responsible for ensuring that a task specific job hazard analysis (JHA), also known as a safe work plan, is developed. The JHA will select, implement and document the appropriate site-specific control measures as defined within this policy. Supervisors will direct the work in a manner that ensures the risk to workers is minimized, adequately controlled and that practices defined by this policy will be

followed. Supervisors are responsible for ensuring Unger Construction employees and subcontractors are following expectations. Supervisors will be held accountable for enforcing the requirements of this program. Undesirable behavior will not resolve itself, therefore supervisors must be directly involved with modifying behaviors inconsistent with program expectations. Supervisors will be held accountable for enforcing Unger Construction's disciplinary program.

Workers (Employees and Subcontractors)

Unger Construction has high expectations and requires safety excellence for each employee, crew, project and for our entire company. Workers are required to follow the minimum procedures outlined in this program. Workers are responsible for knowing the hazards and the control measures established in the JHA. Workers are responsible for using the assigned PPE in an effective and safe manner. Workers are responsible for stopping unsafe acts and correcting unsafe conditions on the spot as soon as they are discovered. Any deviations from this program must be immediately brought to the attention of your supervisor. Workers that choose to conduct themselves in a manner that is inconsistent with these expectations will be held accountable for those decisions and may incur disciplinary actions.

Hazardous Material Survey

Unger Construction requires hazardous materials surveys before demolition or renovation work begins. The survey shall include all of the following: A visual inspection of a facility or a portion thereof for suspect materials, sampling and laboratory analysis of any suspect materials found for the presence of asbestos. The hazardous materials survey will also furnish a written report that includes: a description of the area(s) visually inspected, a detailed description of any suspect material sampled, the results of any laboratory analysis of suspect materials, the method of analysis, and the total amount of asbestos containing material. Typically a floor or roof plan is included with the report to reference the written information visually.

The person conducting the survey must be certified pursuant to OSHA and/or EPA regulations. The survey may be performed by a certified Site Surveillance Technician (SST) under the supervision of a licensed consultant. Note: The survey may be performed by a certified Site Surveillance Technician (SST) under the supervision of a licensed consultant. Note: The survey needs to be kept in a project file so that it can be accessed when working on future projects.

If lead or asbestos have been confirmed to be present employees and subcontractors must follow Unger Construction's Lead and/or Asbestos program. If hazards such as asbestos or lead will be disturbed during remediation, a properly licensed professional must perform the work and follow appropriate regulations.

Job Hazard Assessment (Safe Work Plan)

Unger Construction utilizes JHA's as our means of hazard assessment and establishing a safe work plan. JHA's are performed by supervisors and/or workers. Our library of hazard assessments is maintained on the "S" drive. Before beginning a new task refer to the JHA library, generally speaking all scopes of our work are covered. For situations that have not yet been covered select one that is substantially similar and use it as a baseline. JHA's on the "S" drive are organized by work area and job description. JHA's include strategies for elimination, substitution, engineering and administrative controls. After applying all appropriate reduction and elimination technique, the remaining hazards will be analyzed and the

proper PPE to reduce the hazards will be selected. PPE will be identified for hazards that are in the process of being reduced or eliminated and/or when hazard-reduction efforts are not 100% effective in eliminating the hazards.

For complex or moderate to high hazard tasks, tasks where an additional level of safety planning is needed, the safety director will perform the JHA with the supervisor and workers.

Discussion

Unger Construction does not self-perform electrical work and does not have anyone on staff that is qualified to perform electrical work. Electrical safety is subcontracted with that said Unger Construction will take the necessary steps to ensure the subcontractor is in full compliance with regulations that govern electrical work.

Training

OSHA and NFPA 70E require that workers be qualified in order to work on or near energized electrical systems. Unger Construction requires proof of training for qualified workers, arc flash procedures (determining severity of potential exposure, planning, safe work practices and selecting personal protective equipment).

Appropriate training will be provided for those employees who face a risk of electric shock in the form of classroom and/or on the job instruction. Each employee required to be trained will become familiar with the safe work practices required by this policy and the OSHA Electrical Standard that pertain to his/her respective job assignment(s).

Qualified persons (i.e. those persons permitted to work on or near exposed energized parts) will, at a minimum, be trained in the following: The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment, The skills and techniques necessary to determine the nominal voltage of exposed parts, The clearance distances and the corresponding voltages to which the qualified person will be exposed.

Retraining will be provided if a worker is found to be performing below expectations. Additionally, retraining will be provided at least every 3 years.

Proof of training is available on the "S" drive. The training data base can be sorted by employee name or by subject. This ensures supervisors and employees are able to confirm they have the necessary training and if they don't which employees do. Employees that need training should contact their project manager or superintendent to make arrangements for them to be trained.

General Requirements

Only qualified workers are allowed to work on or near electrical systems. Current certification cards are required regardless of the workers comfort level or years of experience. Additionally, permission must be granted by the foreman, superintendent or project manager.

NFPA70e

The National Fire Protection Association or NFPA 70E, are the principle regulations to establish minimum requirements for electrical safety. OSHA has adopted these regulations and they apply to every worker that may approach or be exposed to electrical energy. NFPA 70E outlines a four-step approach to electrical safety:

1. Turn off the power. Work de-energized, whenever possible. This isn't always feasible. When it is working on or near exposed live conductors and parts, NFPA 70E requires the following:
2. Live work permit. Have the customer sign an Energized Electrical Work Permit.
3. Plan the work. Have a written plan for performing the live work safely.
4. Use personal protective equipment. This includes flame-resistant (FR) clothing, insulated tools, face shields, and flash suits.

Work Practices

De-energization of electrical equipment provides the highest level of safety when servicing or maintaining electrical equipment. Working on live electrical parts should be avoided when possible and should only be performed in the following two scenarios: De-energizing the equipment creates additional hazards, such as shutdown of hazardous ventilation systems or life safety systems; and Equipment must be energized to allow for testing that can only be performed live.

Only employees that are qualified persons are allowed to work on live electrical parts that are 50 V or higher. Qualified persons must perform live electrical work in compliance with the most current National Fire Protection Association 70E Standard for Electrical Safety in the Workplace (NFPA 70E).

The following work practices must be followed when working on live electrical parts:

Personal protective equipment (PPE) must be used when required; Conductive apparel (watches, bracelets, rings, key chains, necklaces, zippers, cloth with conductive thread, etc.) must not be worn; Non-conductive hand tools must be used and must be rated for the voltage at which live electrical work is being performed; Barricades and signage must be posted a safe distance away from the work area and unqualified persons must not be allowed in the work area; Conductive materials and tools must be kept a safe distance away from live electrical parts; and Electrical equipment must be restored to safe conditions and all safeguards must be replaced when work is complete.

When electrical equipment is not required to be live during servicing or maintenance work, equipment should be de-energized in accordance with the Unger Construction's Control of Hazardous Energies (CoHE) also known as Lockout/Tagout (LOTO) policy.

If a breaker trips after resetting "once", staff shall contact Electrical staff to troubleshoot the problem.

Ladders made from conductive materials such as aluminum or steel pose an electrocution hazard when working on or near exposed conductors. Only non-conductive ladders can be used when working on or near exposed conductors.

Confined spaces with live, exposed electrical parts are considered permit-required confined spaces. Work inside these spaces must be conducted in accordance with the Confined Space policy.

Overview of Safety Practices When Working Live, Energized or Hot

Energized electrical work is permitted in the following situations: a) when an employer can demonstrate that de-energizing will cause additional or increased hazards. Examples of increased or additional hazards include, but are not limited to, interruption of life support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment. b) When de-energizing is infeasible due to equipment design or operational limitations. Examples of work that might be performed on or near exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include performing diagnostics and testing (e.g., start-up or troubleshooting) of electric 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

Energized electrical work on systems of 50 volts or more requires an Energized Electrical Work Permit signed off by an authorized representative of Unger Construction. When working “live” around exposed energized parts, NFPA 70E requires the following a Live Work Permit, at Unger Construction this type of work is covered under the Energized Electrical Work (EEW) permit, some electrical firms use the term hot work permit. Both Unger Construction and the customer/client need to review and approve the energized electrical work permit.

Planning

Determine Shock Hazard Boundaries. There are three of these: Limited approach boundary, Restricted approach boundary, Prohibited approach boundary.

Determine Flash Protection Boundary (FPB). The default flash protection boundary for systems operating at 600 volts is 48 inches. A qualified person who works closer than 48 inches to live parts must wear personal protective clothing (PPE) including flame-resistant (FR) clothing. This PPE is for arc-flash and arch-blast protection, not protection against electric shock.

Determine Hazard/Risk Category (HRC). NFPA 70E has several tables that help electrical workers select the correct type of PPE to wear based upon the task they are performing live. There are five different HRCs: 0, 1, 2, 3 and 4. Use Appropriate PPE. Workers must wear PPE specified by the tables in NFPA 70E whenever they are within the Flash Protection Boundary (48 inches for 600-volt equipment), whether or not they are actually touching the live equipment. Tasks such as voltage testing, for equipment troubleshooting or to verify whether power has been turned, off is “live work” that requires workers to wear PPE.

Only qualified persons can enter the restricted approach boundary. Entering the prohibited approach boundary is considered the same as touching live parts. These boundaries are for shock protection only; they determine when electrical workers must use voltage-rated (rubber) gloves and voltage-rated (fiberglass) tools.

Arc Flash Introduction

Arc flash is described as the sudden release of large amounts of heat and light energy at the point of the fault. Exposure to an arc flash frequently results in a variety of serious injuries and in some cases, death.

People have been seriously injured even when ten feet or more from the arc center. If there are nearby flammable materials, these can be ignited resulting in secondary fires that can destroy entire facilities.

During an arc flash can reach 35,000 degrees Fahrenheit. The heat energy and intense light at the point of the arc is termed arc flash. Air surrounding the arc is instantly heated and conductors are vaporized causing a pressure wave termed arc blast. It's more like an explosion; blast pressures can cause injury or death. Arc flashes and blasts can be life threatening and require special attention and training to prevent such occurrences. An arc-blast can also result in flying metal, some of which may be molten.

Arc flash injuries are typically Burns, Loss of Hearing, Concussions, Loss of Sight, Collapsed Lungs, Broken Bones, Loss of Limb and Loss of Life.

The Arc Flash Hazard Analysis

An arc flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the flash protection boundary and the personal protective equipment that people within the flash protection boundary shall use.

Approach Distances

NFPA 70E has developed requirements to reduce the risk of injury to workers due to shock and arc flash hazards. There are three shock approach boundaries (limited, restricted and prohibited). The limited, restricted and prohibited approach boundaries are based on the voltage of the energized equipment. Before a worker approaches exposed electric conductors or circuit parts that have not been placed in a safe work condition, a flash hazard assessment must be performed. Until equipment is placed in a safe work condition, it is considered *live*. It is important to note that conductors and equipment are considered live when checking for voltage while putting equipment in a safe work condition. The arc flash hazard analysis should determine the arc flash boundary (AFB) and level of personal protective equipment (PPE) that the worker must wear. The arc flash boundary is based on voltage, the available fault current and the time it takes for the upstream protective device to operate and clear the fault. The boundaries are summarized below.

Limited Approach Boundary

Limited Approach Boundary is "a shock protection boundary to be crossed by only qualified persons (at a distance from a live part) which is not to be crossed by unqualified persons unless escorted by a qualified person". The limited approach boundary is the minimum distance from the energized item where unqualified personnel may safely stand. No untrained personnel may approach any closer to the energized item than this boundary. The boundary is determined by NFPA 70E Table 2-1.3.4 and is based on the voltage of the equipment. A qualified person must use the appropriate PPE and be trained to perform the required work to cross the limited approach boundary and enter the limited space.

Restricted Approach Boundary

A shock protection boundary to be crossed by only qualified a person (at a distance from a live part) which, due to its proximity to a shock hazard, requires the use of shock protection techniques and equipment when crossed. To cross the Restricted Approach Boundary into the Restricted Space, the qualified person, who has completed required training, must wear appropriate personal protective

equipment (PPE). Also, he must have a written approved plan for the work that they will perform and plan the work to keep all parts of the body out of the Prohibited Space. This boundary is determined from NFPA Table 2-1.3.4 and is based on the voltage of the equipment.

Prohibited Approach Boundary

A shock protection boundary to be crossed by only qualified persons (at a distance from a live part) which, when crossed by a body part or object, requires the same protection as if direct contact is made with a live part. Only qualified personnel wearing appropriate personal protective equipment (PPE), having specified training to work on energized conductors or components, and a documented plan justifying the need to perform this work may cross the boundary and enter the Prohibited Space. Therefore, personnel must obtain a risk assessment before the prohibited boundary is crossed. This boundary is determined by NFPA 70E Table 2-1.3.4 and is based upon the voltage of the equipment.

Arc Flash Boundary (AFB)

The AFB is a safe approach distance from energized equipment or parts. NFPA 70E establishes the default arc flash boundary at 4 feet for low voltage (< 600V) systems where the total fault exposure is less than 5000 amperes-seconds (fault current in amperes multiplied by the upstream device clearing time in seconds). NFPA 70E also allows the AFB to be calculated. In some instances, calculations may decrease the boundary distance. Persons crossing into the arc flash boundary are required to wear the appropriate PPE as determined by calculating methods contained in NFPA 70E. In addition, a qualified person must accompany unqualified persons.

Flash Protection Barrier (FPB)

The first step is to determine if the work being done is within the flash protection boundary (FPB). The FPB can be calculated using the equations given in 70E or by using one of the many software programs, both freeware and commercial, which are available. Unger Construction prefers to utilize the tables provided within NFPA 70e because they provide a more conservative approach to clearance distances. The flash protection boundary is the distance from the energized parts at which a worker could sustain a curable burn as a result of an arcing fault.

Voltage	Boundary
up to 750V	3 feet
750V to 2kV	4 feet
2kV to 15kV	16 feet
15kV to 36kV	19 feet
over 36kV	Must be Calculated

Insulating Equipment and Insulated Tools

Insulated tools are to be used while working on energized equipment. Insulating equipment (insulating blankets, covers, line hose, gloves, and sleeves) and insulated tools shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage.

Insulating equipment or insulated tools with any of the following defects may not be used: A hole, tear, puncture, cut, mechanical stress (series of interlacing cracks), An embedded foreign object, Any of the following texture changes: swelling, softening, hardening, or becoming sticky or inelastic. Any other defect that damages the insulating properties.

Defective Insulating Equipment, Insulated Tools or PPE

Workers may not use insulating equipment failing to pass inspections or electrical tests. Failed equipment shall be taken out of service and destroyed by the supervisor after it fails the test. Insulating equipment found to have other defects that might affect its insulating properties shall be removed from service and returned for repair, testing or replacement. Only manufacturer qualified repairs will be performed. Repaired insulating equipment will be retested before employees may use it.

Personal Protective Equipment (PPE)

Gloves are required to be tested and certified by a third party every 6 months. Gloves that are out of date are considered defective and cannot be used. Before donning the gloves perform a glove inspection look for a hole, tear, puncture, or cut. Do an inflation test for gloves for possible tears or punctures. Gloves are not permitted to be repaired—they shall be replaced.

Extra care is needed to protect insulating gloves from sharp objects. Protector gloves are required when handling or working near sharp objects. Protector gloves shall be worn over insulating gloves, except as follows: Protector gloves need not be used with Class 00 or 0 gloves, under limited-use conditions, where small equipment and parts manipulation necessitate unusually high finger dexterity.

When determining PPE requirements for arc flash protection determine Hazard/Risk Category (HRC) per the NFPA 70e tables. There are five different HRCs: 0, 1, 2, 3 and 4. Workers must wear PPE specified by the tables in NFPA 70E whenever they are within the Flash Protection Boundary whether or not they are actually touching the live equipment. Tasks such as voltage testing, for equipment troubleshooting or to verify whether power has been turned, off is "live work" that requires workers to wear PPE.

Arc flash PPE is much more than wearing gloves and safety glasses. Protective equipment, sufficient for protection from an electrical flash, is required for any part of the body which could be within the arc flash boundary. Examples of the equipment could include a hard hat, face shield, flame resistant neck protection, ear protection, Nomex suit, insulated rubber gloves with leather protectors and insulated leather footwear. All workers entering the flash protection boundary must be wearing appropriate Personal Protective Equipment.

Proper PPE selection is critical to protecting the worker from injury. PPE selection shall be determined by the tables provided within NFPA 70e. PPE must have an arc rating equal to or greater than the

calculated incident energy from the tables. Arc flash face shields may look like an ordinary face shield but they are different. In addition to the impact rating arc flash face shields are rated for heat/flame exposure. Arc flash face shields shall not be used for any other purpose. Cleaning and processing of these garments to its mending, patching and repair

Arc Flash PPE is much more than Fire Retardant. Arc Flash protective garments are designed and tested to insulate the user from the harmful energy, not just self-extinguish. All arc flash rated PPE shall be identified with a label from the manufacture which will include the limits of protection. If the label of PPE does not have an Arc Rating (ATPV), it is not Arc Flash protection.

Typical protective clothing systems summary: NFPA 70E Table 3-3.9.3			
Hazard/ Risk Category	Clothing Description (Number of Layers is in Parentheses)	Total Weight (oz/yd²)	ATPV Rating of PPE (cal/cm²)
0	Untreated Cotton (1)	4.5–7	N/A
1	FR Shirt and FR Pants (1)	4.5–8	5
2	Cotton underwear plus FR shirt and FR pants (2)	9–12	8
3	Cotton underwear plus FR shirt and FR pants plus FR coverall (3)	16–20	25
4	Cotton underwear plus FR shirt and pants plus double layer switching coat and pants (4)	24–30	40

Pre-use inspection

All workers entering the flash protection boundary must be qualified and must be wearing appropriate Personal Protective Equipment. Garments shall be clean and in good condition. Garments that have been mended, patched or repaired will be rejected. All PPE, tools and test instrumentation will be inspected by Unger Construction before work can begin.

Planning and Approval

Before workers approach exposed electric conductors or circuit parts that have not been placed in a safe work condition, the flash hazard analysis must be performed. The analysis should determine the flash protection boundary and level of personal protective equipment the worker must wear. Work permits known as energized electrical work (EEW) or hot work permits are required. Additionally, a job hazard analysis (JHA) and access interruption notice (AIN) are required.

De-energized Conditions

Some level of confusion usually surrounds de-energized conditions. Some workers feel that if the circuit is de-energized they don't need to wear the arc flash PPE. The issue is actually in determining that the circuit is indeed de-energized. To determine if it is, in fact de-energized, the employee needs to test for the absence of voltage, using a voltage tester. To conduct this test, he or she must enter into the prohibited or restricted area. To cross the prohibited approach boundary, the person conducting the work must: have specific training, have a documented plan justifying need for work within the restricted area, perform a hazard assessment, have a work plan and analysis approved by authorized person, wear PPE rated for the hazard. Once confirmation is achieved the arc flash PPE can be doffed.

Labeling

NFPA 70-NEC Section 110.16 states that field labeling of switchboards, panel boards, industrial control panels, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized, must be field marked to warn qualified persons on the danger of electric arc flash. The marking must be clearly visible to qualified persons before they examine, adjust, service, or perform maintenance on the equipment.

Our clients, not manufacturers or installers, are responsible for complying with the National Electric Code labeling requirements. Switchboards, panel boards, industrial control panels, and motor control centers must be field marked. Many companies are also marking conduits, disconnect switches, and any other equipment where the risk of arc flash exists. Any equipment installed after 2002 needs to be labeled. For equipment installed before 2002, labeling must be applied if ANY modifications or upgrades take place. Smart employers are taking the safe, efficient approach of labeling all their electrical equipment, regardless of when it was installed. The marking must be clearly visible to qualified persons before they examine, adjust, service, or perform maintenance on the equipment.



Clearance Around Electrical Equipment

Disconnects must be clearly labeled with the voltage and the equipment that it is powering, unless the disconnect is located and arranged such that its purpose is evident.

There must be a clear path from the disconnect box to the equipment that it powers; Electrical panels must be able to open at least 90 degrees; and Panel doors to panels and disconnect boxes must always remain closed when they are not being serviced.

Electrical equipment must be provided with sufficient access and working space to permit ready and safe operation and maintenance of the equipment. Working clearances of 36 inches shall be provided in front of all electrical equipment such as electrical panels and disconnect boxes. Except as permitted by OSHA or the NEC, the working space in front of live parts operating at 600 volts or less that requires servicing, inspection or maintenance while energized may not be less than indicated in Table 1 below.

TABLE 1: Minimum Clearance Requirements for Electrical Equipment

Nominal Voltage to Ground	Minimum Clear Distance for Condition ⁽³⁾		
	A	B	C
0-150	3' ⁽¹⁾	3' ⁽¹⁾	3'
151-600	3' ⁽¹⁾	3-1/2'	4'
601-2,500	3'	4'	5'
2,501-9,000	4'	5'	6'
9,001-25,000	5'	6'	9'
25,001-75 kV ⁽²⁾	6'	8'	10'
Above 75 kV ⁽²⁾	8'	10'	12'

(1) Minimum clear distance may be 2-1/2' for installations built prior to April 16, 1981.

(2) Minimum clear distance in front of electrical equipment with nominal voltage to ground above 25 kV may be the same as for 25 kV under conditions A, B and C for installations built prior to April 16, 1981.

(3) Conditions A, B and C are as follows: (A) Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides are effectively guarded by an insulating material. Insulated wire or insulated bus bars operating at not over 300 volts are not considered live parts. Concrete, brick or tile walls are considered to be grounded. (B) Exposed live parts on one side and grounded parts on the other. (C) Exposed live parts on both sides of the workspace not guarded as per condition (A), with the operator between.

Electrical Rooms and Closets

Storage of any material is prohibited in rooms designated for electrical equipment. Only qualified persons are allowed to enter High Voltage (greater than 600 volts) rooms. High voltage rooms must be locked at all times.

Hazardous Locations

Hazardous locations are areas where fire or explosion hazards may exist due to the presence of flammable gases or vapors, flammable liquids, or combustible dusts. Electrical equipment, tools, and systems can become a source of ignition in these areas. Electrical system components and electrical

tools must be designed and constructed to be suitable for installation and use in hazardous locations. Electrical equipment must be designated as Class I, or II. Class I for areas in which flammable vapors, liquids, or gases may be present, Class II for areas in which combustible dust may be present.

Unattended Operations

No exposed live electrical equipment shall be left unattended unless properly barricaded as outlined in NFPA 70E.