# Electrical

**Short description**

This section outlines the guidance for assessing and controlling hazards associated with electrical energy.

**Contact person**


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# 1 Objective and area of application

During construction, workers may potentially be exposed to a variety of serious hazards, such as arc flashes (which include arc flash burn and blast hazards), electric shock, falls, and thermal burn hazards that can cause injury and death. The objective of this section of the HSEQ Manual seeks to inform Centennial employees and subcontractors of their obligations to develop the appropriate hazard prevention and control methodologies designed to prevent workplace injuries and illnesses.

Electrical equipment must be free from recognized hazards that are likely to cause death or serious physical harm. Equipment shall be suitable for the installation and use, it shall be installed and used in accordance with any instructions included in the listing or labeling and it shall be maintained in accordance with the NEC and/or OSHA. (“Suitable” means that the equipment is listed or labeled for the intended use by a nationally recognized testing laboratory, e.g., Factory Mutual (FM), Underwriters Laboratory (UL), etc.)

# 2 Superior and additional applicable documents

1000_GP_11_01_en_6.0 Global Policy on Health, Safety, Environment/Sustainability and Quality (HSEQ)

29 CFR 1926

29 CFR 1910

NFPA 70 - National Electric Code

NFPA 70E - Standards for Electrical Safety in the Workplace

ASTM F18

This section of the HSEQ Manual applies to all Centennial employees and subcontractors who are performing work in Centennial facilities and / or on project sites. There may be more stringent requirements than this section as defined by specific State, local or contact specific HSEQ requirements. If there is a conflict between this section and other applicable regulations, the more stringent will apply.

# 3 Definitions

The following definitions of terms are important for an understanding of this procedure.

| Term | Definition |
|---|---|
| AHA | Activity Hazard Analysis |
| AWG | American Wire Gauge |
| Centennial | All Centennial employees, joint venture employees, subcontractors, and business partners |

| | |
|---|---|
| DFOW | Definable feature of work |
| Electrical hazard | Recognized dangerous condition such as exposed energized parts or unguarded electrical equipment that is energized is may be unexpectedly become energized |
| Electric shock or burn | An electric shock occurs when electric current passes through the body. This can happen when touching an energized part. If the electric current passes across the chest or head, death can result. At high voltages, severe internal and external burns can result from current passing through the body |
| Energized parts | Energized components that can be inadvertently touched or approached nearer than a safe distance and are not suitably guarded, isolated, or insulated |
| Exposed | Terminals, conductors, or equipment that is not shielded or guarded for incidental contact |
| EMF | Electric Magnetic Field |
| FM | Factory Mutual |
| Guarding or shielding | Nonconductive shields installed in electrical cabinets, boxes or lines that may be inadvertently contacted |
| Hazardous voltage | Voltages in excess of 50 volts or capable of releasing energy that could harm personnel or equipment |
| High voltage | 600 volts or greater |
| Hot stick | An insulated live-line tool that that allows a *qualified person* to manipulate switches, fuses or other electrical devices while still allowing safe minimum approach distances |
| HSEQ | Health, Safety, Environment and Quality |
| HSEQ Director | Leads the HSEQ Team |
| Inadvertent contact | Any unintentional contact with hazardous voltage due to work in close proximity to energized components |
| NEC | National Electric Code |
| NFPA | National Fire Protection Agency |
| NFPA 70E | Standard for Electrical Safety in the Workplace |
| OSHA | Occupational Safety and Health Administration |
| Qualified person | One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk |
| UL | Underwriters Laboratories |
| ZVV | Zero voltage verification.  Verifying an electrically safe work condition by testing to confirm the absence of electrical voltage after performing LOTO |

# 4 General electrical requirements

Centennial employees, subcontractors and lower tier contractors shall identify the electrical hazards and hazardous voltages associated within each DFOW and establish the controls necessary to maintain an acceptable level of risk. To assist in the evaluation of electrical hazards, subcontractors shall employ an Electrical Hazard Analysis consistent with the requirements of NFPA70E, Standard for Electrical Safety in the Workplace (most current version) for shock and arc flash hazards. The identified hazards and control measures shall be documented in the associated Activity Hazard Analysis (AHA) that provides an acceptable level of hazard identification and control for the associated task or work sequence. See HSEQ Manual Section 6 paragraph 4 for specifics.

The safe electrical work practices that are employed shall prevent electric shock, burns, arc flash or other injuries that could result from either direct or indirect contact of electrical current. Specialized training, observing required approach distances, and the use of appropriate personal protective equipment (PPE) shall be in accordance with the requirements of the current version of the NFPA70E.

## 4.1 Qualified person

A qualified person shall be trained and knowledgeable in the construction and operation of equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method. Specific training shall be in accordance with the requirements of the current version of the NFPA70E to include the following:

- The proper use of the special precautionary techniques, applicable electrical policies and procedures, PPE, insulating and shielding materials, and insulated tools and test equipment.
- Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment
- Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts
- Approach distances and the corresponding voltages to which the qualified person will be exposed
- Decision-making process necessary to be able to do the following:
    - Perform the job safety planning
    - Identify electrical hazards
    - Assess the associated risk
    - Select the appropriate risk control methods from the hierarchy of controls identified in 110.1(G), including personal protective equipment
- Selection and usage of the appropriate test instrument and verification the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the employee to understand all limitations of each test instrument that might be used.

An employee who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person, and who in the course of such training demonstrates an ability to perform specific duties safely at his or her level of training, and who is under the direct supervision of a qualified person shall be a qualified person for the performance of those specific duties.

## 4.2 Electrical PPE

Subcontractors and lower tier contractors are responsible for identifying, providing, and maintaining their own electrical PPE. Maintenance of electrical PPE includes the required testing, maintenance, and certification. Records of such testing shall be made available for review.

PPE appropriate to the hazard present shall be in accordance with the requirements of the current version of the NFPA70E and may include:

- Leather protective gloves
- Insulated rubber gloves
- Eye and face protection
- Hearing protection
- Non-conductive headgear
- Arc-Flash protective clothing as required by NFPA 70E
- Electrical blankets and barriers
- Hot-sticks and similar tools

Personnel working on electrical distribution systems shall be provided with the appropriate electrical protective equipment. This equipment shall be inspected, tested, and maintained in safe conditions in accordance with the manufacturer. Subcontractors and lower tier contractors shall use rubber gloves, sleeves, blankets, covers and line hoses as required by special conditions for work on energized facilities. Rubber goods provided to protect employees who work on energized facilities must meet ASTM F18 standards. Electrical workers' rubber insulating protective equipment shall be visually inspected for damage and defects prior to each use.

Personnel shall wear rubber-insulating gloves where there is a danger of hand or arm injury from electric shock or arc flash burns due to contact with energized parts. Leather glove protectors should be worn over voltage-rated rubber gloves.

Rubber protective equipment must be subjected to periodic electrical tests as shown below:

- Rubber insulating gloves shall be inspected before first issue and every 6 months thereafter
- Rubber insulating blankets and sleeves shall be inspected before their first issue and every 12 months thereafter
- Rubber insulating line hose and covers shall be tested whenever their insulating value is suspect

## 4.3 Temporary wiring

### 4.3.1 Tools and equipment

All equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded. Only approved and listed for construction grounded power outlet receptacles shall be used to distribute power. “Daisy chaining” of power outlets is prohibited. Relocatable power taps and surge protectors are prohibited on Centennial project sites.

### 4.3.2 Flexible cords and cables

Flexible cords are for temporary use only, to supply electrical power to portable equipment such as audio video, hand drills and drop lights, not as a substitute for fixed wiring. These cords must be properly rated and listed for the intended use. Extension cords are not to be used inside equipment for providing electrical power to components. Only UL-listed flexible cords that are suitable for conditions of use and location shall be used on Centennial projects.

Flexible cord sets shall be:

- A minimum of 14 AWG and three wire type (14/3)
- Designed for hard or extra hard use
- Protected from damage including foot traffic, vehicles, sharp corners, and pinching
- Inspected prior to use and routinely for external defects or indications of possible internal damage
- Used in continuous length without splice or tap
- Free from frays or damage such as deformed or missing pins or insulation damage
- Suspended by non-conductive means
- Not be “daisy-chained”
- Not be used in excess of 50 feet for 14 AWG cords or 100 feet for 12 AWG cords
- Not be run through doorways, windows or similar pinch points unless protected from damage
- Job made flexible cords and assemblies are prohibited
- Flexible cords used in highly conductive locations such as those with water, must be approved for use in such locations

When possible, flexible cord sets shall be suspended appropriately overhead to avoid tripping hazards and damage caused by foot traffic and equipment.

Damaged or defective flexible cords shall not be used until repaired and shall only be repaired by a qualified person and shall be returned to the “approved state” or the state in which the cord was approved. Only flexible cords of 12 AWG or greater may be repaired in accordance with 29 CFR 1926.405(g) (2) (iii).

### 4.3.3 Ground fault circuit interrupter (GFCI)

GFCI protection shall be provided on all circuits serving portable electric hand tools or semi-portable electric power tools (such as block/brick saws, table saws, air compressors, welding machines, and drill presses).

Receptacle outlets that are part of the permanent wiring of the building or structure and are used for temporary electric power, (including portable generators) shall use a portable GFCI if the receptacle outlets are not already GFCI protected. The portable GFCI shall be as near as practicable to the receptacle outlet.

Subcontractors and lower tier contractors shall provide and use GFCIs on all 120-volt (15, 20 or 30 amperage) circuits as specified below:

- Damp or wet (standing water) work areas outdoors
- Temporary power (e.g., extension cords) during construction, remodeling, maintenance, repair, or similar activities
- When using portable, electric hand tools and equipment with cord/plug connectors.

The users of the GFCIs shall test portable GFCIs using the test button provided before each use. If the GFCI breaker fails the test, tag out of service with a “DANGER — DO NOT OPERATE” tag in accordance with HSEQ Manual Section 15 paragraph 4.5.5 and removed from service. Tripped circuit breakers may not be re-energized until it has been determined that the equipment and circuit can be safely re-energized.

## 4.4 Hazardous energy control

All equipment and circuits to be worked on shall be de-energized before work begins unless approved by an Energized Electrical Work Permit in accordance with HSEQ Manual Section 13. Personnel shall be protected by a Hazardous Energy Control Program (HECP) and procedures (i.e. lockout/tagout, blanking, positive means of blocking, grounding, etc.). Positive means shall be provided for rendering controls or devices inoperative while repairs or adjustments are being made to the equipment they control.

For additional specific information on the control of hazardous electrical energy see HSEQ Manual Section 13- Hazardous Energy Control.

## 4.5 Energized parts

Energized parts operating at greater than 50 volts shall be guarded or covered to protect all persons or objects from harm, injury, or death. Electric equipment and lines shall be considered energized until determined to be de-energized by tests, verification, or other means.

The work practices used by subcontractors and lower tier contractor shall be sufficient to prevent electric shock or other injuries that could result from either direct or indirect electrical contact. These work practices must be used when work is performed near or on equipment or circuits that are or may be energized. The work practices used must be consistent with the nature and extent of the electrical hazard.

High voltage equipment (i.e., switchyards, transformers, etc.) shall be protected from unauthorized access by the installation of protective barriers in accordance with HSEQ Manual Section 15- Protective Barriers, Warning Signs and Tags. Switchboxes, receptacle boxes and metal cabinets shall always be covered or protected while energized. Missing knock-outs or panel fillers shall be replaced immediately. Equipment with missing knock-outs or panel fillers shall be considered an exposed and unprotected circuit.

## 4.6 Portable and temporary lighting

### 4.6.1 Portable lamps

The following are the requirements for portable hand lamps:

- Be protected from accidental contact or damage
- Molded composition (metal shell or paper lined shall not be used)
- Equipped with a handle
- Equipped with a substantial guard over the bulb

### 4.6.2 Temporary lighting

The following are the requirements for temporary lighting:

- Bulbs attached to temporary lighting strings and extension cords shall be protected by guards
- Unless designed for suspension, temporary lights shall not be suspended by their electric wire
- Exposed empty light sockets and broken bulbs shall be replaced immediately
- Portable electric lighting used in wet and/or other conductive locations (e.g., drums, tanks, vessels, sumps, scroll cases, etc.) shall be rated and operated at 12 volts or less
- Temporary lighting circuits shall be separate and protected to prevent the use electric tools, remain as a stand-alone circuit, and be labeled in the panel.
- Temporary lighting shall not be suspended by, or in contact with, conductive materials.
- As with all electrical equipment, temporary lights must be approved by a Nationally Recognized Testing Laboratory (NRTL).

# 5 Power transmission and distribution

When work is to be performed on or near overhead lines, the lines must be de-energized and grounded whenever possible. The hazards most directly related to power transmission and distribution lines and facilities occur as a result of electrocution from direct contact with high-voltage electricity or from contact with tools, vehicles, ladders, or other devices that are in contact with high-voltage electricity.

Power transmission and distribution work applies to, but is not limited to the following:

- The erection of new electrical lines and associated equipment
- The alteration, conversion and improvement of existing power lines and associated equipment
- Related activities such as line-clearance tree trimming

HSEQ hazards specific to electric power transmission and distribution projects primarily include:

- Energized power lines
- Worker(s) at heights
- Electric and magnetic fields

Specific procedures for transmission and distribution construction work include:

- Job/work briefings for high voltage activities to ensure the safety of personnel
- Establishing specific protocols for emergency situations
- Availability of appropriate PPE, tools, and equipment
- Standby personnel trained in CPR and first aid
- Notification of personnel potentially affected by the work
- De-energizing and grounding (when feasible)
- Isolation of back feed and alternate power sources

## 5.1 Energized power lines

Subcontractors and lower tier contractors may be exposed to hazards from contact with energized power lines during construction, maintenance, and operational activities.

If it is not possible to de-energize and ground overhead lines, then other protective measures, such as guarding, isolating, or insulating, must be taken before the work is started. These protective measures must prevent direct contact by the qualified person or indirect contact through conductive materials, tools, or equipment. Only qualified persons are allowed to install insulating devices on overhead power transmission and distribution lines.

All other persons, and any conductive object used by workers, may not approach closer than the minimum distances shown below:

| **Approach Distances for Qualified Persons Exposed to Alternating Current** | |
|---|---|
| **Voltage Range (Phase to Phase)** | **Minimum Approach Distance** |
| 300 V and Less | Avoid Contact |
| Over 300 V up to 750 kV | 1 ft. 0 in. |
| Over 750 kV up to 2 kV | 1 ft. 6 in. |
| Over 2 kV up to 15 kV | 2 ft. 0 in. |
| Over 15 kV up to 37 kV | 3 ft. 0 in. |
| Over 37 kV up to 87.5 kV | 3 ft. 6 in. |
| Over 87.5 kV up to 121 kV | 4 ft. 0 in. |
| Over 121 kV up to 140 kV | 4 ft. 6 in. |

Specific hazard prevention and control measures with energized power lines (live line) include:

- De-energizing and properly grounding all energized transmission and distribution lines prior to initiating
- Only permitting trained and qualified workers demolish, install, maintain, or repair electrical equipment
- Unless de-energized and grounded, a minimum of two workers shall always be required for all power transmission and distribution work
- Ensuring that live line work is conducted by specially trained and qualified workers who understand the specific hazards associated with live line work. A qualified worker for live line work should be able to:
    - Distinguish live parts from other parts of the electrical system
    - Determine the voltage of live parts
    - Understand the minimum approach distances outlined for specific line voltages
    - Ensure the use of specialized PPE and procedures when working near or on exposed energized parts
- Workers shall not approach an exposed energized part (even when properly trained) unless:
    - There are adequate barriers, PPE or insulation protecting from contact
    - The energized part is insulated or protected from all workers
    - The worker is properly isolated and insulated from any conductive object (live wire work)

- When construction maintenance and operation is required within the minimum set back distances, specific training, safety precautions, PPE and rated tools and equipment shall be defined in an AHA and/or site-specific safety plan.
- A daily inspection of all tools and equipment shall be completed prior to use according to the manufacturer

## 5.2 Working at heights

Subcontractors and lower tier contractors may be exposed to fall hazards when performing work on transmission and distribution lines and associated activities. All work at heights shall comply with HSEQ Manual Section 20- Fall Protection when working at heights. See Section 20 for additional details.
A minimum clearance of 10 feet must be maintained between energized overhead lines and all vehicles or mechanical equipment capable of having parts or its structure elevated (e.g. mobile scaffolds, elevating platforms, dump trucks, lift trucks, and flatbed trailer cranes). If the voltage of the overhead line is greater than 50 kV, the clearance must be increased by 4 inches for every 10 kV over 50 kV. Cranes shall maintain a clearance of at least 20 feet, unless otherwise approved, in accordance with HSEQ Manual Section 23 Material Handling Equipment and Operations.

## 5.3 Manholes and vaults

Centennial employees or subcontractors shall not enter spaces containing exposed energized parts unless there is sufficient illumination for them to perform the work safely. Employees and workers shall not perform tasks near exposed energized parts where there is insufficient illumination or an obstruction that blocks his or her view of the work to be performed. Performing work or conducting site evaluation in manholes, vaults or similar confined or enclosed spaces that contain exposed energized parts must be provided with, and must use, protective shields, protective barriers, or insulating materials as needed to prevent inadvertent contact with these energized parts.

Employees and subcontractors may also be exposed to atmospheric hazards when entering a manhole or vault. Entrance into a manhole or vault will comply with HSEQ Manual Section 21- Confined Space Entry. See Section 21 for additional details.

## 5.4 Electric and magnetic fields

Electric transmission and distribution workers typically have a higher exposure to EMF than the general public due to working in proximity to electric power lines.

Occupational EMF exposure should be prevented or minimized through the:

- Identification of potential exposure levels in the workplace, including surveys of exposure levels in new projects and the use of personal EMF monitors during activities where exposure could potentially exceed the PEL
- Training of all exposed workers in the identification of hazardous EMF
- Delineation of work areas with expected elevated levels of EMF and limiting access to only trained workers

# 6 Electrical LOTO, ZVV and energized electrical work

Centennial has developed a formal procedure for assisting subcontractors so that LOTO/ZVV and energized electrical work are completed in a safety and compliant manner. The following plans and resources for subcontractors are included as appendices to this procedure:

- LOTO/ZVV 50-600 Volt Template Plan (Appendix 1)
- Energized Electrical Work Permit Flow Chart (Appendix 2)
- Energized Work Job Planning/Briefing Checklist (Appendix 3)
- Energized Electrical Work Permit (Appendix 4)

If a specific scenario arises that is not covered under the above plans and resources then a project/task specific safety plan will be developed and submitted by the subcontractor for Centennial approval before work may begin or continue. The approval process for non-standard project/task specific safety plans will be in accordance with section 5.2.2 of this procedure.

## 6.1 Required training specific to electrical LOTO, ZVV, energized work

Personnel who will perform or who may be exposed to potentially hazardous electrical energy shall be trained in the procedures and understand the applicable provisions for the control of hazardous electrical energy in accordance with the current version of the NFPA70E. Training may be conducted in a classroom setting, field setting or a combination of the two. All training records demonstrating worker proficiency in electrical work procedures will be maintained by the respective subcontractor and maintained in the project safety binder located on the project site. Retraining shall be provided for all qualified, authorized, and affected employees at least every three years and whenever there is a change in his or her job assignment, equipment and/or processes that present new or increased hazards, or when there is a change in the energy control procedure.

The training shall cover, at a minimum, the following elements:

- Specific hazards associated with exposure to electrical energy
- Safety related work practices and procedural requirements for LOTO, ZVV and/or energized electrical work
- Relevant or specific equipment or system requirements for the control of hazardous energy
- Potential additional or residual sources of hazardous energy
- Relationship between electrical hazards and possible injury
    - Personnel exposed to potential shock hazards shall be trained in the methods of release of victims from energized electrical conductors or circuit parts
- Emergency response procedures
    - Cardio-pulmonary resuscitation, first aid and AED training will be certified annually by the subcontractor or a third-party provider

## 6.2 Energized electrical work process

Centennial and subcontractors will ensure that all efforts are exhausted to accomplish electrical work in an electrically safe work condition due to the increased risk and potential for injury that energized electrical work encompasses. Electrical work includes electrical repair but not diagnostic testing. Electrical diagnostic testing does not require an energized electrical work

permit: however, all other safety precautions, training, and PPE requirements in accordance with the current version of the NFPA70E apply to the diagnostic testing process.

Centennial will **only** authorize energized electrical work if one or more of the following conditions are satisfactorily met:

- Greater hazard: energized work shall be permitted where the subcontractor can demonstrate that de-energizing introduces additional or increased hazards
    - Examples include life support equipment, deactivation of emergency alarm systems or shut down of hazardous location ventilation equipment
- Infeasibility: energized work shall be permitted where the subcontractor can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.
    - Examples include performing diagnostics and testing, start up or troubleshooting
- Less than 50 volts: energized electrical conductors and circuit parts that operate at less than 50 volts to ground shall not be required to be de-energized where the capacity of the source and any over current protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burn or to explosion due to electrical arcs
- Client written direction: energized work may be permitted in scenarios where the client has indicated that the work may not be completed in a de-energized state. Written justification from the client's management must accompany the completed permit and become part of the project record

### 6.2.1 Energized electrical work permit

An Energized Electrical Work Permit will be completed and submitted by the subcontractor's qualified person with the following items addressed satisfactorily:

- The description of the circuit to be worked in an energized state shall be detailed and include a sketch or drawing showing all potential sources of hazardous energy and anticipated voltages
- Approval of energized work will meet the justifications permitted by the current version of the NFPA70E as shown above in section 5.2
- The description of safe work practices must be outlined according to the current version of the NFPA70E to include boundaries, appropriately rated PPE, and the means to restrict access to unqualified persons
- An arc flash incident energy analysis will be performed, or the PPE category will be determined in accordance with the current version of the NFPA70E
- The subcontractor will submit evidence of an effective electrical safety program meeting the minimum requirements of the current version of the NFPA70E
- All potential sources of energy shall be identified and recorded on the Energized Electrical Work Permit

### 6.2.2 Energized electrical work permit approval process

Required approval for energized electrical work includes the following:

- SSR/PGM
- PSM
- HSEQ Director

- Customer or facility manager
- Subcontractor management

# 7 Training

Each subcontractor and lower tier contractor performing electrical work shall be trained on the requirements of the current version of the NFPA70E to include (but not limited to):

- Specific hazards of the job and/or task
- Electrical hazard recognition
- Effects of electricity on the body
- Skills to release from electric shock
- Skills and techniques required to distinguish exposed electrical parts
- Selection and use of PPE
- Work procedures with additional or special precautions
- Energy source control
- Cardio-pulmonary resuscitation and first aid
- Safe Release methods

# 8 Amendment history

| Date | Version | Revised content |
|---|---|---|
| 04.24.2015 | 1.0 | Initial Preparation |
| 01.01.2018 | 2.0 | Updates to Paragraph 2 Superior Documents to add the Group Policy and Global Standards, Paragraph 3 Definitions (Centennial and HSEQ Director) and Paragraph 4.1 Qualified Person (new language) |
| 07.01.2019 | 2.1 | Updates to Paragraph 4.3.2 Flexible Cords and Cables and Paragraph 6 Training |
| 10.01.2019 | 2.2 | Introduction of Paragraph 6 Electrical LOTO, ZVV and Energized Electrical Work and introduction of Appendices 1-4 |
| 04.01.2021 | 2.3 | Updates to Paragraph 2 Superior Documents and the addition of “the current version of the NFPA70E” throughout |
| 11.01.2021 | 2.4 | Updates to Paragraph 4.6.2 Temporary Lighting (suspension and NRTL approved), Paragraph 6.2 Energized Electrical Work Process (de-energized) and Appendix 1 (revised the form requirements) |
| 01.02.2026 | 2.5 | Updates to Appendix 1 to reflect required signatures from updated Safety Plan Signature Matrix |
| 10.27.2026 | 2.6 | Updates to Appendix 1 to require a diagram or sketch of work to be performed. |

# 9 Appendix

Appendix 1: 50-600 Volt LOTO/ZVV Plan (0206500_CP_11_31_en_A1.3)

Appendix 2: Energized Electrical Work Permit Flow Chart (0206500_CP_11_31_en_A2)

Appendix 3: Energized Work Job Planning/Briefing Checklist (0206500_CP_11_31_en_A3)

Appendix 4: Energized Electrical Work Permit (0206500_CP_11_31_en_A4)

# LOCKOUT/TAGOUT AND ZERO VOLTAGE VERIFICATION (50-600V)

0206500_CP_11_31_en_A1.3

CENTENNIAL
A BILFINGER COMPANY

**Purpose**:
This plan is intended to provide necessary information for effective site implementation of Safety Policies that apply to specific site conditions. This plan will be completed prior to starting any work on projects that involve exposed energized parts or Lock Out/Tag Out (LOTO).

**Instructions**:
1) This plan is intended to be used by an electrically qualified person and operating in conditions between 50 and 600 volts. If project is outside of this voltage range, then you will need to contact your HSEQ Safety Manager for assistance.
2) Page 1 is general site information, personnel qualifications, basic emergency procedures and LOTO statement.
3) Page 2 contains steps for LOTO and PPE requirements for Zero Voltage Verification on exposed parts for 50-240V and >240-600V.
4) Page 3 defines equipment to be used, communication with other trades, approach boundaries for qualified and unqualified personnel, additional training required and plan review/approval. The approach boundaries include the limited approach, restricted approach and arc flash protection boundaries for AC and DC voltage systems.
5) After LOTO and ZVV have been accomplished and verified, Centennial/JV personnel are now authorized to use a rated voltage test instrument on unprotected parts to re-verify the absence of current. If the presence of voltage is found during this re-verification process, all unqualified personnel will be removed from the exposed area until an electrically qualified person de-energizes and verifies the circuit(s).

**General Site Information**:

Company Name:_____ Project Start Date:_____

Point of Contact:_____ Phone#:_____

Lower Tier Subcontractor (if applicable):_____

Centennial/JV Project Name:_____

Project Description:_____

Qualified Electrician (print name):_____ *(Attach credentials to this plan)*

**Emergency Response Training**:
**(1) Contact Release.** Employees exposed to shock hazards and those responsible for the safe release of victims from contract with energized electrical conductors or circuit parts shall be trained in methods of safe release. Refresher training shall occur annually.

**(2) First Aid, Emergency Response and Resuscitation.**
(a) Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures.
(b) Employees responsible for responding to medical emergencies shall be trained in cardiopulmonary resuscitation (CPR).
(c) Employees responsible for responding to medical emergencies shall be trained in the use of an automated external defibrillator (AED) if an employer's emergency response plan includes the use of this device.
(d) Training shall occur at a frequency that satisfies the requirements of the certifying body.
Informational Note: Employees responsible for responding to medical emergencies might not be first responders or medical professionals. Such employees could be a second person, a safety watch or a crafts person.

**(3) Training Verifications.** Employers shall verify at least annually that employee training required by 110.6(B) is current.

**(4) Documentation.** The employer shall document that the training required by 110.6(B) has occurred.

**Lock Out & Tag Out (LOTO)**:

**Normal Operating Condition.** Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operation condition exists when all of the following conditions are satisfied:

(1) The equipment is properly installed.
(2) The equipment is properly maintained.
(3) The equipment is used in accordance with instructions included in the listing and labeling and in accordance with the manufacturer's instructions.
(4) The equipment doors are closed and secured.
(5) All equipment covers are in place and secured.
(6) There is no evidence of impending failure.

Informational Note: the phrase *properly installed* means that the equipment is instilled in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained* means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure* means that there is evidence such as arcing overheating, loose and bound equipment parts, visible damage or deterioration.

LOTO Steps:

1) Determine all sources of electrical supply to the specific equipment.
2) After properly interrupting the load current, open the disconnecting device(s) for each source.
3) Visually verify that all blades of the disconnecting devices are fully open or that draw-out type circuit breakers are withdrawn to the fully disconnected position.
4) Apply LOTO devices
5) Use an adequately rated voltage detector to test each phase conductor or circuit part to verify that they are de-energized. If verifying from an energized unprotected part, 50 v or greater, you will need to be in PPE for Hazard/Risk Category 1, please see following procedures on Zero Voltage Verification (ZVV).
6) Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them.

**Zero Voltage Verification (ZVV):**

Hazard/Risk Category 1 (*240V and below*) [NFPA 70E - Table 130.7 (C)(15)(a)]
This process is designed for 240V, and below, for voltage testing on exposed parts. While zero voltage verification is being performed, the qualified person will communicate the hazards of potentially energized parts. Signs and barricades will be required. At no time will an unqualified person be allowed to enter the Limited Approach Boundary.

PPE Requirements of the NFPA 70-E Table 130.7(C)(15)(c)
(1) Arc-rated clothing (min arc rating of 4 CAL/cm$^2$)
(2) Arc-rated face shield or arc-flash suit hood (min arc rating of 4)
(3) ANSI Z87.1 Safety glasses or goggles
(4) Hearing Protection (ear canal inserts)
(5) Leather gloves (ASTM F 696) over rubber insulating gloves (ASTM D120)
(6) Hard hat (electrically rated)
(7) Leather footwear

Hazard/Risk Category 2 (*>240V to 600V*) [NFPA 70E - Table 130.7(C)(15)(a)]
This process is designed for >240V to 600V, for voltage testing of exposed parts. While zero voltage verification is being performed, the qualified person will communicate the hazards of potentially energized parts. Signs and barricades will be required. At no time will an unqualified person be allowed to enter the Limited Approach Boundary.

PPE Requirements of the NFPA 70-E Table 130.7(C)(15)(c)
(1) Arc-rated clothing (min arc rating of 8 CAL/cm$^2$)
(2) Arc-rated flash suit hood or Face shield (arc rating of 8) and balaclava (sock hood, arc rating of 8)
(3) ANSI Z87.1 Safety glasses or safety goggles if face shield is utilized.
(4) Hearing protection (ear canal inserts)
(5) Leather gloves (ASTM F 696) over rubber insulating gloves (ASTM D120)
(6) Hard hat (electrically rated)
(7) Leather footwear

*Note: Arc rated protective clothing shall be non-melting or untreated natural fiber (i.e., untreated cotton, wool, rayon, silk, or blends of these materials) with a fabric weight of at least 4.5 oz. per square yard.*

**Equipment Used for Testing**:
Test equipment must be selected based on the intended use and expected voltage or current rating. Leads and probes must be rated at least as much as the instrument.

Make/Model:_____ Voltage Rating:_____

*Note: Verify the test instruments operation before and after zero voltage verification.*

**Communication With Other Trades**:
Once an electrically safe work condition is achieved and verified, the electrical subcontractor will place a de-energized tag on all exposed de-energized circuits or a sign designating the room/area is in an electrically safe working condition. This will allow un-qualified workers to perform work around circuits that have been placed in an electrically safe condition.

**Approach Boundaries:**

| Limited Approach Boundary (Determined by NFPA70E Table 130.4(E)(a) or 130.4 (E)(b)) | | Restricted Approach Boundary | Arc Flash Protection Boundary (Determined by NFPA70E Table 130.7(C)(15)(a) or 130.7(C)(15)(b)) |
|---|---|---|---|
| Exposed Moveable Conductor - 10'0" | Exposed Fixed Conductor - 3'6" | 1'0" | 4'0" |

**Additional Required Training**:
Employees will be trained to understand the specific hazards associated with electrical energy and the relationship between electrical hazards and possible injury. Employees must have received specific training on:

- What electrical hazards are presented by the specific job
- How electrical hazards affect body tissues
- How to avoid exposure to hazards
- How to minimize risk by body positioning
- What PPE is needed for the employee to perform his or her work assignment
- How to select and inspect PPE
- What employer-provided procedures, including specific work practices, the employee must implement
- How increased duration of exposure increases the opportunity of injury
- How to perform a hazard/risk analysis
- How to determine limited, restricted, and prohibited approach boundaries

Affected Panel: _____

Breakers to be locked out: _____

Provide wire diagram or sketch of work to be performed:

**Initials:**_____

**Plan Approval**:

Qualified Electrician (sign):_____ Date:_____

**Review**

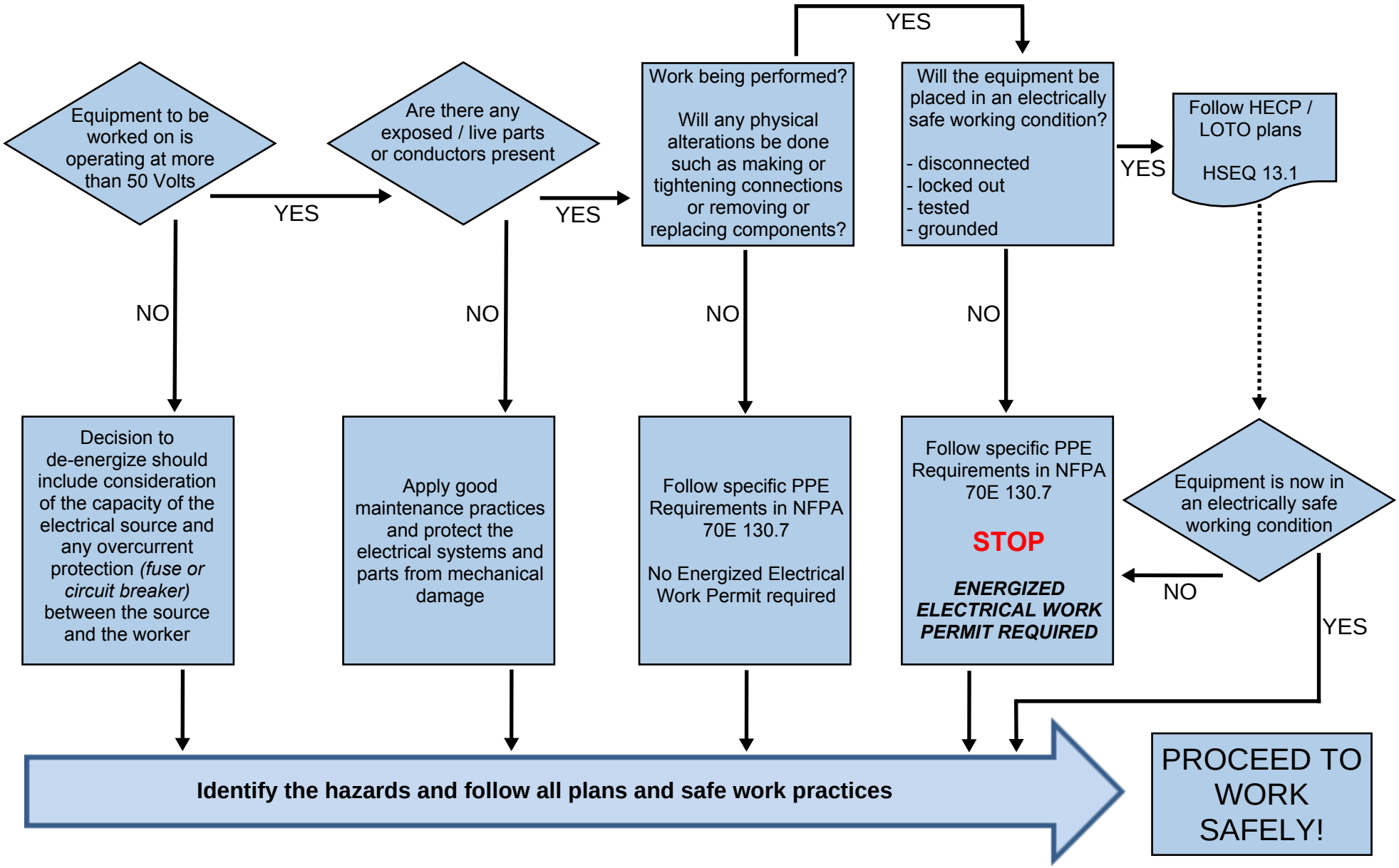
Competent Person(sign):_____ Date:_____

Centennial Rep (sign):_____ Date:_____

# Energized Electrical Work Permit Flow Chart

0206500_CP_11_31_en_A2

CENTENNIAL
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**ENERGIZED WORK JOB**
**PLANNING/BRIEFING CHECKLIST**
0206500_CP_11_31_en_A3

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A BILFINGER COMPANY

## IDENTIFY:

- ☐ Hazards
- ☐ Voltage levels involved
- ☐ Skills required
- ☐ Any "foreign" (secondary source) voltage source
- ☐ Any unusual work conditions
- ☐ Number of people to do the job/task
- ☐ Shock protection boundaries
- ☐ Available incident energy
- ☐ Potential for arc flash (conduct an arc flash risk assessment)
- ☐ Arc flash boundary
- ☐ Any evidence of impending failure?

## ASK:

- ☐ Can the equipment be de-Energized?
- ☐ Are back feeds of the circuits to be worked on possible?
- ☐ Are standby personnel required?
- ☐ Are unqualified workers required for any part of the task?
- ☐ Will the workers be exposed to any other hazards while executing the task?
- ☐ Does a co-Occupancy hazard exist with other contractors/personnel?
- ☐ Is the equipment properly installed and maintained?

## CHECK:

- ☐ Job plans, AHA
- ☐ Single-line diagrams and vendor prints
- ☐ Information on diagrams and prints is accurate
- ☐ Safety procedures
- ☐ Individuals are familiar with the task/process
- ☐ Each affected employee has received safety training within the last three years
- ☐ Vendor Information

## KNOW:

- ☐ What the job is
- ☐ Who else needs to know? (Communication)
- ☐ Who is qualified to perform/supervise the activities?

## THINK:

- ☐ About the unexpected event…what if?
- ☐ Using the right tools, equipment and PPE
- ☐ Install boundaries/warning signs
- ☐ Lock - Tag - Test - Try
- ☐ Test for Voltage - First
- ☐ What else...?

## PREPARE FOR AN EMERGENCY:

- ☐ Are standby personnel current in CPR/FA/AED?
- ☐ Is the required emergency equipment immediately available? Where is it?
- ☐ How will personnel communicate in the event of an emergency? Where are the numbers?
- ☐ What facility alarm or other alarm systems are available? Where are they?
- ☐ How is equipment shut off in the case of an emergency?
- ☐ Are fire extinguishers and an AED immediately available? Where are they?
- ☐ What other emergency equipment may be required?

Electrically Qualified Person (written): _____

(signature): _____ Date: _____

Standby Personnel (written): _____

(signature): _____ Date: _____

**Energized Electrical Work Permit**
0206500_CP_11_31_en_A4

CENTENNIAL
A BILFINGER COMPANY

## I. General Information

Location / work area:_____ Project start date:_____

Start time:_____ am pm Project duration (days or hours):_____

Date of request:_____

Description of circuit/equipment (include a sketch or diagram):

Scope of work:

Requester name/title:_____ / _____

## II. Justification For Energized Work

Justification for energized work request (choose all that apply):

☐ Infeasible ☐ Greater Hazard ☐ <50 Volts ☐ Client Written Direction

Detailed analysis on why the circuit/equipment can NOT be de-energized:

Name of person completing the justification analysis: _____

## III. Shock Hazard Analysis

Nominal voltage:_____(volts) Maximum voltage:_____(volts)

Approach Boundaries (indicate feet & inches, example **3'6"**)

Limited approach:_____ Restricted approach: Wire Diagram Prohibited approach: Initials:_____

## IV. Flash Hazard Analysis

Arc flash boundary (indicate feet & inches, example **3'6"**):_____ Hazard/risk category (0-4):_____

## V. Personal Protective Equipment

Choose all that apply:

☐ Hardhat ☐ Safety glasses ☐ Arc rated face shield ☐ Arc rated clothing

☐ Balaclava ☐ Leather work boots ☐ Rubber insulated gloves ☐ Arc flash hood

☐ Leather gloves ☐ Hearing protection ☐ Other: _____

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## VI. Safe Work Practices

Choose all that apply (VR = Voltage Rated):

☐ Restrict Access ☐ Barricades ☐ Communication equipment ☐ Warning signs/tags

☐ Non-conductive ladders ☐ Insulated (VR) tools ☐ Insulated (VR) mat/blanket

☐ Voltage testing/measuring tools ☐ Other: _____

## VII. Pre-Job Requirements

Check all that apply:

☐ Review diagrams, work orders, manuals ☐ Inspect PPE, insulating materials, tools

☐ Notify affected personnel ☐ Test voltage (testing/measuring equipment)

☐ Conduct pre-job briefing ☐ Remove conductive apparel/jewelry

☐ Determine emergency response ☐ Verify personnel have been trained

☐ AHA completed/reviewed ☐ Centennial / JV job planning/briefing checklist

## VIII. Essential Personnel

Electrically Qualified Person: _____
(attached credentials [i.e. journeyman card or similar])

Standby personnel: _____ _____

CPR/FA trained person(s): _____ Date of training: _____

_____ Date of training: _____

## IX. Approval For Energized Work (signature required)

SSR / PGM: _____ Date: _____

HSEQ Team Representative: _____ Date: _____

Customer / Facility Manager: _____ Date: _____

Subcontractor Management: _____ Date: _____

Additional notes / space:

# Centennial Energized Electrical Work Permit Instructions

**PART I. GENERAL INFORMATION**

**DESCRIPTION OF CIRCUIT/EQUIPMENT/JOB LOCATION:**

The description of the circuit to be worked in an energized state shall be detailed and include a sketch or drawing showing all potential sources of hazardous energy and anticipated voltages.

**SCOPE OF WORK:**

Include all features of work and job steps involved that will potentially expose workers to energized parts.

**PART II. JUSTIFICATION FOR ENERGIZED WORK REQUEST**

**JUSTIFICATION OF WHY THE CIRCUIT/EQUIPMENT CANNOT BE DE-ENERGIZED OR THE WORK IS DEFERRED UNTIL THE NEXT SCHEDULED OUTAGE:**

Centennial and our joint ventures will ensure that all efforts are exhausted to accomplish electrical work in an electrically safe work condition due to the increased risk and potential for injury that energized electrical work encompasses. Centennial/JV will only authorize energized work if one or more of the following conditions are satisfactorily met:

**Greater Hazard**: Energized work shall be permitted where the subcontractor can demonstrate that de-energizing introduces additional or increased hazards. Examples include: life support equipment, deactivation of emergency alarm systems or shut down of hazardous location ventilation equipment.

**Infeasibility**: Energized work shall be permitted where the subcontractor can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations. Examples include: Performing diagnostics and testing, Start up or troubleshooting.

**Less than 50 Volts**: Energized electrical conductors and circuit parts that operate at less than 50 volts to ground shall not be required to be de-energized where the capacity of the source and any over current protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burn or to explosion due to electrical arcs.

**Client Written Direction:** Energized work shall be permitted in scenarios where the client has indicated that the work may not be completed in an energized state. Written justification from the client's management must accompany the completed permit.

Please indicate one of the above justifications from the drop down menu for completing this work/task in an energized state and provide a detailed analysis on why it is absolutely necessary to complete the work in an energized state in the corresponding box.

**PART III. SHOCK HAZARD ANALYSIS**

This section will indicate the approach distances (in feet) for both qualified and unqualified personnel for all shock protection boundaries (limited approach, restricted approach and prohibited approach) This information may be found in NFPA 70E Table 130.4 (D)(a) for alternating current systems and Table 130.4 (D)(b) for direct current voltage systems. These boundaries are based on voltage range, type and equipment and circuit parts.

**PART IV. INCIDENT ENERGY ANALYSIS**

An analysis will be conducted to determine the flash protection boundary and the hazard/risk category for the work or task. Where an arc flash protection boundary is not completed, for the purpose of this plan, a 4 foot default boundary will be used. For larger potential fault currents, a incident energy analysis will need to be performed to determine the arc flash protection boundary. Additionally, the hazard/risk category will be determined either through the completed incident energy analysis or alternatively by consulting NFPA 70E Table 130.7 (C)(15)(a) [AC Systems] or 130.7 (C)(15)(b) [DC Systems]. Please state the flash protection boundary and hazard/risk category.

**PART V. PERSONAL PROTECTIVE EQUIPMENT (PPE)**

The arc flash protection boundary is intended to trigger the need for PPE that will protect the worker(s) from thermal injuries. The required PPE used for entering the flash protection boundary may be determined by consulting the incident engery analysis, referencing NFPA 70E Table 130.5 (G) or by consulting the NFPA 70E Table 130.7 (C)(15)(a) for AC Systems and Table 130.7 (C)(15)(b) for DC Systems. Please use this section of the permit to indicate all PPE that will be required for the job/task.

**PART VI. SAFE WORK PRACTICES**

The limited approach boundary is the closest distance that an unqualified person may approach energized parts. Please use this section to indicate what methods will be used to ensure that unqualified workers access will be restricted as well as what specific measures an electrically qualified person will use to ensure their safety while working within the limited approach boundary.

**PART VII. PRE-JOB REQUIREMENTS**

This section will include a meeting of all affected personnel where site specific conditions are discussed and tools/equipment will be inspected prior to work. The Centennial/JV Energized Work Job Planning/Briefing Checklist will be reviewed and site specific emergency response will be coordinated.

**PART VIII. ESSENTIAL PERSONNEL**

This section is used to identify job/task essential personnel. The electrically qualified person will be identified and proof of their qualification will accompany the completed energized electrical work permit. Standby personnel will also be identified in this block along with CPR/FA training with dates.

**PART IX. APPROVAL FOR ENERGIZED WORK**

This section includes all parties responsible for approving the Energized Electrical Work Permit prior to performing the work. Required approval includes:
1) The Centennial/JV Senior Site Representative (SSR)
2) An HSEQ Team Representative
3) The customer or facility manager
4) A member of the subcontractor management team that will be performing the energized work.