

Electrical

Short description

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

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Content

1	Objective and area of application.....	3
2	Superior and additional applicable documents.....	3
3	Definitions.....	3
4	General electrical requirements.....	5
4.1	Qualified person.....	5
4.2	Electrical PPE.....	6
4.3	Temporary wiring.....	6
4.3.1	Tools and equipment.....	6
4.3.2	Flexible cords and cables.....	7
4.3.3	Ground fault circuit interrupter (GFCI).....	7
4.4	Hazardous energy control.....	8
4.5	Energized parts.....	8
4.6	Portable and temporary lighting.....	8
4.6.1	Portable lamps.....	8
4.6.2	Temporary lighting.....	8
5	Power transmission and distribution.....	9
5.1	Energized power lines.....	9
5.2	Working at heights.....	10
5.3	Manholes and vaults.....	11
5.4	Electric and magnetic fields.....	11
6	Training.....	11
7	Amendment history.....	12
8	Appendix.....	12

1 Objective and area of application

During the course of 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_5.0 Global Policy on Health, Safety, Environment/Sustainability and Quality (HSEQ)

29 CFR 1926

29 CFR 1910

NFPA 70E

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

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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 <i>qualified person</i> 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

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 requirements of NFPA 70E, 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. This may include specialized training, observing required approach distances, and the use of appropriate personal protective equipment (PPE) consistent with the requirements of NFPA 70E.

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 that should be accomplished is as follows:

- 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 considered to 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 used. Specific requirements are outlined in the NFPA 70E 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
- Adequately sized conductors for load
- Used in continuous length without splice or tap
- Free from frays or damage
- Suspended by non-conductive means
- 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.

Flexible cords 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 is started 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 be covered or protected at all times 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 from electric tool and equipment circuits

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 be required at all times 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 Training

Each subcontractor and lower tier contractor performing electrical work shall be trained in the following minimum procedures:

- 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
 - Minimum of two personnel
 - All new workers within three months of hire (transmission and distribution)

7 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)

8 Appendix

There are no appendices to this section.