k. Thermite Welding. (10-8.k)

(1) Thoroughly dry the mold for a thermite weld and install an acceptable cover recommended by the manufacturer before the charge is ignited to prevent spray back during the thermite welding reaction.

(2) Storage of Thermite Welding Supplies.

(a) Store bulk thermite welding materials in a detached shed or building at least 50 feet (15.2 m) from the welding area.

(b) Maintain bulk storage areas for thermite welding materials dry and locked.

(c) Tightly close storage containers for the starting material immediately after each use.

(3) Do not remove thermite welding molds until sufficient cooling has taken place, as stated in the manufacturer's operating instructions.

(4) Do not smoke in areas where thermite welding material is being used or stored.

10-9. Figures and Tables.
Not Applicable.

10-10. Checklists and Forms.
Not Applicable.

Chapter 11
Electrical

11-1. References.

a. ANSI/American Society of Safety Engineers (ASSE) Z490.1, Criteria for Accepted Practices in Safety, Health and Environmental Training (https://webstore.ansi.org) (11-1.a)

b. ANSI/NEMA C84.1, Electrical Power Systems and Equipment - Voltage Ratings (60 hertz (Hz)) (2020) (https://webstore.ansi.org/) (11-1.b)

c. ASTM F855, Standard Specifications for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment (2020) (https://www.astm.org/products-services/standards-and-publications.html) (11-1.c)

d. ASTM F2249, Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energized Electric Power Lines and Equipment (2020) (https://www.astm.org/products-services/standards-and-publications.html) (11-1.d)

e. British Standards Institution (BSI) British Standard (BS) 7671, Requirements for Electrical Installations (2018) (https://www.bsigroup.com/en-US/Standards/) (11-1.e)

f. IEEE 80, Guide for Safety in AC Substation Grounding (2013) (https://standards.ieee.org/access-standards/) (11-1.f)

g. IEEE 837, Qualifying Permanent Connections Used in Substation Grounding (2014) (https://standards.ieee.org/access-standards/) (11-1.g)

h. IEEE 1048, Guide for Protective Grounding of Power Lines (2016) (https://standards.ieee.org/access-standards/) (11-1.h)

i. IEEE 1246, Guide for Temporary Protective Grounding Systems Used in Substations (2011) (https://standards.ieee.org/access-standards/) (11-1.i)

j. IEEE C2, National Electrical Safety Code (NESC) (2017) (https://standards.ieee.org/access-standards/) (11-1.j)

k. NFPA 70, National Electrical Code (NEC) (2020) (https://www.nfpa.org/Codes-and-Standards) (11-1.k)

l. NFPA 70B, Recommended Practice for Electrical Equipment Maintenance (2020) (https://www.nfpa.org/Codes-and-Standards) (11-1.l)

m. NFPA 70E, Standard for Electrical Safety in the Workplace (2021) (https://www.nfpa.org/Codes-and-Standards) (11-1.m)

n. NFPA 855, Standard for the Installation of Stationary Energy Storage Systems (2020) (https://www.nfpa.org/Codes-and-Standards) (11-1.n)

o. UFC 3-560-01, Operation and Maintenance: Electrical Safety (Change 2- 2019) (https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc) (11-1.o)

p. UL 1248, Standard for Engine-Generator Assemblies for Use in Recreational Vehicles (https://standardscatalog.ul.com/Catalog.aspx) (11-1.p)

q. UL 467, Grounding and Bonding Equipment (2013) (https://standardscatalog.ul.com/Catalog.aspx) (11-1.q)

r. UL 508A, Training on Industrial Control Panels (https://standardscatalog.ul.com/Catalog.aspx) (11-1.r)

s. UL 943, Ground-Fault Circuit-Interrupters (2016) (https://standardscatalog.ul.com/Catalog.aspx) (11-1.s)

t. UL 943C, Special Purpose Ground-Fault Circuit-Interrupters (2012) (https://standardscatalog.ul.com/Catalog.aspx) (11-1.t)

u. UL 2201, Standard for Carbon Monoxide (CO) Emission Rate of Portable Generators (https://standardscatalog.ul.com/Catalog.aspx) (11-1.u)

v. 29 CFR 1910, Occupational Safety and Health Standards (https://www.osha.gov/laws-regs/regulfations/standardnumber/1910) (11-1.v)

w. 29 CFR 1910.137, Personal Protective Equipment (https://www.govinfo.gov/app/details/CFR-2020-title29-vol5/CFR-2020-title29-vol5-sec1910- 137) (11-1.w)

x. 29 CFR 1910.268, Telecommunications (https://www.govinfo.gov/content/pkg/CFR- 2019-title29-vol5/pdf/CFR-2019-title29-vol5-sec1910-268.pdf) (11-1.x)

y. 29 CFR 1910.269, Electric Power Generation, Transmission, and Distribution (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol5/pdf/CFR-2020-title29-vol5-sec1910-269.pdf) (11-1.y)

z. 29 CFR 1910 Subpart S, Electrical (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol5/pdf/CFR-2020-title29-vol5-part1910-subpartS.pdf) (11-1.z)

aa. 29 CFR 1917.157, Battery Charging and Changing (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol7/pdf/CFR-2020-title29-vol7-sec1917-157.pdf) (11-1.aa)

bb. 29 CFR 1926, Safety and Health Regulations for Construction (https://www.osha.gov/laws-regs/regulations/standardnumber/1926) (11-1.bb)

cc. 29 CFR 1926.56, Illumination (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol8/pdf/CFR-2020-title29-vol8-sec1926-56.pdf) (11-1.cc)

dd. 29 CFR 1926.1408, Power Line Safety (Up to 350 kV) – Equipment Operations (https://www.govinfo.gov/content/pkg/CFR-2022-title29-vol8/pdf/CFR-2022-title29-vol8-sec1926-1408.pdf) (11-1.dd)

ee. 29 CFR 1926.1410, Power Line Safety (All Voltages) – Equipment Operations Closer Than the Table A Zone (https://www.govinfo.gov/content/pkg/CFR-2022-title29-vol8/pdf/CFR-2022-title29-vol8-sec1926-1410.pdf) (11-1.ee)

ff. 29 CFR 1926 Subpart K, Electrical (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol8/pdf/CFR-2020-title29-vol8-part1926-subpartK.pdf) (11-1.ff)

gg. 29 CFR 1926 Subpart V, Electrical Power Transmission and Distribution (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol8/pdf/CFR-2020-title29-vol8-part1926-subpartV.pdf) (11-1.gg)

11-2. Definitions.

a. Arc. A controlled electrical discharge between the electrode and the work piece that is formed and sustained by a gas that has been heated to such a temperature that it can conduct electric current. (11-2.a)

b. Arc Flash. Light and heat produced from an unintended electric arc fault with sufficient electrical energy to cause substantial damage or injury. An arc flash results from either a phase to ground or a phase-to-phase fault caused by such occurrences as accidental contact with electrical systems, buildup of conductive dust, corrosion, dropped tools, or improper work procedures. (11-2.b)

c. Arc Flash Boundary. When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur. (11-2.c)

d. Arc Flash Hazard. A dangerous condition associated with the possible release of energy caused by an electric arc. An arc flash hazard may exist when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard. (11-2.d)

e. Arc Rating. A value of the IE necessary to pass through any given material, or multiple layers of materials, to cause, with 50% probability, breakopen or onset of a second- degree skin burn injury. This value is measured in calories/cm². The necessary arc rating for an article of clothing is determined by performing an arc flash analysis or a risk assessment. Arc rating is reported as the lower value of either the ATPV or the energy of EBT. (11-2.e)

f. Authority Having Jurisdiction (AHJ). A government office, group, or individual designated in writing as responsible for enforcing the requirements of this chapter. (11-2.f)

g. Authorized Individual Hazardous Energy Control (HEC). Someone who meets the criteria for a QP as defined in this manual (see paras 1-2 or 2-2, as applicable), who is designated in writing to request, receive, implement, and remove hazardous energy isolation procedures. (11-2.g)

h. Barricade. A physical obstruction (for example, tape, screens, cones), intended to warn of and limit access to a hazardous area. (11-2.h)

i. Barrier. A physical obstruction that is intended to prevent contact with energized lines or equipment. (11-2.i)

j. Battery (Primary Lithium Metal). A single cell or multi-cell battery that contains lithium metal and is not designed to be recharged. Typically, they are metal encased in cylindrical, prismatic, or coin shaped cells. (11-2.j)

k. Battery (Secondary Lithium Metal). A single cell or multi-cell battery that contains lithium salt in a liquid or polymer-based electrolyte that is designed to be recharged and may or may not contain an integrated electrical controller. Typically, they are encased in cylindrical, prismatic, or polymer pouch soft cases. Laptop, cell phone, drone, cordless tool batteries all fall in this category. (11-2.k)

l. Bond. An electrical connection from one conductive element to another to minimize potential differences or providing suitable conductivity for fault current or for mitigation of leakage current and electrolytic action. (11-2.l)

m. Bonding. The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and capacity to safely conduct any current likely to be imposed. (11-2.m)

n. Bonding Jumper. A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. (11-2.n)

o. Bracket Grounding. A protective grounding method, typically used with electric power transmission and distribution activities, which involves installing grounds at two locations, one on each side of the work location, typically some distance apart and away from the work location. Bracket grounding application requires detailed engineering analysis and must be based on an evaluation of the potential hazards to the workers, work site conditions, type of construction, and the nature of the work to be done. (11-2.o)

p. Cable. A conductor with insulation, or a stranded conductor with or without insulation and other coverings (for example, single-conductor cable), or a combination of conductors insulated from one another (for example, multiple-conductor cable). (11-2.p)

q. Distribution Lines and Equipment. Electric lines and equipment with operating voltages from 4kilovolt (KV) to 46KV. (11-2.q)

r. Effectively Grounded. Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-

carrying capacity to prevent the buildup of voltages which may result in undue hazard to connected equipment or to people. (11-2.r)

s. Electrician Master/Journeyman. An industry term showing a level of competency and training that is required to safely perform electrical work according to national or state standards. (11-2.s)

t. Energized. Electrically connected to, or is, a source of voltage. (11-2.t)

u. Engineering Supervision. An industry term derived from NFPA 70 and NESC indicating oversight, approval, or stamped approval by a licensed professional electrical engineer and synonymously used with the following terms: engineering evaluation, engineering judgement, engineering analysis, qualified engineering study, and engineering supervision. (11-2.u)

v. Generator, Mobile. Mobile describes equipment, such as vehicle-mounted generators, that are capable of being moved on wheels or rollers. (11-2.v)

w. Generator, Portable. Portable describes equipment that is easily carried by personnel from one location to another. (11-2.w)

x. Ground. As a noun, the conductive body, usually earth, to which an electric potential is referenced or an incidental or accidental conductive connection between an electric circuit or equipment and a reference ground. As a verb, the connecting or establishing of an intentional or accidental connection between an electric circuit or equipment and a reference ground. (11-2.x)

y. Grounded. Connected to earth or to some conducting body that serves in place of the earth. (11-2.y)

z. Grounded Conductor. A system or circuit conductor that is intentionally grounded. (11-2.z)

aa. Grounded System. A system of conductors in which at least one conductor or point (usually the middle wire or neutral point of a transformer or generator windings) is intentionally grounded, either solidly or through a current limiting device (not a current-interrupting device). (11-2.aa)

bb. Ground-Fault Circuit-Interrupter (GFCI). A device used to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the over current protection device of the supply circuit. (11-2.bb)

cc. Grounding Conductor. A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes. (11-2.cc)

dd. Grounding Electrode (Ground Electrode). A conductor embedded in the earth, that is used to maintain conductors connected to it at ground potential and to dissipate current conducted to it into the earth. (11-2.dd)

ee. Induced Current. The generation of a current in a conductor caused by its proximity to a second alternating current (AC) source (for example, a moving direct current (DC) source, such as a motor, or an extraneous voltage source, such as lightning). (11-2.ee)

ff. Isolation. An activity that physically prevents the transmission or release of energy. (11-2.ff)

gg. Limited Approach Boundary. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. (11-2.gg)

hh. Live-Line Bare-Hand Technique (Work). A highly specialized technique (usually used on medium and high-voltage transmission lines) where a QP working from an insulated aerial platform is electrically bonded to an energized line. This technique effectively cancels any electrical potential difference across the worker's body and protects the employee from electric shock. (11-2.hh)

ii. Live-Line Tools. Tools used by QPs to handle energized conductors. The tool insulates the employee from the energized line, allowing the employee to perform the task safely. (Also known as "hot sticks"). (11-2.ii)

jj. Lockout/Tagout (LOTO). See chapter 12. (11-2.jj)

kk. Minimum Approach Distance (MAD). An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement. NFPA 70E calls MAD the Restricted Approach Boundary, this chapter will use the terms interchangeably. (11-2.kk)

ll. Mobile. Equipment that is capable of being moved on wheels or rollers. (11-2.ll)

mm. Portable. Equipment that is easily carried by personnel from one location to another. (11-2.mm)

nn. Qualified Person (QP), Electrical. Someone who meets the criteria for a QP as defined in this manual (cee chapters 1 and 2). The term "Qualified Person (QP)", as used in this chapter, refers to "Qualified Person, Electrical." (See para 11-3.b) (11-2.nn)

oo. Restricted Approach Boundary. See MAD. (11-2.oo)

pp. Separately Derived System. A premises wiring system whose power is derived from generator, transformer, or converter winding and has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system. (11-2.pp)

qq. Service. The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served. (11-2.qq)

rr. Substation. A high-voltage electric system facility used to switch generators, equipment, and circuits or lines in and out of a system. (11-2.rr)

ss. Temporary Protective Ground (TPG). A personal protection device consisting of a specialized full fault rated cable assembly connected between a de-energized circuit and ground. The device creates a zone of equipotential to limit the voltage to a safe value. (11-2.ss)

tt. Transmission Lines and Equipment. Electric lines and equipment with operating voltages from 69KV to 765KV. (11-2.tt)

uu. Unqualified Person. A person who is not a QP but has received safety training to identify the hazards and reduce the associated risk. (11-2.uu)

vv. Voltage Classes. See ANSI C84.1. (11-2.vv)

(1) Low Voltage. Nominal system voltages of 1000 volts or less.

(2) Medium Voltage. Nominal system voltages greater than 1000 volts and less than 100 kV.

(3) High Voltage. Nominal system voltages equal to or greater than 100 kV and equal to or less than 230 kV.

(4) Extra-High Voltage. Nominal system voltages greater than 230 kV but less than 1000 kV.

ww. Working Distance. The distance between a person’s face and chest area and a prospective arc source. (11-2.ww)

xx. Working On. Activities which involve intentional contact with energized electrical conductors or circuit parts with tools or body parts regardless of the PPE a person is wearing which are not in an electrically safe work condition (ESWC). This includes the process of establishing and verifying an ESWC, troubleshooting, manipulation of cables, or performing any repairs/alterations. (11-2.xx)

11-3. Personnel Required Qualification/Training.

a. Electrical Safety Training. All employees exposed to electrical hazards, to include QPs and Unqualified Persons, must be trained to identify and understand the hazards associated with electrical energy, to include possible injury. Training must include safety-related work practices and procedural requirements, as necessary, to provide protection from the electrical hazards associated with their respective job or task assignments. (11-3.a)

(1) Training must be provided by an electrically qualified source to the level of work being performed.

(2) Training may be an interactive classroom (virtual or live), on-the-job, or a combination of the two.

(3) Supervisors must identify the risks to each employee and determine the type and extent of the training.

b. Qualified Persons (QPs), Electrical. QPs must demonstrate the skills and knowledge related to the construction, operation, and maintenance of electrical equipment and installations, and receive relevant safety training to recognize, avoid, and control associated hazards that might be present with respect to that equipment, the work method, and job or task assignments. (11-3.b)

Note. A person can be considered qualified with respect to certain equipment and tasks, but still be unqualified for others.

(1) All QPs must be trained, at a minimum, according to NFPA 70E requirements and procedures.

(2) QPs that install and/or remove electric conductors, equipment, or raceways, or manipulate cables must have verifiable credentials and be familiar with applicable code and electrical safety requirements. Verifiable credentials consist of national, state, or local certifications or licenses that a Master or Journeyman Electrician may hold, or for USACE employees, USACE-sponsored local training programs (for example, hydropower training program, navigation training program) depending on the work being performed. Such QPs must be trained to the level of duties as assigned. All training programs must be approved by the AHJ and be properly documented. All credentials must be submitted to the USACE supervisor for approval or to the KO or COR for acceptance.

(3) Exception to paragraph 11-3(b)(2). In work locations where the state, host nation, province, territory, commonwealth, or tribal sovereign nation does not require licensing for QPs, it is permissible to make an exception to the requirement for documented and validated licensing and apply the local licensing laws over the work location provided the following conditions are met:

(a) The contract employer submits the local laws governing licensing to the USACE supervisor for approval or for the KO or COR for acceptance.

(b) The USACE supervisor/KO or COR submits the documentation to the AHJ to evaluate the local laws as being sufficient to ensure proper training and/or oversight and worker safety.

(c) If at any time, the AHJ determines that the employees are not sufficiently trained in electrical work or safety, the AHJ will notify the USACE supervisor/KO or COR. After the employee has received the proper training, the AHJ will reevaluate before the person may continue to work.

(d) The AHJ provides evaluation (that is, approval or disapproval) documentation to the USACE supervisor/KO or COR.

(e) The exception for electrical licensing does not preclude the requirement for emergency response training (see para 11-3.d).

(4) All QPs must be trained and be competent in the proper selection and use of the special precautionary techniques, PPE, insulating and shielding materials, and insulated tools and test equipment for working on or near exposed energized parts of electric equipment (see chapter 5). The training must include instruction on selecting appropriate test instruments and the limitations of each test instrument that might be used. QPs must demonstrate how to use a device to verify the absence of voltage, including interpreting indication provided by the device.

(5) QPs that perform work that involves exposure to electrical hazards with electric power generation, transmission, and/or distribution lines and equipment must be trained according to 29 CFR 1910.269 , 29 CFR 1926 Subpart V, and NESC.

(6) QPs that perform work within the limited approach boundary must, at a minimum, also be trained on the following:

(a) The skills and techniques necessary to distinguish exposed energized live parts from other parts of electrical equipment.

(b) The skills and techniques necessary to determine the nominal voltage of exposed live parts.

(c) Approach distances specified for personnel in tables 11-1, 11-2, 11-3 and the corresponding voltages to which the QP will be exposed.

(d) Minimum clearances specified for vehicular and mechanical equipment in table 11-4.

(e) Decision making process necessary to perform job safety planning (for example, to assist in preparing the APP and AHA), identify electrical hazards, assess the associated risk, and select the appropriate risk control methods form the hierarchy of controls, including PPE (see para 11-7.a(9)).

(7) An individual who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a QP may be considered as a QP for the performance of those specific duties under the following conditions:

(a) They demonstrate an ability to safely perform specific duties at their achieved level of training.

(b) They are under the direct supervision of a QP.

c. Unqualified Persons. Unqualified Persons who may be exposed to shock and arc flash hazards must be trained and be familiar with any electrical safety-related practices necessary for their safety. (11-3.c)

d. Emergency Procedures. All employees exposed to shock hazards and any employees responsible for taking action in the case of emergency must be trained in first aid response (for example, CPR, AED) according to chapter 3, NFPA 70E, and annually in the methods of release for victims who contact exposed energized electrical conductors or circuit parts. (11-3.d)

Note. In situations where exception is made for QP licensing (see para 11-3.b(3)), such persons must still receive the training as required by this paragraph.

e. Lithium Batteries. Employees responsible for storage and handling of new, used, and damaged lithium-based batteries must be trained in the following: (11-3.e)

(1) Proper fire prevention methods to be used for primary and secondary lithium-based batteries.

(2) How to recognize the differences between primary and secondary batteries.

(3) Eye protection required during fire mitigation.

(4) Shipping and handling protocols.

(5) Safe storage and handling practices.

(6) How to identify damaged cells or cells that are beginning to exhibit thermal runaway.

f. Retraining. Provide retraining in safety-related work practices and changes to applicable standards at least every three years, or when any of the following conditions exists: (11-3.f)

(1) When there are changes to applicable standards.

(2) The AHJ, supervision, or annual inspection determine the employee is not following the safety-related work practices.

(3) New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices differ from those that the employee would normally use.

(4) For tasks that are performed less than once per year, retraining must be performed before performing the work.

(5) When safety-related work practices are not normally used by the employee during regular job duties, perform retraining before performing the work.

(6) A change in the employee's job assignment.

g. Training Documentation. All electrical safety training must be documented according to OSHA and ANSI Z490.1, to include an outline of the training, each employee's name, and the dates of the training. Training documentation must be provided when the employee demonstrates proficiency, be retained for the duration of employment, and be verifiable. (11-3.g)

11-4. Roles and Responsibilities.

a. Qualified Persons (QPs), Electrical. QPs are responsible for the following: (11-4.a)

(1) Performing inspections according to paragraph 11-5.

(2) Assist in developing AHAs according to paragraph 11-6.

(3) Complying with the safety-related work practices and procedures provided by their employer.

(4) Ascertain by inquiry, direct observation, and by instruments whether any part of an exposed or concealed electric power circuit is located where it could bring any person, tool, or machine into physical or electrical contact with it prior to starting the work.

(5) When Unqualified Persons are working near a limited approach boundary, the QP in charge of the work area must inform them of the existing electrical hazards.

(6) The QP must work with supervision to determine the number of workers required to perform the job safely and identify the number of workers in the corresponding AHA. Work must be performed with enough workers to provide a safe working environment (see para 11-8.e(3)). The Journeyman/Apprentice ratio must be according to state, local, and host nation requirements applicable to where the work is being performed.

(7) Only QPs are authorized to perform the following:

(a) Establish ESWCs.

(b) Work on electrical conductors or circuit parts that have not been put into an ESWC.

(c) Interact with equipment where conductors or circuit parts are not exposed, but an increased likelihood of injury from an exposure to an arc flash hazard exists (see NFPA 70E table 130.5(c)).

(d) Install and/or remove electric conductors, equipment, or raceways, or manipulate cables. Such QPs must have verifiable credentials. (See para 11-3.b)

(e) Place and remove TPG.

(f) Work on power generation, transmission, and distribution lines and equipment.

(g) Operate aerial lift equipment within the minimum clearances (see table 11-4). provided the non-insulated equipment and grounded portions of the lift remain outside of the clearances listed in table 11-3.

b. Unqualified Persons. Unqualified Persons may assist QPs with electrical-related tasks provided they are properly trained in safety awareness and escorted and supervised by the QP. They must follow the established safety-related work practices and procedures. (11-4.b)

(1) Unqualified Persons may not conduct electrical work which exceeds their level of specific training received.

(2) An Unqualified Person may be qualified for one type of work, but unqualified for another based on the training received.

(3) Unqualified Persons may cross the limited approach boundary to assist the QP only after they are informed of the additional hazards and don the appropriate PPE. The Unqualified Person must always be escorted by the QP.

(4) Unqualified Persons may cross the arc flash boundary only if they are wearing the appropriate PPE and are under the close supervision of a QP.

c. Host Employer. The Host Employer must inform contract employers of the following: (11-4.c)

(1) Known hazards covered by this manual that are related to the contract employer's work and that might not be recognized by the contract employer or its employees.

(2) Information about the employer's installation that the contract employer must know to make the assessments required by this manual.

(3) Report observed contract employer-related violations of this chapter to the KO or COR, which will notify the contractor employer.

(4) If work must be performed on an energized system, then the host employer or system owner must first demonstrate that de-energizing introduces additional or increased hazards (for example, interruption of life support equipment, removal of light for an area) or is infeasible due to equipment design or operational limitations (for example, testing, troubleshooting). (See para 11-8.e(4))

(5) All known hazardous locations within the facility prior to construction activities. Any discrepancies between established hazardous locations and contract requirements will be addressed by the KO or COR.

d. Contract Employer (Contractor). (11-4.d)

(1) The contract employer must ensure employees are instructed in the hazards communicated by the host employer, in addition to the basic training required by paragraph 11-3 of this chapter.

(2) The contract employer must determine, through regular supervision or through inspections conducted on at least an annual basis, that each employee is complying with the safety-related work practices required by this chapter and the safety-related work rules required by the host employer.

(3) The contract employer must advise the host employer of the following:

(a) Any unique hazards presented by the contract employer's work.

(b) Hazards identified during the course of work by the contract employer that were not communicated by the host employer.

(c) The measures the contract employer took to correct any violations reported by the host employer under paragraph 11-4.c and to prevent such violation from recurring in the future.

(4) The contract employer must obtain authorization by host employer prior to entry of energized substations.

e. Authority Having Jurisdiction (AHJ), Electrical. The AHJ is responsible for the following actions: (11-4.e)

(1) Communicate through the USACE supervisor/KO or COR for all necessary coordination with contract employers.

(2) Inspect and evaluate equipment that is not listed by a NRTL, document approval, and label as safe prior to installation and use.

(3) Review and approve, in writing, Energized Electrical Work Permit (EEWP) prior to commencement of work (see para 11-8.e(4)).

(4) Interpret and ensure compliance with applicable electrical standards.

(5) Document all approvals, interpretations, or changes. Route any findings that interact with contracts through the KO or COR for final decision.

(6) Ensure compliance with electrical standards by performing electrical inspections of modifications of existing equipment and new construction, including construction by outside employers (contractors).

(7) Determine and establish which code, standard, or criteria is to be used for approving equipment, material, installation, and/or procedures. In most locations, this will be the decision to use the NEC/NFPA 70, NESC, or a combination of the codes.

(8) Provide interpretation of the requirements of this chapter. Such interpretations and clarifications must not have the effect of waiving or exempting requirements specifically provided for in the criteria.

(9) Determine electrical competency levels of individuals.

(10) Inspect emergency temporary installations for safety prior to energizing.

11-5. Inspection Requirements.
The following list is understood to be commonly found inspection requirements, but is not intended to be all-inclusive:

a. Inspect insulating gloves and arc flash PPE prior to each use. See chapter 5 for all PPE requirements and testing requirements and frequencies. (11-5.a)

b. Inspect insulated tools and equipment prior to each use. Inspect the insulation in addition to other aspects of the tool that may affect its use. (11-5.b)

c. Inspect Assured Equipment Grounding Conductor Program (AEGCP) according to paragraph 11-7.b. (11-5.c)

d. Flexible Cords. Inspect all portable flexible cords or cables (for example, extension cords) before use on each shift. (11-5.d)

e. Test temporary electrical distribution systems for polarity, ground continuity, and ground resistance before initial use and before use after modification. Associated GFCIs will be tested monthly. (11-5.e)

f. Power Transmission and Distribution (construction). Inspect power transmission and distribution according to paragraph 11-8.q. (11-5.f)

g. Lithium Batteries. Visually inspect each secondary lithium-based battery's external casing prior to each use, before storage (excluding new, undamaged packaged cells), and before charging for visible damage, bulges, hissing, leaking, smoking, or increased temperature. (11-5.g)

h. Inspect new or modified equipment to verify it has been installed per applicable codes and standards before being energized. (11-5.h)

11-6. Activity Hazard Analysis (AHA) Requirements.
Develop AHAs according to paragraphs 1-6 or 2-6, as applicable. When work is performed that meets the definition of working on electrical equipment, or for activities near enough to expose employees to any electrical hazard they present, include the following in the AHA:

a. Tasks and the number of people needed to safely complete the work. (11-6.a)

b. Identification of the electrical hazards and boundary distances associated with each task. (11-6.b)

c. A shock risk assessment according to paragraph 11-8.b(1) for tasks involving a shock hazard. (11-6.c)

d. An arc flash risk assessment according to paragraph 11-8.b(2) for tasks involving an arc flash hazard. (11-6.d)

e. HEC (for example, LOTO), clearance, and switching procedures (see chapter 12). (11-6.e)

f. Electrical PPE (see chapter 5). (11-6.f)

g. Health considerations (for example, asbestos, polychlorinated biphenyl). (11-6.g)

h. Environmental considerations, such as wet locations. (11-6.h)

i. Use of EEWP, as required. (11-6.i)

j. Personal insulating and grounding methods. (11-6.j)

k. Temporary power system sketches and AHJ's acceptance documentation. (11-6.k)

l. Competent Persons (rescue, QP, first aid/CPR, AED, contact release). (11-6.l)

m. Emergency procedures when "two-person rule" (see 1910.269) is in effect (see paras 11-3(d) and 11-8.e(3)). (11-6.m)

n. Restricted access locations (for example, substations, vaults). Following the acceptance of an AHA, the contractor must ensure approval for entering restricted access locations is documented and attached to the AHA daily. (11-6.n)

11-7. Minimum Plan Requirements.

a. An Electrical Safety Plan (ESP) is required when personnel perform work that involves exposure to electrical hazards. The ESP must be developed according to NFPA 70E and when work involves exposure to electrical hazards associated with electric power generation, transformation, transmission, and/or distribution lines and equipment, additional requirements according to 29 CFR 1926.950, 29 CFP 1910.269, and the NESC. UFC 3-560-01 was developed for the DoD and can be used as a resource when developing a new safety plan. The plan must include the following: (11-7.a)

(1) Roles and Responsibilities. Identify QPs while outlining their responsibilities and providing qualifications.

(2) Training. The ESP must include training for qualified and unqualified persons meeting the requirements of paragraph 11-3. The ESP must document the contract employer's sources for the required training and outline course content. Training completion documentation must be kept as part of the ESP.

(3) Emergency Response. Develop rescue plan for work that involves exposure to electrical hazards. Also, in addition to first aid and resuscitation requirements identified in chapter 3 and paragraph 11-3.d, train employees exposed to shock hazards and first responders in methods of safe release. Provide and document annual refresher training on the release methods.

(4) Hazard Awareness. The ESP must educate and provide an awareness of the hazards employees are exposed to while performing electrical work. These may

include, but are not limited to, shock and arc flash. The contract employer must identify any hazards they anticipate encountering while performing their work.

(5) Job Safety Planning. Prior to the performance of any work, the contract employer must develop an AHA and conduct a briefing with the employees performing the work. An AHA must be developed according to the requirements of paragraphs 1-6 and 2-6 for all activities, tasks, or DFOW identified for each major phase of work. AHAs for electrical work must include the additional requirements identified in paragraph 11-6. The AHA must address an EEWP if required. The requirements for the EEWP are documented in paragraph 11-8.e(4).

(6) Principles. The ESP must include the various principles comprising the program. Address all the principles included in Annex E of NFPA 70E, such as: inspecting and evaluating electrical equipment, identifying electrical hazard, and protecting employees from shock, burn, blast, and other hazards due to the working environment. Include additional principles, as appropriate.

(7) Controls. The ESP must include controls that will be implemented to ensure safety. Annex E of NFPA 70E provides a list of controls. Examples from the annex include:

(a) The employer develops programs and procedures, including training, and ensuring the employees apply them.

(b) Employees are to be trained to be qualified for working in an environment influenced by the presence of electrical energy.

(c) Procedures are to be used to identify the electrical hazards and to develop job safety plans to eliminate those hazards or to control the associated risk for those hazards that cannot be eliminated.

(d) Every electrical conductor or circuit part is considered energized until the absence of voltage is verified (see para 11-8.d).

(e) Precautions appropriate to the working environment are to be determined and taken.

(8) Procedures. The ESP must detail procedures used by employees exposed to electrical hazards prior to starting work. Annex E of NFPA 70E provides a list to include qualifications and number of employees to be involved, identification of hazards and assessment of risks of the task, safe work practices to be used, and PPE involved.

(a) Operations Adjacent to Overhead Lines. Standard emergency communication procedures must be established and rehearsed to assure rapid emergency shutdown for all work being conducted on overhead power lines. (See para 11-8.s)

(b) Power Transmission and Distribution. See paragraph 11-8.q for additional information.

(c) Work in Energized Substations. See paragraph 11-8.r for additional information.

(9) Risk Assessment Procedures. When working with electricity, employees must attain the knowledge to be able to identify the hazards, assess the risk presented by the hazard, and implement controls. The program must educate employees on the following Hierarchy of Control Methods:

(a) Elimination.

(b) Substitution.

(c) Engineering Controls.

(d) Awareness.

(e) Administrative Controls.

(f) PPE.

(10) Inspection. The ESP must address the inspection of new or modified equipment to verify it has been installed per applicable codes and standards before being energized.

(11) Condition of Maintenance. An employee must be able to assess the maintenance condition of existing equipment as it may affect the risk of hazard exposure. The ESP must include elements that employees must consider when assessing the condition and determining risk.

(12) Incident Investigation. The ESP must show how the contract employer will identify, investigate, and document incidents. Incidents include “close calls” or “near misses” that do not result in a fatality, injury, damage to health, or damage to equipment.

(13) Auditing. The ESP must be audited to ensure its requirements protect employees and that personnel are following and supporting the program. Program audits must be performed at least every three years. The contract employer must perform annual “field work” audits to verify employee participation in the program. Revise the procedures or training program if audits determine that personnel are not following the program requirements.

(14) Lithium Containing Batteries. The ESP must contain specific paragraph covering lithium-based batteries used or stored on the work site. This paragraph of the

ESP requires specific approval by the AHJ who may require limited group storage or charging rules based on the location; quantity, size, and type of batteries being stored or other unique conditions to the site (see chapter 9). The ESP must contain at a minimum the following:

(a) Inventory all types of primary and secondary lithium-based batteries at each site to include quantity, storage, and charging location, fire prevention methods at each location, hazard labeling, and intended use. The location map must be submitted to the USACE supervisor/KO or COR for transfer to fire protection officials at the site.

(b) A lithium-based battery hazard analysis for storage and charging locations.

(c) Required training for employees for use, handling, inspection, storage, transport, and charging of the types of lithium-based batteries at each site (see para 11-3.e).

(d) Be based on industry standards, manufacturer's recommendations, NFPA fire protection standards for building storage and charging location regulations, and NRTL Standards for storage and/or charging containers.

b. Assured Equipment Grounding Conductor Program (AEGCP). When an AEGCP is used in place of GFCIs for ground-fault protection, the AEGCP must be developed according to 29 CFR 1926.404 (29 CFR 1926 Subpart K) requirements. The AEGCP must be submitted and approved by the USACE supervisor or accepted by the KO or COR and made available upon request by any affected persons (see para 11-8.l.(9)(h)). The AECGP must consist of the following: (11-7.b)

(1) Identification of the conditions or need for the exemption.

(2) Written procedures for equipment inspections, tests, and test schedule.

(a) Visual Inspections. Visually inspect all cord sets, attachment caps, plugs and receptacles, and any equipment connected by cord and plug before each day's use for external damage and for indication of possible internal damage (for example, deformed or missing pins, damaged insulation). Ensure flexible cords are being inspected and those arriving onsite between tests are identified and tested.

(b) Removing Equipment. Equipment found to be damaged or defective or which fails any of the prescribed inspections or tests must be removed from service until repaired or replaced.

(c) Testing. Perform a continuity test and a terminal connection test on all electrical equipment:

(c-1) Before first use.

(c-2) Before placing back in service following any repairs.

(c-3) Before equipment is used after any incident that can be reasonably suspected to have caused damage (for example, when a cord set is run over).

(c-4) At intervals not to exceed three months, except that cord sets and receptacles that are fixed and not exposed to damage must be tested at intervals not to exceed six months.

Note. A continuity test ensures that the equipment grounding conductor is electrically continuous. A terminal connection test ensures that the equipment grounding conductor is connected to its proper terminal at receptacles and cord plugs. (See 29 CFR 1926.404)

(3) Documentation of results for all cord sets, receptacles that are not part of the permanently wiring of a building or structure, and cord sets and equipment connected by cord and plug used on construction sites. All inspections and tests must be documented to identify all equipment that passed the inspection or test, the date of the inspection or test, and the individual responsible for the inspection.

(4) Designation of one or more CPs (see chapters 1 and 2) to implement and enforce the AEGCP at each site it is implemented.

11-8. General Requirements.

a. General. (11-8.a)

(1) All electrical wiring and equipment must be a type listed by a NRTL for the specific application for which it is to be used. For equipment not listed by a NRTL, the AHJ must determine if use is allowable. The AHJ must inspect, approve, and label safe for use all electrical equipment not a type listed by a NRTL.

Note. Examples of non-NRTL equipment would be IEC rated but not NEMA rated products, “CE” marked equipment covered by Declarations of Conformity to European Union (EU) directives and European Standard (EN) standards, or USACE constructed control panels that would fall under the UL-508A listing that are used only at the facility where they are constructed.

(a) Contract employers must verify that the equipment they are using is properly listed.

(b) Rental equipment must be listed by a NRTL. Rental equipment not listed by a NRTL must be approved by the AHJ prior to initial use.

(2) Excavation and Trenching. See chapter 25 for utility verification and work activity procedures.

(3) All electrical work must comply with applicable NESC (for example, NESC, NFPA70, NFPA 70E, NFPA 70B), OSHA, and USCG requirements (see paras 11-3 and 11-4). If the requirements of this chapter differ with the above requirements, the AHJ will determine, approve, and document the basis for which code or standard applies to the work based on the requirements.

Note. When working OCONUS, all electrical work must comply with either the host nation's requirements, NFPA70 (NEC) or IEEE-C2 (NESC), or BSI BS 7671. In general, the host nation requirements will be used in countries with an existing electrical code, NFPA 70 (NEC) or IEEE- C2 (NESC) will be used in countries where 60 Hz power is predominant and the country does not have an established electric code, and BSI BS 7671 will be used in countries where 50 Hz power is predominant and where no electric code exists.

(4) Comply with the design safety standards for electrical systems included in 29 CFR 1910 and 29 CFR 1926 for all work covered by this chapter.

(5) Comply with the design requirements included in the NESC and NFPA70 for all work performed and covered by the scope of these two standards.

(6) Comply with the more stringent design specifications included in contract unless they violate OSHA requirements.

b. Electrical Hazard Risk Assessments. Conduct shock and arc flash risk assessments, at a minimum, to identify safety-related work practices prior to any electrical hazard exposure. Document the results in the AHA. (See para 11-6) (11-8.b)

(1) Shock Risk Assessment. A shock risk assessment is used to identify the shock hazards, estimate the likelihood and severity of an injury occurring, and determine whether additional protective measures (for example, engineering controls, PPE) are necessary. The shock risk assessment must include the following:

(a) Use the shock risk assessment to determine the voltage that personnel might be exposed to, the approach distances, and any PPE or insulated equipment needed to protect against the hazard.

(b) Limited Approach Boundary. The limited approach boundary must be defined in each shock risk assessment (see tables 11-1 and 11-2).

(b-1) When Unqualified Persons are working at or near the limited approach boundary, the QP in charge of the work must identify the electrical hazards and warn them of the boundary.

(b-2) An Unqualified Person must not cross inside the limited approach boundary of energized conductors or circuit parts unless there is a need in which the QP must

instruct them on the hazards present and continuously escort them while inside the boundary.

(c) MAD (Restricted Approach Boundary). The MAD must be defined in the shock risk assessment. The MAD lies inside the limited approach boundary (see table 11-3). A QP must not approach or take a conductive object closer than the MAD unless:

(c-1) The QP is insulated or guarded from energized electrical conductors or circuit parts operating at 50 volts or more. Insulating gloves and sleeves are considered insulation only with regards to the energized parts upon which work is performed; or

(c-2) The energized electrical conductors or circuit parts are insulated from the QP and from any other conductive object at a different potential.

(2) Arc Flash Risk Assessment. An arc flash risk assessment is used to identify the arc flash hazards, estimate the likelihood and severity of an injury occurring, and determine whether additional protective measures (for example, PPE) are necessary.

(a) Use the arc flash risk assessment to determine the appropriate safety-related work practices, the arc flash boundary, the working distance, and any PPE to be used within the arc flash boundary.

(b) Arc Flash PPE. Select arc flash PPE using one of the following methods, but not both:

(b-1) Incident Energy (IE) Analysis. An IE Analysis uses short circuit, coordination, and arc flash studies to determine the IE for a given operating condition at a piece of equipment. The analysis method must account for the overcurrent device characteristics as well as the fault clearing time and condition of maintenance. Use NFPA 70E table 130.5(G) to identify the arc flash PPE when the IE analysis method is used. Unless it is part of the scope of the current contract, the responsibility for the IE Analysis usually lies with the host employer or system owner.

(b-2) Arc Flash PPE Category Method. If an IE Analysis is not performed by the contract employer or provided by the host employer or system owner, use NFPA 70E table 130.7(C)(15)(a) to determine the arc flash PPE category for AC equipment or NFPA 70E table 130.7(C)(15)(b) for DC equipment. The tables include maximum fault currents, maximum clearing times, and minimum working distances for determining the PPE category. When equipment exceeds these ratings, an IE analysis must be performed. When the arc flash PPE category has been determined from the appropriate table, use NFPA 70E table 130.7(C)(15)(c) to identify the PPE appropriate for the task.

Note. Prior to commissioning new equipment, the Category Method must be used if an IE Analysis is not performed. The Category Method cannot be used if the parameters

for use of the tables are not met. All temporary construction power distribution equipment must have the PPE Category indicated prior to initial energization.

(c) Equipment Labeling. Labels must be placed on energized equipment that is likely to require examination, adjustment, servicing, or maintenance while energized. Labels are required to warn of potential shock and arc flash hazards. Unless it is part of the scope of the current contract, the responsibility for labeling usually lies with the host employer or system owner. Labels must include the following:

(c-1) Nominal system voltage.

(c-2) Limits of approach.

(c-3) Arc flash boundary.

(c-4) At least one of the following from c-5 through c-7:

(c-5) Available IE and the working distance or the arc flash PPE category based on NFPA 70E Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) for the equipment, but not both.

(c-6) Minimum arc rating of clothing.

(c-7) Site-specific level of PPE.

(3) Physical or Mechanical Barriers. Provide suitable temporary barriers or other means to designate arc flash and electrical shock boundaries. Install the barriers no closer than the limited approach boundary or arc flash boundary, whichever is the greater distance. Boundaries must ensure that a workspace cannot be used as a passageway while electrical work is being performed. Barriers must be installed prior to performing work that exposes workers to electrical hazards.

(4) Insulating Tools. All insulating tools used to protect employees from electrical hazards must comply with 29 CFR 1910.137 and chapter 5 of this manual. Properly rated insulating tools must be used when working on energized equipment when there is a risk of the tool contacting another energized conductor or grounded conductive objects.

c. PPE. Personnel working inside the limited approach and/or arc flash boundaries must select the proper shock and arc flash PPE based on the requirements of this chapter and chapter 5. (11-8.c)

(1) Arc flash PPE must cover potentially exposed areas as completely as possible. Shirt and coverall sleeves must be fastened at the wrists, shirts tucked into pants, and shirts, coveralls, and jackets closed at the neck.

(2) All garments, including fall protection harnesses, worn over arc rated protective clothing must also be arc rated.

d. Establishing an Electrically Safe Work Condition (ESWC). All equipment and circuits must be de-energized before work is started unless energized work can be justified. A QP must complete and verify the following to establish electrically safe working conditions: (11-8.d)

(1) Determine all possible sources of electrical supply to the specific equipment using up-to-date drawings, schematics, and labels.

(2) Control all sources of electrical energy to minimize employee exposure to electrical hazards.

(3) Visually verify the disconnecting device is open or circuit breaker is withdrawn whenever possible.

(4) Apply HEC devices (see chapter 12).

(5) Verify each phase conductor or circuit part is de-energized using an adequately rated test instrument (see NFPA 70E).

(6) Where induced voltages are possible, stored electrical energy exists, or if required within this chapter, ground the conductors or circuit parts before touching them.

e. Work Involving Electrical Hazards. (11-8.e)

(1) Energized electrical conductors or circuit parts operating at 50V or more must be placed into an ESWC prior to performing any work if either of the following conditions exist:

(a) An employee is to be within the limited approach boundary (see tables 11-1 and 11-2).

(b) An employee is to interact with equipment where conductors or circuit parts are not exposed but an increased likelihood of an arc flash hazard exists.

(2) Conductive Articles Being Worn. Do not wear conductive jewelry or clothing (for example, wristbands, watch chains, rings, bracelets, necklaces, body jewelry, piercings, metal frame glasses, material with conductive thread) within the MAD or where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts.

(3) Number of Personnel. The nature and hazards of the electrical work dictate the number of personnel required to work safely.

(a) At least two persons must always be in the immediate area when work is being performed on exposed, energized electrical conductors or circuit parts carrying 50V or more. Each person must be able to see and hear the other. This ensures that each person can assist the other in case of an accident. Each person must know the location of, have unobstructed access to, and know how to operate the power cutoff for the work area, how to perform safe contact release, and how to contact emergency personnel.

(b) Exceptions for one person:

(b-1) Work on systems in an ESWC.

(b-2) Routine electrical measurements on energized systems with nominal system voltages of 600 volts AC or 250 volts DC or less using appropriate PPE.

(b-3) Routine circuit switching if the equipment has been properly maintained and site conditions allow for safe performance of work.

(b-4) Routine electrical measurements or switching above 600 volts AC or 250 volts DC using appropriate PPE and live-line tools if the worker is positioned out of reach or possible contact with energized parts.

(b-5) Emergency repair work to safeguard the general public, if previously authorized.

(4) Energized Electrical Work Permit (EEWP). All equipment and circuits must be placed into an ESWC before work is performed on them, unless the work meets the EEWP exemption located under paragraph 11-8.e(5) or the host employer or system owner can show that there are additional hazards or an increased risk from de-energizing. Once it has been determined that equipment must be worked on in an energized condition, an EEWP must be submitted to the USACE supervisor/KO or COR and AHJ for acceptance. Do not perform energized work without prior authorization. All permits must be prepared, signed, and authorized in advance of performing any electrical work. A non-mandatory ENG Form 6277 (Energized Electrical Work Permit) is provided in paragraph 11-10. Other permit formats may be accepted provided they contain the following minimum information:

(a) Description of the circuit and equipment to be worked on and their location.

(b) Description of the work to be performed

(c) Justification for why the work must be performed in an energized condition.

(d) Description of work practices to be followed.

(e) Shock risk assessment: voltage exposure, limits of approach, and PPE.

(f) Arc flash risk assessment: available IE at working distance or arc flash PPE category, arc flash PPE, and arc flash boundary determination.

(g) Means to restrict access of Unqualified Persons in work area.

(h) Evidence of completing the job briefing, including safety, tools, PPE, any other hazards and control.

(i) The USACE supervisor, USACE facility/site manager, and the AHJ are required to sign the EEWP. If the permit is requested by Contract Employer the EEWP will include signatures for SSHO, USACE facility/site manager, KO or COR, and the AHJ.

(5) Exemptions to an EEWP. An EEWP is not required when a QP utilizes safe work practices and PPE while performing the following tasks:

(a) Testing, troubleshooting, or voltage measuring.

(b) Thermography, ultrasound, or visual inspections if the MAD is not crossed.

(c) Access to, and egress from, an area with energized electrical equipment if no electrical work is performed and the MAD is not crossed.

(d) General housekeeping and miscellaneous non-electrical tasks if the MAD is not crossed.

(e) Work within an energized industrial control panel provided all following conditions are met; the circuit being worked on is placed in an ESWC, the voltage levels of any conductor inside the industrial control panel is less than or equal to 300V AC phase to phase or 130V dc, shock hazards presented by energized conductors can be mitigated by avoiding contact, and the work site has documented AHJ approval.

f. Flexible Cords. Use flexible cords according to 29 CFR 1926.405 (29 CFR 1926 Subpart K) and 29 CFR 1910.305 (29 CFR 1910 Subpart S), as applicable. (11-8.f)

(1) Portable flexible cords must contain adequately sized conductors required for the load plus an adequately sized equipment ground conductor. A QP must determine appropriate hard or extra hard usage flexible cord length and size according to NFPA table 400.4. Portable flexible cords used in construction and maintenance on circuits less than 600V must be minimum 14 American Wire Gauge (AWG).

(2) Protect portable flexible cords passing through work areas from damage (for example, foot traffic, vehicles, sharp corners, protections, pinching). Protect flexible cords passing through holes by bushings or fittings.

(3) Portable flexible cords may be used only in continuous lengths without splice or tap. The repair of hard-service cords/cord sets is only permitted if conductors are spliced according to NFPA 70, which requires that cords be spliced by a QP, the insulation is equal to the cable being spliced, and wire connections are soldered, and the following conditions are met:

(a) Maintenance. Hard-service cord and junior hard-service cord No. 14 and larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced (see 29 CFR 1910.305).

(b) Construction. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced (see 29 CFR 1926.405).

(4) Do not use worn or frayed portable flexible cords.

(5) Portable flexible cords must be supported in place at intervals that ensure that they will be protected from physical damage. Support must be in the form of cable ties, straps, or similar- type fittings installed so as not to cause damage. Do not use nails or suspend by bare wire.

g. Fuses. When fuses are installed or removed with one or both terminals energized, use an insulated fuse pulling tool for the rated voltage. (11-8.g)

h. Attachment Plugs and Receptacles. (11-8.h)

(1) When portable electric equipment or flexible cords are used in highly conductive work locations, such as those inundated with water or other conductive liquids, listed equipment must be used.

(2) Attachment plugs for use in work areas must be constructed so that they will endure rough use and must be equipped with a strain relief to prevent strain on the terminal screws.

(3) Physical attachment of plugs into receptacles rated over 240 volts must be made with the circuit de-energized according to chapter 12 unless one of the following conditions are met:

(a) The cord connected load has been switched to the off position, unloading the circuit and the plug or receptacle is de-energized by design with an integral disconnect, before electrical contact is made.

(b) The receptacle is de-energized by local disconnect which is considered under the sole control of the individual attaching the plug.

(c) The receptable is protected by a residual current device (RCD) set to open at currents not exceeding 30 milliamps and a trip time of 400 milliseconds.

(4) When a NEMA standard configuration exists for a particular voltage, amperage, frequency, or type of current, the NEMA standard plug and receptacle must be used. When NEMA standard configurations do not exist, such as OCONUS, standard plug and receptacle pairs must be rated for the particular voltage configuration, amperage, frequency, type of voltage, and appropriately listed.

i. Clear Spaces. Provide and maintain access to, and egress from, working space around all electrical equipment to permit ready and safe operation and maintenance according to NFPA 70, Spaces About Electrical Equipment. Open equipment doors must not impede access to and egress from the working space. A space of 24" (15" on cranes) must be the minimum distance required when one or more doors are open for access or egress to not be considered impeded. Where required clearance is not feasible (for example, floating plant, vessels), establish procedures to ensure sufficient clearance is maintained for fully opening the door and/or servicing the electrical enclosure so that personnel can escape upon an arc flash event. (11-8.i)

j. Labeling. The following equipment must be labeled or marked as indicated at a minimum. Other labeling or marking requirements and the means and methods of acceptable application and construction of the labels or markings may be required by other paragraphs of this manual or by documents referenced by this manual that are required to be adhered to. (11-8.j)

(1) Mark, label, or arrange all switches, fuses, and automatic circuit breakers for ready identification of the circuits or equipment that they supply.

(2) Mark switchboxes, receptacle boxes, metal cabinets, enclosures around equipment, and temporary power lines to indicate the system voltage.

k. Motors and Controllers. Provide insulating mats or platforms where live parts of motors or controllers operating at over 150V to ground are guarded against accidental contact only by location and where adjustment or other attendance may be necessary during the operation of the apparatus so that the attendant cannot readily touch live parts unless standing on the mats or platforms (see 29 CFR 1926.405). (11-8.k)

l. Grounding and Bonding. Unless otherwise noted in this manual, provide a permanent, continuous, and effective path to ground by grounding and bonding all electrical circuits, equipment, and enclosures according to 29 CFR 1910.304, NFPA 70, and NESC as applicable to the installation. (11-8.l)

(1) Generators.

(a) Portable Generators. The frame of a portable generator is not required to be grounded and may serve as the grounding electrode for a system supplied by the

generator if the generator supplies only equipment mounted on the generator and/or cord-and-plug-connected equipment through receptacles mounted on the generator, and the non-current-carrying metal parts of the equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

(b) Mobile/Vehicle-Mounted Generators. The frame of a vehicle is not required to be grounded and may serve as the grounding electrode for a system supplied by a generator located on the vehicle under the following conditions:

(b-1) The frame of the generator is bonded to the vehicle frame.

(b-2) The generator supplies only equipment located on the vehicle or cord-and-plug- connected equipment through receptacles mounted on the vehicle.

(b-3) The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

(b-4) The system complies with provisions of 29 CFR 1910.304.

(c) Portable and vehicle mounted generators used for construction activities must have GFCI protection. The neutral must be bonded to the frame of the generator and/or vehicle (see NFPA 70 445.20(B) and 590.6(A)(3)). Portable GFCIs are allowed for use with generators manufactured or remanufactured prior to January 1, 2011, when used according to paragraphs 11-8.l(1)(a) and (b) of this chapter.

Note. USACE does not recognize the exception in 29 CFR 1926.404(b)(1)(ii) that states “Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters” since it conflicts with current NFPA 70 590.6(A)(3), UL-1248, UL-2201, and was removed from 29 CFR 1910.304(b)(4)(ii)(A) in 2007.

(d) Portable generator installation is allowed as a temporary backup generator in a ‘floated neutral’ configuration (see NFPA 70). The temporary backup generator must not operate as a separately derived system and must be connected to a transfer switch that bonds the floated neutral to the utility neutral.

(e) The manufacturer must mark the generator indicating if the neutral or grounded conductor is bonded to the frame of the generator. Remark the generator upon field modification of this bonding.

(f) A system conductor (neutral or grounded conductor) that is required to be grounded according to NFPA 70 or 29 CFR 1910.304 must be bonded to the generator frame where the generator is a component of a separately derived system.

(g) For OCONUS portable and vehicle mounted generators that have varying standards differing from this manual, refer to the host nation codes for grounding and bonding of these types of generators.

(2) Portable and semi-portable electric tools and equipment must be grounded by a multi- conductor cord having an identified grounding conductor and a multi-contact polarized plug and receptacle.

(3) Portable and semi-portable electric tools protected by an approved system of double insulation, or equivalent, do not need to be grounded. Double-insulated tools must be distinctly marked and listed by a NRTL.

(4) Ground all floodlights, light plants, and work lights unless they are marked by the manufacturer as double-insulated.

(5) Do not use a grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug for purposes other than grounding.

(6) Temporary Structures, Equipment, and Fencing. Temporary structures, equipment, and fencing must comply with NFPA 70 Article 545, Relocatable Structure and Article 590, Temporary Installations in addition to the following:

(a) Bond all metal piping systems on portable or temporary structures or equipment with electrical power supplied and water and sewer services attached according to NFPA 70 Article 250 boding requirements.

(b) Where temporary buildings or structures are placed or constructed under or near overhead electrical power transmission and distribution lines, bond the metallic components on each building or structure together and ground them to earth when any of the following conditions exist:

(b-1) The building or structure is within 100 feet (30.5 m) horizontally of the outside overhead wire.

(b-2) The building or structure has more than 2,000 ft^2 (185 m^2) of metal surface and is located within 100 to 150 feet (30.5 to 45.7 m) horizontally of the outside overhead wire.

(b-3) The building or structure is used to store flammable materials and is within 250 feet (76.2 m) horizontally of the of the outside overhead wire.

(c) Connect temporary buildings, structures, or fencing located near substations and power generation facilities to the facility ground grid mat with engineered products and cables. Consult the facility owners for proper grounding procedures. Near is defined in paragraphs 11-8.l(6)(b) and 11-8.l(6)(d) as applicable. All metallic components on each building or structure should be bonded together by construction of

the building or by addition of bonding jumpers. See paragraph 11-8.l(6)(d) below for fencing bonding.

(d) When temporary metallic or electrically conductive fencing is placed or constructed under or near overhead electrical power transmission and distribution lines, each wire or woven mesh of wires must be bonded together and ground to earth if any of the following conditions exist:

(d-1) It is in the right-of-way of the power lines.

(d-2) It parallels the line within 125 feet (38.1 m) horizontally of the outside overhead wire and is longer than 150 feet (45.7 m).

(d-3) It parallels the line 125 to 250 feet (38.1 to 45.7 m) horizontally from the outside overhead wire and is longer than 6,000 feet (1,829 m).

(7) Grounding Electrode and System Ground Connections.

(a) For 1000V and above (phase to phase) system grounding, use IEEE 837 rated equipment.

(b) For less than 1000V (phase to phase) system grounding, use UL 467 listed equipment.

(c) For all buried or encased grounding, when connecting a system ground grid to grounding buses and terminals, use IEEE 837 rated equipment.

(d) Before energizing electrical systems, properly ground and bond all equipment to the appropriate code. Do not break bonding and grounding connections until systems are deenergized.

(e) Do not use a designated grounding conductor as a current carrying conductor.

(8) Conductors used for temporary bonding or grounding stationary and movable equipment must be of ample size to create an equipotential zone.

(a) When attaching bonding and grounding clamps or clips, a secure and positive metal-to- metal contact must be made.

(b) Attach the ground end first, then the equipment end. Attach or remove the equipment using insulated tools or other suitable devices. When grounding and bonding equipment that contains flammable liquids, reverse this process (that is, attach the equipment end first then ground) to minimize the possibility of sparks near the flammable liquid.

(c) When removing grounds, remove the line or equipment end first using insulated tools or other suitable devices. When removing grounds from equipment with flammable liquids, reverse this process to minimize the possibility of sparks near the flammable liquid.

(9) GFCI Protection for Personnel. All receptacle outlets (125-volt, 15-, 20-, 30-amperage and greater) that provide temporary electrical power during construction, remodeling, maintenance, repair, or demolition must GFCI protection for personnel.

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

(b) GFCI devices used in general construction and for permanent installations must be UL 943 class A rated. Special purpose GFCI devices are allowed under engineering supervision and must be UL 943C class C, D, or E rated. GFCI devices must be tested before initial use and before use after modification.

(c) In lieu of the requirement to install individual circuit protection, temporary power feeders are permitted to be protected by a ground fault protection equipment (GFPE) or RCD installed in a readily accessible location (see NFPA 70).

(d) Protect receptable outlets that are not part of the permanent wiring of the building or structure with GFCIs using a receptacle outlet with integral GFCI protection, a standard receptacle outlet connected downstream of a receptacle outlet with integral GFCI protection, or receptacles protected by a GFCI-type circuit breaker.

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

Note. Exception: In industrial facilities where conditions of maintenance and supervision ensure that only QPs are involved, an AEGCP (see para 11-7.b) is permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power was interrupted or if their design is not compatible with GFCI protection.

(f) Protect electric tool circuits that are hard-wired directly to an electrical source of power by a GFCI-type circuit breaker.

(g) Install GFCIs according to NFPA 70. Ground electrical circuits of permanent wiring according to NFPA 70.

(h) GFCIs may be sensitive to some equipment (for example, concrete vibrators) or unavailable for the voltage and current rating, or a GFPE/RCD cannot be used. In

these instances, an AEGCP is acceptable in lieu of GFCIs provided it meets the requirements of paragraph 11-7.b.

(10) Temporary Protective Ground (TPG). Place and remove TPGs when grounding lines and equipment is required according to this chapter and OSHA, NFPA 70E, and NESC requirements.

(a) All de-energized conductors and equipment must be tested by a QP using a properly selected voltage meter or detector rated and designed for the system to be measured prior to the application of TPGs.

(b) Place TPGs between the work location and all sources of energy as close as practicable to the work location in such a manner that the employer can demonstrate employees will not be exposed to hazardous differences in electric potential.

(b-1) If work is to be performed at more than one location in a line section, ground and short circuit one location along the line section and ground the conductor to be worked on at each work location. Bracket grounding must be performed under engineering supervision using calculations according to IEEE 1048 and IEEE 1246.

(b-2) Maintain the applicable MAD in table 11-3 from ungrounded conductors at the work location.

(b-3) Where the making of a TPG is impractical, or the conditions resulting from it would be more hazardous than working on the lines or equipment without grounding, the grounds may be omitted and the line or equipment worked as energized.

(c) Grounds may be temporarily removed only when necessary for test purposes. Use extreme caution during the test procedures. Consider all lines or equipment from which grounds have been removed to be energized.

(d) When TPG electrodes are used (for example, for protective grounding during crane operations beneath an energized transmission line), such electrodes must have a resistance to ground low enough to provide protection from the anticipated system fault current. All work must be performed under engineering supervision using calculations according to IEEE 80, IEEE 1048, and IEEE 1246.

(e) TPGs connected to a tower must be made with a tower clamp capable of conducting the expected fault current.

(f) All TPG equipment must meet the following:

(f-1) Equipment must be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

(f-2) Equipment must have an ampacity greater than or equal to that of #2 AWG copper.

(f-3) Equipment must have an impedance low enough so that it does not delay the operation of protective devices in case of accidental energizing of the lines or equipment.

(f-4) Equipment must be tested using the listing agency's recommended testing frequencies and procedures. ASTM listed cable sets must be tested according to ASTM F2249 standards. IEC listed cable sets must be tested using IEC standards.

Note. ASTM F855 is an example of a standard that meets these requirements. If another testing standard is used, it must be evaluated by engineering and the AHJ to determine these requirements are met.

m. Temporary Wiring and Lighting. (11-8.m)

(1) A sketch of proposed temporary power distribution systems must be submitted to the USACE supervisor for approval or acceptance by the KO or COR for use before temporary power is installed. The sketch must show the location, voltages, and means of protection of all circuits (that is, receptacles, disconnecting means, grounding, GFCIs, and lighting circuits). Include the accepted sketch in the AHA associated with the temporary system. (See para 11-6)

(2) Testing. Check all temporary electrical distribution systems and devices for acceptable polarity, ground continuity, and ground resistance before initial use and before use after modification. GFCIs must be tested monthly. Portable type GFCIs must be tested for designed functionality before each use.

(3) Measure ground resistance and circuits at the time of installation for compliance with paragraph 11-8.l(7). Record the measurement and provide a copy to the USACE supervisor/KO or COR.

(4) Provide vertical clearance of temporary wiring for circuits carrying 600V or less:

(a) 10 feet (3 m) above finished grade, sidewalks, or from any platform.

(b) 12 feet (3.7 m) over areas, other than public streets, alleys, roads, and driveways, that are subject to vehicular traffic other than truck traffic.

(c) 15 feet (4.5 m) over areas, other than public streets, alleys, roads, and driveways, that are subject to truck traffic.

(d) 18 feet (5.5 m) over public streets, alleys, roads, and driveways.

(5) Provide vertical clearance of temporary wiring for circuits carrying more than 600V according to NESC.

(6) Wet Locations.

(a) Only use submersible electric pumps in wet locations when the pump is designed by the manufacturer for such purpose.

(a-1) A QP must install and test each pump.

(a-2) Employees must be trained to operate pumps according to the manufacturer's instructions.

(a-3) When personnel are or could be present in the water during pump operation, the pump must be equipped with a UL 943 class A GFCI. UL 943C class C, D, and E rated special- purpose GFCI devices, used for pump operation, are allowed under engineering supervision.

(a-4) If pump manufacturer does not allow personnel in the area when pumps are used in water, an appropriate Hazardous Energy Control Program (HECP), to include LOTO, must be in place (see chapter 12).

(b) Where a receptacle is used in a wet location, contain it in an enclosure that is weatherproof whether or not an attachment plug is inserted.

(c) All temporary lighting strings in outdoor or wet locations (for example, tunnels, culverts, valve pits, floating plant) must consist of lamp sockets and connection plugs permanently molded to the hard service cord insulation.

(d) Wires must be insulated from their supports.

(7) Temporary Lighting.

(a) Illumination. Provide temporary lighting according to chapter 7. Construction areas, ramps, runways, corridors, offices, shops, and storage areas must be lighted to not less than the minimum illumination intensities listed in 29 CFR 1926.56(a), table D-3 while any work is in progress.

(b) Protect all lamps for general illumination from accidental contact or breakage. Ground all metal-case sockets.

(c) Do not suspend temporary lights by their electric cords unless cords and lights are designed for this means of suspension.

(d) Immediately replace exposed empty light sockets and broken bulbs.

(e) Portable electric lighting used in wet and/or other conductive locations (for example, drums, tanks, vessels, sumps, scroll cases) must be rated and operated at 12 volts or less. 120- volt lights may be used if protected by a GFCI. (See para 11-8.l(9))

(8) Portable Hand Lamps. Portable hand lamps must be wired with flexible cord and a polarized or grounding type attachment plug. If the portable lamp uses an Edison-based lamp holder, the grounded conductor must be identified and attached to the screw shell and the identified blade of the attachment plug. In addition, portable handlamps must comply with the following:

(a) Equip hand lamps with a handle of molded composition or other insulating material.

(b) Do not use metal-shell, paper-lined lamp holders.

(c) Hand lamps must be equipped with a handle and a substantial guard over the bulb. The guard must be attached to the lamp holder or the handle.

(d) Ground metallic guards by means of an equipment grounding conductor run within the power supply cord.

(9) When temporary wiring is used in tanks or other confined spaces, provide an approved disconnect that is properly identified, NRTL labeled, and rated for this application and environment at or near the entrance to such spaces, for the purpose of readily disconnecting the electrical power in case of an emergency.

(10) If type nonmetallic sheathed, nonmetallic sheathed corrosion resistant, and service entrance (SE) cables are used in temporary installations, they must meet NFPA 70 requirements, including the following:

(a) Install along studs, joists, or similar supports while closely following the building finish or running boards.

(b) Attach firmly to each cabinet, box fitting, or fixture by means of a cable clamp. Do not use non-metallic sheathed cables as portable extension cords, where subject to frequent flexing, or as a SE cable and do not lay them on the ground subject to any type of traffic.

(c) Keep temporary lighting circuits separate from electric tool circuits. Receptacle circuits must be dedicated to either temporary lighting or electric tools and must be labeled "LIGHTS ONLY" or "TOOLS ONLY," as applicable.

n. Batteries and Battery Charging. In addition to the following, also adhere to 29 CFR 1926.441 (29 CFR 1926 Subpart K) and 29 CFR 1917.157. (11-8.n)

(1) Stationary energy storage systems (ESS) must be installed in locations designed for the intended ESS technology and aggregate capacity.

Note. NFPA 855 is a source that can be used to comply with this requirement.

(2) Store batteries in enclosures with outside vents or in well-ventilated rooms and arrange them to prevent the escape of fumes, gasses, electrolyte spray, or liquid electrolyte into other areas.

(3) Sufficiently diffuse and ventilate gases from battery storage areas to prevent the accumulation of explosive mixtures.

(4) Battery Storage and Handling.

(a) Provide facilities within 25 feet (7.6 m) of battery handling areas for quick emergency drenching of the eyes and body (see chapter 6).

(b) Use only insulated tools in the battery area to prevent accidental shorting across battery connections.

(c) For lead acid batteries, provide bicarbonate of soda to neutralize any acid spillage (1 lb/gal (0.1 kg/L) of water) for flushing and neutralizing spilled electrolyte and for fire protection.

(5) Battery Charging.

(a) Locate battery charging installations in areas designated for that purpose.

(b) Protect charging apparatus against physical damage.

(c) When charging batteries, keep the vent caps in place to avoid spray of electrolyte. Take care to assure vent caps are functioning.

(d) Prior to charging batteries, check the electrolyte level and adjust it to the proper level.

(e) Keep exit routes from battery areas unobstructed.

(6) PPE. Provide and ensure use of the following PPE for safe battery handling (see chapter 5).

(a) Goggles and face shields appropriate to the chemical and electrical hazard.

(b) Acid-resistant rubber gloves.

(c) Protective rubber aprons and safety shoes.

(d) Lifting devices of adequate capacity, when required.

(7) Lithium-Based Batteries. When lithium-based batteries are present in the workplace, adhere to the following:

(a) Temporary site constructed or permanent construction buildings used for the charging or storage of lithium-based batteries must meet applicable fire protection consensus standards and be approved and documented by a fire protection engineer.

(b) All batteries must be NRTL approved.

(c) All portable containers used for storage or charging of lithium-based batteries must be NRTL approved.

(d) All batteries and portable storage or charging containers used OCONUS must be approved by the host nation NRTL equivalent entity or HQUSACE-SO. Temporary site constructed or permanent construction buildings used for charging or storage must meet the requirements of paragraph 11-8.n(7)(a) above.

o. Hazardous (Classified) Locations. Classify the locations of electrical equipment and wiring based on the properties of the flammable vapors, liquids or gases, or combustible dusts or fibers that may be present and the likelihood that a flammable or combustible concentration or quantity is present. The host employer must document these hazardous locations within the facility. (11-8.o)

(1) All hazardous location installations must comply with the requirements of NFPA 70 and 29 CFR 1910.307 (29 CFR 1910 Subpart S).

(2) If a contract employer or USACE employee believes there is a location that should be classified as a hazardous location, the contract employer must immediately notify the USACE supervisor/KO or COR in writing of the concern. A licensed fire protection professional engineer must perform the hazardous location determination.

(3) All equipment, wiring methods, and installations of equipment in hazardous (classified) locations must be either listed as intrinsically safe or listed for the hazardous location.

p. Underground or Concrete-Encased Electrical Installations. Perform underground electrical installations according to 29 CFR 1926.965 (29 CFR 1926 Subpart V). (11-8.p)

(1) Guarding Underground Openings.

(a) Promptly place warning signs and rigid barricades when covers of manholes, handholes, or vaults are removed.

(b) When an employee enters an underground opening, protect the opening with a barricade, temporary cover, or other guard appropriate for the hazard.

(c) Adequately illuminate underground opening guards and warning signs.

(2) Treat maintenance holes and unvented vaults as confined spaces (see chapter 34).

(3) Smoking is prohibited in maintenance holes and vaults.

(4) Provide ventilation when open flames must be used in manholes.

(5) Before using open flames in maintenance holes or vaults, test the holes/vaults and determine that they are safe or cleared of any combustible gases or liquids.

(6) When underground utilities are exposed (for example, electric, gas, water, telephone, or cables other than the one being worked on), protect them from damage.

(7) Maintain metallic sheath continuity by bonding across the opening, or other equivalent means, when working on buried cable or cable in manholes.

(8) Before cutting into a cable or opening a splice, identify the cable, verify it is the proper cable, and de-energize. Utilize remote cable spiking tools to ground the cable when positive identification is not possible before cutting.

q. Power Transmission and Distribution. The requirements in this subparagraph apply to the erection of new electric transmission and distribution lines and equipment, and the alteration, conversion, and improvement of existing electric transmission and distribution lines and equipment. In addition to the following, also adhere to 29 CFR 1910.269 and 29 CFR 1926.950 (29 CFR 1926 Subpart V)). (11-8.q)

(1) Before starting work, evaluate and determine the existing conditions of concern. Conditions of concern include but are not limited to location and voltage of energized lines and equipment, conditions of poles, and location of circuits and equipment including power and communication lines and fire alarm circuits.

(a) Consider electric equipment and lines as energized until test results or other analysis indicate that they are de-energized and have been properly grounded.

(b) New lines or equipment may be considered de-energized and worked as such where the lines or equipment are grounded or where the hazard of induced voltages is not present and adequate clearances or other means are implemented to prevent contact with energized lines or equipment.

(c) Determine the operating voltage of equipment and lines before working on or near energized parts.

(2) Comply with the clearance requirements of either subparagraph (a) or (b) below.

(a) No QP may approach or take any conductive object without a listed insulating handle closer to exposed energized parts than shown in table 11-3 (phase to ground) unless one of the following conditions exists:

(a-1) The QP is insulated or guarded from the energized part (gloves or gloves with sleeves rated for the voltage involved is considered insulation of the QP from the energized part).

(a-2) The energized part is insulated or guarded from the QP and any other conductive object at a different potential.

(a-3) The QP is isolated, insulated, or guarded from any other conductive object(s), as during live-line, bare-hand work.

(b) Do not exceed the minimum phase to ground working distance and minimum clear hot stick distances in table 11-3. The minimum clear hot stick distance refers to the distance from the hot end of live-line tools to the lineman when performing live-line work. If conductor support tools (for example, link sticks, strain carriers, and insulator cradles) are used, the clear length of insulation must be at least as long as the insulator string or as long as the minimum phase to ground distance in table 11-3.

(3) When de-energizing lines and equipment that are operated in excess of 600 volts adhere to the following. In addition, requirements in chapter 12 apply.

(a) Clearly identify the equipment or section of line to be de-energized and isolate them from all sources of voltage.

(b) After all designated switches and disconnects have been opened, rendered inoperable, and tagged and/or locked, conduct visual inspections to ensure that equipment or lines are de- energized.

(c) Apply TPGs on the disconnected equipment or lines to be worked on (see para 11-8.l(10)).

(d) Erect guards or barriers as necessary to adjacent energized lines.

(e) When more than one crew requires the same line or equipment to be de-energized, place a prominent LOTO device for each crew on the line or equipment by the Authorized Individual(s) holding the clearance(s) on the equipment or line.

(f) Upon completion of work on de-energized lines or equipment, each Authorized Individual holding a clearance must determine that all employees in the crew are clear and request a release of the clearance. The TPGs installed will then be removed.

Authorized Individual will report to the utility operator or line operator that all tags and locks protecting the crew may be removed.

(4) When opening or closing a disconnect switch or circuit breaker on a power transmission/distribution line, limit the exposure to potential explosion. Establish safe operating procedures to minimize the risk of explosion.

(5) When working on a line or equipment inside the demarcation zone of a power generation plant, adhere to 29 CFR 1910.269(d) (see chapter 12).

(6) Tools. In addition to the following, also adhere to 29 CFR 1926.951, 29 CFR 1926.955, and 29 CFR 1926.956 (29 CFR 1926 Subpart V).

(a) All hydraulic tools that are used on or around energized lines or equipment must use non-conducting hoses having adequate strength for the normal operating pressures.

(b) All pneumatic tools that are used on or around energized lines or equipment must have non-conducting hoses of adequate strength for the normal operating pressures and have an accumulator on the compressor to collect moisture.

(c) Portable metal or conductive ladders must not be used near energized lines or equipment except in specialized work such as in high voltage substations where nonconductive ladders might present a greater hazard than conductive ladders. Conductive or metal ladders must be prominently marked as conductive, and all precautions must be taken when used in specialized work.

(d) Do not use conductive pull tape or rope when working on or near energized parts.

(7) Material Handling and Storage.

(a) When hauling poles during the hours of darkness, attach illuminated warning devices to the trailing end of the longest pole.

(b) Do not store materials and equipment under energized bus, energized lines, or near energized equipment if it is possible to store them elsewhere. If materials or equipment must be stored under energized lines or near energized equipment, maintain clearance according to table 11-4 and exercise extraordinary caution to maintain these clearances when operating equipment or moving materials near such energized equipment.

(c) Tag lines must be of a non-conducting type when used near energized lines.

(d) Restricted Areas. Do not store material within working spaces of energized lines or equipment within a restricted area.

(8) Overhead Lines and Live-Line Barehand Work. Construct and maintain of overhead lines according to 29 CFR 1926.964 (29 CFR 1926 Subpart V).

(9) Develop an AHA and hold a briefing according to paragraph 11-6 before stringing operations. The following details must be included:

(a) The plan of operation.

(b) The type of equipment to be used.

(c) Grounding devices and procedures to be followed.

(d) Crossover methods to be employed.

(e) Clearance authorizations that are required.

(10) Pulling lines and accessories must be inspected regularly and replaced or repaired when damaged or when dependability may be doubtful.

(11) Before stringing parallel to an existing energized transmission line, a competent determination must be made to ascertain if dangerous induced voltage buildups will occur, particularly during switching and ground fault conditions. This determination must be done under direct engineering supervision.

(12) Before using the live-line bare-hand technique on energized high-voltage conductors or parts, check the following:

(a) The voltage rating of the circuit on which the work is to be performed.

(b) The clearances to ground of lines and other energized parts involved in the work.

(c) The voltage limitations of the aerial-lift equipment intended to be used.

(13) All work must be personally supervised by a QP trained and qualified to perform live-line bare-hand work.

(14) Use only tools and equipment designed, tested, and intended for live-line bare-hand work. Keep all tools and equipment clean and dry.

(15) After completing a thorough inspection of the condition and cleanliness of the electrical insulating components and systems of aerial devices that are rated and used

as an insulating device, QPs must test them for compliance with their rating according to the manufacturer's instructions.

r. Work in Energized Substations. Perform work in substations according to 29 CFR 1926.966 (29 CFR 1926 Subpart V). (11-8.r)

(1) Prior to entry each day, authorization must be obtained from the substation operator by the contract employer. Document the authorization and controls and attach to the AHA.

(2) When work is to be done in an energized substation determine if the facilities are energized and any protective equipment and precautions that are necessary for the safety of personnel.

(3) Follow the appropriate approach distances identified in the electrical hazard risk assessments (see para 11-8.b).

(4) Only QPs are allowed to perform work on or adjacent to energized equipment.

(5) Take precautions to prevent accidental operation of relays or other protective devices due to jarring, vibration, or improper wiring.

(6) QPs must control the use of vehicles, gin poles, cranes, and other equipment when in proximity to unguarded exposed conductors.

(7) When a substation fence must be expanded or removed, provide a temporary fence affording similar protection, when the site is unattended. Maintain an adequate interconnection with ground between the temporary fence and permanent fence.

(8) Keep all gates to unattended substations locked except when work is in progress.

(9) When manually operating gang switches, make a visual inspection to ensure all insulators and the switch handle ground are in good condition. Insulating gloves must be worn when operating switch handles if an equipotential zone is not established. (See 29 CFR 1910.269 Appendix C)

s. Operations Near Energized Transmission Lines and Distribution Lines and Equipment. (11-8.s)

(1) Overhead transmission and distribution lines used during construction must be carried on towers and poles that provide safe clearances over roadways and structures, provided that:

(a) Clearances are adequate for the movement of vehicles and for the operation of construction equipment and meet the clearances required in the NESC.

(b) All electric power or distribution lines are placed underground in areas where there is extensive use of equipment having the capability to encroach on the clearances listed in table 11-4 during construction activities.

(c) Overhead outdoor trolley conductors and other portable overhead cables used to supply moveable construction equipment (for example, gantry cranes, mobile cranes, shovels) are protected and meet clearance requirements in the NESC.

(2) Do not perform work activities adjacent to overhead lines until a survey has been conducted to ascertain the safe clearance from energized lines (see para 11-8.b).

(3) Consider all overhead wires energized unless the persons owning such line or operating officials of the electrical utility supplying the line certifies that it is not energized and it has been tested and visibly grounded.

(4) Do not initiate any work activity that could affect or be affected by overhead lines until coordinated with the appropriate utility officials.

(5) Establish and rehearse the standard emergency communication procedures to assure rapid emergency shutdown for all work being conducted on overhead power lines.

t. Mechanical Equipment Operations Near Energized Transmission and Distribution Lines and Equipment. (11-8.t)

(1) Electrically Unqualified Persons operating mechanical equipment near energized lines or equipment for construction or maintenance must comply with 29 CFR 1910.333(c)(3)(i) and (iii) (29 CFR 1910 Subpart S) for distance requirements.

(2) QP's operating mechanical equipment near energized lines or equipment must comply with 29 CFR 1926.959 (29 CFR 1926 Subpart V) when performing construction or maintenance work activities. The MADs referenced in 29 CFR 1926.959(d) (29 CFR 1926 Subpart V) will be in table 11-3 of this chapter.

Note. 29 CFR 1910.269(p) contains identical language to 29 CFR 1926.959.

(3) Do not place or site floating plant and associated equipment within 20 feet (6 m) of overhead transmission or distribution lines.

(4) Unless using protective equipment for the voltage involved, employees standing on the ground must avoid contacting equipment or machinery working near energized lines or equipment.

(5) Bond lifting equipment that is used closer than table 11-4 to energized equipment or lines to an effective ground or consider it to be energized and barricade it.

(6) Mobile cranes and derricks (see chapters 16 and 18).

(a) Work using cranes and derricks for construction or maintenance must comply with 29 CFR 1926.1408 and 29 CFR 1926.1410.

(b) Cranes and other equipment (for example, excavators, forklifts) used to hoist loads with rigging are prohibited from operating when any part of the equipment, load line, or load (including rigging and lifting accessories) is closer than the minimum clearance in 29 CFR 1926.1408 to an energized power line, unless allowed in chapter 16 or 29 CFR 1926.1410.

(c) All mobile cranes and derricks must be effectively grounded when being operated near energized lines or equipment or the equipment be considered energized (see para 11-8.l(10)).

(d) If cage boom guards, insulating links, or proximity warning devices are used on cranes, they must not alter the requirements of any other regulation of this manual, even if such devices are required by law or other regulation. Insulating links must be rated for the energized lines they are working near.

(7) Aerial Lift Trucks. See chapter 18 and paragraph 22-8m.

(a) Use of aerial lift trucks must comply with paragraph 11-8.t(1) for electrically unqualified persons and paragraph 11-8.t(2) for electrically qualified persons.

(b) The aerial device manufacturer must state in the operator's manual and on the instruction plate whether the aerial device is insulating or non-insulating.

(c) Aerial lift trucks must be grounded, barricaded, and considered as energized equipment, or the aerial lift truck must be insulated for the work being performed. Tables 11-3 and 11-4 must be legibly printed on a plate of durable non-conductive material and must be mounted on the bucket or its vicinity to be visible to the operator of the boom.

(d) Equipment or material must not be passed between a pole or structure and an aerial lift while an employee working from the basket is within reaching distance of energized conductors or equipment that are not covered with insulating protective equipment.

u. Work Near Communication Towers. In addition to the following, also adhere to 29 CFR 1910.269(S) and 29 CFR 1926.967(k) (29 CFR 1926 Subpart V). (11-8.u)

(1) Before working near transmitter towers where there is potential for an electrical charge to be induced in equipment or materials, de-energize the transmitter or conduct tests to determine if an electrical charge could be induced.

(2) Electrically ground equipment to the upper rotating structure supporting the boom and attach ground jumper cables to materials being handled by boom equipment when electrical charge could be induced while working near energized transmitters to dissipate induced voltages. Provide crews with nonconductive poles having large alligator clips or other similar protection to attach the ground cable to the load. Workers must use insulating gloves.

v. Communication Facilities. Perform work on communication facilities according to 29 CFR 1910.269 and 29 CFR 1910.268. (11-8.v)

(1) Do not look into an open wave guide or antenna that is connected to an energized electromagnetic source.

(2) If the electromagnetic radiation level within an accessible area exceeds the levels identified in chapter 6, post the area with appropriate signage.

(3) When an employee works in an area where the electromagnetic radiation is unknown or could exceed the levels given in chapter 6, take measurements to ensure that employee's exposure is not greater than that permitted.

11-9. Figures and Tables.

Table 11-1
Limited Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts - Alternating-Current (AC) Systems

Nominal System Voltage[3] ***(Phase to Phase)***	**Limited Approach Boundary[2]** ***Overhead Exposed Movable Conductor[1]***	**Limited Approach Boundary[2]** ***Exposed Fixed Circuit Part[#]***
Less than 50 V	Not specified	Not specified
[*]50 - 150 V	10 feet 0 inches (3.0 m)	3 feet 0 inches (0.9 m)[a^]
151 - 300V	10 feet 0 inches (3.0 m)	3 feet 6 inches (1.06 m)[a^]
301 - 750 V	10 feet 0 inches (3.0 m)	4 feet 0 inches (1.0 m)[a]
0.751 - 15 kV	10 feet 0 inches (3.0 m)	8 feet 3 inches (2.51 m)[b]
15.1 - 36 kV	10 feet 0 inches (3.0 m)	9 feet 0 inches (2.74 m)[b]
36.1 - 46 kv	10 feet 0 inches (3.0 m)	9 feet 6 inches (2.90 m)[b]
46.1 - 72.5 kV	10 feet 8 inches (3.25 m)	10 feet 0 inches (3.0 m)[b]
72.6 - 121 kV	12 feet 4 inches (3.76 m)	10 feet 9 inches (3.28 m)[c]

Table 11-1
Limited Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts - Alternating-Current (AC) Systems — Continued

Nominal System Voltage[3] ***(Phase to Phase)***	**Limited Approach Boundary[2]** ***Overhead Exposed Movable Conductor[1]***	**Limited Approach Boundary[2]** ***Exposed Fixed Circuit Part[#]***
138 - 145 kV	13 feet 2 inches (4.01 m)	11 feet 4 inches (3.45 m)[c]
161 - 169 kV	14 feet 0 inches (4.27 m)	11 feet 10 inches (3.61 m)[c]
170 - 242 kV	16 feet 5 inches (5.00 m)	13 feet 8 inches (4.17 m)[c]
345 - 362 kV	20 feet 4 inches (6.20 m)	18 feet 3 inches (5.56 m)[c]
400 - 420 kV	20 feet 4 inches (6.20 m)	20 feet 11 inches (6.38 m)[c]
500 - 550 kV	26 feet 8 inches (8.13 m)	23 feet 8 inches (7.21 m)[c]
765 - 800 kV	35 feet 0 inches (10.67 m)	29 feet 8 inches (9.04 m)[c]

Note:

[*] This includes circuits where the exposure does not exceed nominal 120 volts.

[1] Calculated from 29 CFR 1910.333I(3)(i) (2014 ed.). Exposed movable conductors describe a condition in which the distance between the conductor and a person is not under the control of the person, for example, pole supported overhead line conductors.

[2] USACE Limited Approach Boundaries are different from NFPA 70E (2020 ed.). All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.

[3] Voltage ranges per ANSI C84.1, table 1 (2020 ed.). For AC single-phase systems above 250 volts, select the range that is equal to the systems maximum phase to ground voltage multiplied by 1.732.

[a] NFPA 70 (2020 ed.) table 110.26(A)(1), column 2.

[b] NESC (2017 ed.) table 431-1 value plus 6 feet unqualified person falling forward inadvertent movement adder.

[c] NESC (2017 ed.) table 431-1, sea level to 3000 feet column value plus 6 feet unqualified person falling forward inadvertent movement adder.

[^] Work within an energized industrial control panel provided all following conditions are met; the circuit being worked on is placed in an ESWC, the voltage levels of any conductor inside the industrial control panel is less than or equal to 300V AC phase to phase or 130V DC, shock hazards presented by energized conductors can be mitigated by avoiding contact, and the work site has documented AHJ approval.

[#] In locations covered by NESC (2017 ed.) and 29 CFR 1910.269 (2014 ed.), considered Generation, Transmission, or Distribution, it is assumed that Unqualified Persons are restricted from access or are continuously escorted and the limited approach distance requirement to deenergize equipment would not apply and table 11-4 MADs must be observed unless energized work is authorized and being performed. Temporary barriers should still be erected at the distances listed in column 3 above to let other Qualified Persons work is being performed and to stay out unless authorized.

Table 11-2
Limited Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts - Direct-Current (DC) Systems

Nominal Potential Difference *Phase to Phase*	**Limited Approach Boundary** *Exposed Movable Conductor*	**Limited Approach Boundary** *Exposed Fixed Circuit Part*
Less than 50 V	Not specified	Not specified
–0 - 300 V	10 feet 0 inches (3.0 m)	3 feet 6 inches (1.0 m)
0.301 - 1 kV	10 feet 0 inches (3.0 m)	3 feet 6 inches (1.0 m)
1.1 - 5 kV	10 feet 0 inches (3.0 m)	5 feet 0 inches (1.5 m)
5 - 15 kV	10 feet 0 inches (3.0 m)	5 feet 0 inches (1.5 m)
15.1 - 45 kV	10 feet 0 inches (3.0 m)	8 feet 0 inches (2.5 m)
45.1 - 75 kV	10 feet 0 inches (3.0 m)	8 feet 0 inches (2.5 m)
75.1 - 150 kV	10 feet 8 inches (3.3 m)	10 feet 0 inches (3.0 m)
150.1 - 250 kV	11 feet 8 inches (3.6 m)	11 feet 8 inches (3.6 m)
250.1 - 500 kV	20 feet 0 inches (6.0 m)	20 feet 0 inches (6.0 m)
500.1 - 800 kV	26 feet 0 inches (8.0 m)	26 feet 0 inches (8.0 m)

Note:
[1] All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.

[2] Exposed movable conductors describe a condition in which the distance between the conductor and a person is not under the control of the person, for example, pole supported overhead line conductors.

Table 11-3
Qualified Person (QP) Minimum Approach Distances (MADs) - Alternating-Current (AC) Systems

Nominal Voltage[#] ***(Phase to Phase)***	**Distances[##]** ***Phase-to-ground exposure***	**Distances[##]** ***Phase-to-phase exposure***
*50 - 300 V	Avoid Contact	Avoid Contact
*301 - 750 V	1 foot 1 inch (0.33 m)	1 foot 1 inch (0.33 m)
0.751 - 5 kV	2 feet 1 inch (0.63 m)	2 feet 1 inch (0.63 m)
5.1 - 15 kV	2 feet 2 inches (0.65 m)	2 feet 3 inches (0.68 m)
15.1 - 36 kV	2 feet 7 inches (0.77 m)	3 feet 0 inches (0.89 m)
36.1 - 46 kv	2 feet 10 inches (0.84 m)	3 feet 3 inches (0.98 m)
46.1 - 72.5 kV	3 feet 4 inches (1.0 m)	4 feet 0 inches (1.2 m)
72.6 - 121 kV	3 feet 9 inches (1.13 m)	4 feet 8 inches (1.42 m)
122 - 145 kV	4 feet 4 inches (1.3 m)	5 feet 5 inches (1.64 m)
146 - 169 kV	4 feet 10 inches (1.46 m)	6 feet 5 inches (1.94 m)
170 - 242 kV	6 feet 8 inches (2.01 m)	10 feet 2 inches (3.08 m)
243 - 362 kV	11 feet 3 inches (3.41 m)	18 feet 2 inches (5.52 m)
363 - 420 kV	14 feet 0 inches (4.25 m)	22 feet 5 inches (6.81 m)
421 - 550 kV	16 feet 8 inches (5.07 m)	27 feet 1 inch (8.24 m)
551 - 800 kV	22 feet 7 inches (6.88 m)	37 feet 5 inches (11.38 m)

[*] For single-phase systems, use voltage-to-ground.
[#] Voltage ranges per ANSI *C84.1, table 1 (2020 ed.).*
[##] *Based on 29 CFR 1910.269 tables R-6 and R-7 (2014 ed.).*
Note:
[1] Employers may use the MADs in this table provided the work site is at an elevation of 900 meters (3,000 feet) or less. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, calculations will be made under engineering supervision.
[2] Table R-3 of 29 CFR 1910.269 (2014 ed.) may also be used under engineering supervision.
[3] Table R-8 of 29 CFR1910.269 (2014 ed.) or NFPA 70E (2020 ed.) table 130.4(E)(b) will be used for the DC MADs.
[4] Tables found in NESC (2017ed.) or 29 CFR 1910.269 Appendix B (2014 ed.) may also be applied which are based on known transient overvoltage levels of the system for the MADs under engineering supervision.
[5] NFPA 70E calls the MAD the Restricted Approach Boundary.