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OWNER: Engineering	**PPD-EH-2009**	**REVISION: 13**
SUBJECT MATTER AREA: Electrical Safety	**PREPARER: A. Gutmanis**	**Page 1 of 84**
PROCESS/PROGRAM DESCRIPTION	**CONCURRENCE/DATE: A. J. Reed 10/6/20 [Approval Signature on File]**	
TITLE: ELECTRICAL SAFETY PROGRAM	**APPROVED BY/DATE: Mark Gibbs 10/5/20 [Approval Signature on File]**	
USQD ☒ UCD ☐ CAT X ☐ EXEMPT ☐	**EFFECTIVE DATE: 10/20/20**	
USQD/UCD/CAT X No: USQD-MS-PPDEH2009-1661	**REQUIRED REVIEW DATE: 10/20/23**	
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This document is approved for public release per review by:

David Hamrin 10/1/20
UCOR Classification & Information Control Office Date

REVISION LOG

Revision	Effective Date	Description of Changes	Pages Affected
13	10/20/20	Intent change. Clarify Section 6.0, Overhead Utilities. Add new Section 7 with electrical requirements for Buildings/Facilities and ground fault events on ungrounded delta systems. Update NCR disposition requirements in Section 4.9.3 to be consistent with QA documents. Add requirements for audits of Electrical Safety Program and Field Work. Revised Form-3090, Form-3090a, and Form-2957. Add Form-3526 and Form-3528. Implemented changes to resolve UCOR 2020 Electrical Safety Program Assessment Findings recorded in CAMS as IF-2020-0609, 0610, 0611, 0612, 0613, and Opportunities for Improvement recorded in CAMS as MCR-2020-0378, 0379, 0380, 0381, and 0382.	All
12	7/15/19	Intent change. Updated appointing of Electrical AHJ with new Engineering Organization Structure. Clarified responsibilities and definitions. Clarified organizational changes to ESC. Clarified Section 5.8, Energized Electrical Work Permit. Corrected Voltage Range in Section 5.6 Note. Clarified Section 6.0, Overhead Utilities. Revised Form-3090 and added new Form-3090a.	6-9, 13, 15-16, 23-25, 27-31, 36-37, 40-41, 45, 47, 56, 60-61, 63, 65-69
11	1/7/19	Intent Change. Incorporated CHT-UCOR-218, Rev. 5, *Electrical Authority Having Jurisdiction*; CHT-UCOR-219, Rev. 4, *Electrical Safety Committee;* and UCOR-4110, *UCOR Electrical Program Description, Oak Ridge, Tennessee*. Includes October 2018 UCOR logo/tagline rebranding.	All
10	3/29/18	Intent change. Clarified the exclusion of LOTO with EEWP. Addresses CAMS Issue IF-2018-0070. Changed Note prior to #5 in Energized Electrical Work Permit section, to sub-step g, to clarify EEWP requirements. Updated Responsibilities to Senior Advisor to the Office of the President under Roles and Responsibilities # 1 and 2 and Engineering Manager for # 3, 4, and 5 to reflect organizational changes.	7, 8, 26
9	5/1/17	Intent change. Clarified operations near overhead line requirements.	11, 22, 46-48
8	4/17/17	Intent change. Clarified PPE requirements. Added Record documents. Added Attachment F, requirements for discovery of Code of Record-deficient equipment. Addresses CAMS Issue IF-2016-0507 Action 27.	17, 20, 26 49-52

REVISION LOG			
7	8/15/16	Intent change. Reorganized sections. Removed training requirements matrix and consolidated PPE requirements. Added attachment for operations near overhead lines. Clarified requirements. Removed information already discussed in other documents. Corrected inconsistencies with other program documents. Added new Form-3090. Addresses some actions in CAMS Issues IF-2016-0275, 0277, 0278, 0280, 0504, 0506, and 0507.	All
6	1/15/16	Intent change. Clarified requirement for Absence of Nominal Voltage checks. Clarified requirements for barricades. Added attachment for PPE requirements for equipment that has not been properly maintained. Clarified definitions and format changes.	All
5	5/15/15	Intent change. Clarified PPE requirements for 50–300 V circuits. Added attachment to consolidate PPE requirements. Added dedicated section for Arc Flash Protection. Clarified which requirements apply to distribution work as opposed to utilization work. Added several definitions. Added clarity around determining induced voltages. Added AHJ duty concerning approval of non-NRTL purchases. Implemented changes to resolve DOE 2014 Assessment Findings recorded in CAMS as IF-2015-0222, 0223, and 0224.	All
4	7/31/14	Non-intent change. Reworded portion of Step 1, Section L, Energized Electrical Activities – General Requirements, clarify requirement to use Energized Electrical Work Permit.	22
3	7/21/14	Non-intent change. Minor clarifications to note and section title.	6, 13
2	7/21/14	Intent change. Added attachment for Non-NRTL Legacy Program. Reorganized safe work and equipment rules into logical groupings. Added additional equipment information. Added discussion of induced voltages. Clarified responsibilities and definitions. Added Training Flowdown Matrix. Revised attachment for Electrical Installation Equipment Inspections. Revised AHJ reporting structure. This revision also addresses some actions in CAMS Issues IF-2014-0515 and IF-2014-0516.	All
1	8/19/13	Updated procedure references; revised roles and responsibilities to more clearly define the electrical AHJ reporting structure; defined interpretations vs. guidance; defined criteria for AHJ inspection and approval of electrical equipment; clarified GFCI testing requirements; defined training needs for Non-Electrical Workers; added and revised definitions; added two new forms (Form-2907 and Form-2908);and revised Form-2359. Revisions addressed I/CATS Issues I0080896, I0080899, and I0080817.	3-15, 18-23, 25-32, 34-36
0	12/5/11	Initial Release. Replaces BJC-EH-2009 (Rev. 11), *Electrical Safety*.	All

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INTRODUCTION

PURPOSE

This program description establishes the electrical program, electrical safety requirements and guidance, responsibilities of management for controls, and guidance for UCOR, an Amentum-led partnership with Jacobs, electrical equipment or UCOR facility electrical systems during the design, construction, maintenance, demolition, and operation to prevent injury for both qualified and unqualified personnel. This program description also prescribes the responsibilities and actions required for the safe performance of work by personnel working within the Limited Approach Boundary (LAB) and Arc Flash Boundary (AFB) of electrical equipment or circuits that may be energized.

SCOPE

This UCOR program description describes the specific electrical safety responsibilities and minimum requirements to control electrical hazards and to prevent injury and property damage. Direction is provided within this program description to implement electrical safety requirements and achieve compliance with applicable regulations and standards during the design, construction, maintenance, demolition, and operation of facilities, and research and development of electrical systems.

This program description is an Exhibit L flowdown document (which refers to the UCOR-U.S. Department of Energy [DOE] mandatory procedure list) and applies to UCOR employees and subcontractors at all tiers except for other DOE prime contractors working under DOE-approved programs and subcontractors working under UCOR-approved programs. It addresses the qualifications, tools, personal protective equipment (PPE), approval levels, and precautions used for activities with equipment, components, or conductors that may be electrically energized. With the exception of training requirements, the provisions and requirements in this program description also apply to visitors. Visitors shall be considered Unqualified Persons (see Sect. 5.10). Applicable requirements from this program description shall be included in requests for subcontracted work.

Regulations governing electrical system installation and work on or around electrical equipment are determined by the location of the service point. The service point for UCOR electrical systems is defined in Section 1, Definitions/Acronyms. Electrical equipment installed on the line side of the service point is considered electrical power generation, distribution, and transmission equipment as described in 29 Code of Federal Regulations (CFR) Part 1910.269, Electric power generation, transmission, and distribution, and 29 CFR Part 1926, Safety and Health Regulations for Construction, Subpart V, Electrical Power Transmission and Distribution. Electrical equipment installed on the load side of the service point is considered electrical utilization equipment, as described in 29 CFR Part 1910, Occupational Safety and Health Standards, Subpart S, Electrical, and 29 CFR Part 1926, Subpart K, Electrical.

Unless stated otherwise in this program description or authorized by the Electrical Authority Having Jurisdiction (EAHJ), installations on the line side of the service point shall comply with the Institute of Electrical and Electronics Engineers (IEEE) C2, National Electrical Safety Code[1®] (NESC). Work practices on electrical equipment on the line side of the service point shall comply with 29 CFR Part 1910.269 and NESC.

Unless stated otherwise in this program description or authorized by the EAHJ, installations on the load side of the service point shall comply with National Fire Protection Association (NFPA) 70® (National Electrical Code®, or NEC), and Subpart S of 29 CFR Part 1910. Work practices on electrical equipment on the load side of the service

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®Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

point shall comply with 29 CFR Part 1910, Subpart S, and NFPA 70E®, Standard for Electrical Safety in the Workplace®.

Many UCOR facilities are in various stages of deactivation and/or demolition. De-energized (isolated and/or air-gapped) systems and facilities are not required to conform to national codes and standards, nor be maintained. Energized equipment, including temporary equipment actively being used for deactivation and/or demolition, must be in compliance.

AUDIENCE

This program description applies to all UCOR personnel, subcontractors (as communicated through their contract) except for other DOE prime contractors working under DOE-approved programs, subcontractors working under UCOR-approved programs, and visitors.

EXPECTATIONS AND STRATEGY

The requirements in this program description are derived from regulations in 10 CFR Part 851, Worker Safety and Health Program. Deviations from specific requirements in these regulations require special permission, provided in writing by the UCOR EAHJ as provided for in the regulations. Compliance will reduce the risk of exposure to electrical hazards to an acceptable level for both personnel and property.

Personnel safety is the highest priority. All electrical equipment shall meet the requirements of applicable codes and standards, as outlined in this procedure, to safeguard personnel. Energized electrical equipment shall be maintained in a safe operating condition, and personnel shall follow UCOR safe work rules.

GENERAL REQUIREMENTS

1. The principles of the Integrated Safety Management System (ISMS)—as implemented by PROC-FS-1001, *Integrated Work Control Program*; PROC-EH-2002, *Hazardous Energy Control (Lockout/Tagout)*; and other associated programs—shall be used to provide the specific work methods for conducting safety-related work, including hazard and risk evaluations, job briefings, and conducting safety-related work procedures at UCOR facilities.

2. Warnings, postings, and/or labeling on electrical equipment or barricades around electrical equipment shall be read and followed.

3. No work shall be performed within the LAB of energized equipment except by a Qualified Electrical Worker (QEW).

4. Unqualified Persons shall not enter the AFB of energized equipment while electrical work is being performed or the LAB of electrical equipment with exposed energized parts of 50 V or more, unless the Unqualified Person is continuously escorted by a QEW and is wearing the appropriate PPE. Unqualified person shall never cross the Restricted Approach Boundary (RAB).

5. Under normal conditions with no exposed energized parts, the LAB and AFB are not in effect, and persons are permitted in the vicinity of electrical equipment.

6. **Clear Spaces.** Working space required by other code and standards shall not be used for storage of materials, equipment, or supplies. This space shall be kept clear to permit safe operation and maintenance of electrical equipment. See requirements in Section 7 for working space and clearances. Refer to NFPA 70E 130.6(H).

7. **IF** equipment or environmental conditions (e.g., unusual noise, odor, smoke, arcing, or visual degradation) indicate that electric equipment, components, or conductors are likely to fail and/or cause injuries, **THEN**

promptly notify the appropriate personnel to de-energize the electrical device in order to protect personnel from hazards associated with the potential failure of an electrical device.

8. **Blind Reaching.** Never reach or insert equipment blindly into areas that may contain exposed energized parts. Refer to NFPA 70E 130.6(A)(3)(B).

9. **Illumination.** Ensure that illumination is adequate to perform the task safely. Employees shall not enter spaces where electrical hazards exist unless illumination is provided that enables the employees to perform work safely. Refer to NFPA 70E 130.6(C)(1).

10. Hazardous (Classified) locations (as determined by the UCOR Fire Protection AHJ) may require intrinsic safety and special types of equipment rated for specific duty in hazardous locations (i.e., intrinsically safe equipment). The EAHJ and FP AHJ will determine the appropriate equipment needed using the applicable federal regulations and codes.

NOTE: Prior to the 2018 edition of NFPA 70E, UCOR was invoking an exception that stated that for voltages of 240V or less, equipment fed from transformers 125kVA or less do not have an arc flash hazard. This was in reference to IEEE 1584-2002, Section 9.3.2. Since then, the IEEE standard has removed this exemption. Subsequently, the 2018 edition of NFPA 70E also no longer supports this position. Legacy exception labels on equipment are acceptable, as permitted by NFPA 70-2018, 130.5(H) Exception No. 1, unless changes in the electrical distribution system render the label inaccurate. Labels applied prior to the effective date of the 2018 edition of the standard shall be acceptable if they complied with the requirements for equipment labeling in the standard in effect at the time the labels were applied.

11. For PPE requirements while operating and working on equipment with an arc flash exception label, follow the Arc Flash Hazard label or the work documents when the installation has been analyzed and appropriately documented with an approved Arc Flash Hazard Analysis.

12. For mobile equipment performing work operations or equipment “in transit” near energized overhead utility lines, see Section 6, Overhead Utilities.

A. EMERGENCY RESPONSE

NOTE: Accident/Incident reporting requirements are outlined in PROC-EH-2001, *Accident/Incident Reporting*.

1. **IF** an electrical emergency occurs that potentially affects the immediate safety of personnel, **THEN**

   - Take appropriate mitigating actions only if safe and you are trained to do so.
   - Have the electrical source de-energized as quickly as possible.

2. Immediately report emergencies requiring assistance by dialing 911 from a site phone, using an alarm pull box, contacting the Emergency Services Watch Office (ESWO)/Laboratory Shift Superintendent (LSS)/Plant Shift Superintendent (PSS), sending a messenger, or using the building public-address (PA) system, if available. (Do not call 911 from a mobile phone and expect to get onsite emergency response. Use the numbers in the following step when using mobile phones to summon assistance.)

3. Any person discovering an emergency condition should alert the ESWO/LSS/PSS by one of the following means as soon as practical following initial emergency services notification and when safe to do so:

- East Tennessee Technology Park (ETTP) ESWO: (865) 574-3282, (865) 574-4911, or Radio Channel 9
- Oak Ridge National Laboratory (ORNL) LSS: (865) 574-6606 or Radio Channel 1
- Y-12 National Security Complex (Y-12) PSS: (865) 574-7172 or Radio Channel 4

4. Report any work-related injury/illness to supervision and/or the ESWO/LSS/PSS.

5. Consider all electrical shocks to be medically serious with the exception of static discharges in non-powered installations (non-powered includes such cases as touching doorknobs or other people).

6. Ensure the injured person is continuously monitored until medical aid is obtained.

7. Escort injured person to the nearest medical facility for observation, even if the person shows no apparent signs of injury.

8. Provide all pertinent information to the medical facility (such as voltage level, exposure duration, equipment type, and points of contact).

9. Make timely notification of electrical incidents or injuries to the Electrical AHJ.

B. INCIDENT INVESTIGATIONS

1. Electrical incident investigation requirements of NFPA 70E section 110.1(J) shall be accomplished through PROC-EH-2001, *Accident/ Incident Reporting*, PROC-FO-1063, *Issue Review and Investigation Process*, and PROC-PQ-1220, *Occurrence Notification and Reporting*.

ADMINISTRATIVE REQUIREMENTS

A. PROGRAM AUDITS

1. **Electrical Safety Program Audit.** The electrical safety program shall be assessed to help ensure that the principles and procedures of the program are being followed. Program audits shall be conducted and documented every three years at a minimum.

2. **Field Work Audit.** Audits of field work shall be conducted and documented at least once a year to ensure the requirements contained in the procedures of the electrical safety program are being followed. Field audits should be scheduled using the "Graded-Approach" to ensure strategic coverage of all UCOR work sites at intervals not to exceed 3 years.

3. **Documentation.** Electrical Safety Program audits shall be documented in accordance with PROC-PQ-1420, *Assessments*. Field Work Audits shall be documented using Form-3526, Electrical Field Work Audit Checklist. Where the audit determines that the principles and procedures of the program are not being followed, appropriate actions to correct any observations or findings shall be taken. Any Observations or Findings shall be documented as issues in the UCOR Corrective Action Management System (CAMS) in accordance with PROC-PQ-1210, *Issues Management Program*.

OTHER DOCUMENTS NEEDED

NOTE: Other Documents Needed and Source Documents, as listed, shall be the latest edition/revision unless otherwise stated or unless stipulated by reference in one of the listed documents.

- IEEE C2-2017, National Electrical Safety Code
- NFPA 70, National Electrical Code, 2020 Edition
- NFPA 70E, Standard for Electrical Safety in the Workplace, 2018 Edition
- NFPA 790, Standard for Competency of Third-Party Field Evaluation Bodies
- NFPA 791, Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation
- 10 CFR Part 851, Worker Safety and Health Program
- 29 CFR Part 1910, Subpart S, Electrical
- 29 CFR 1910.7, Definition and requirements for a nationally recognized testing laboratory
- 29 CFR Part 1910.147, The control of hazardous energy (lockout/tagout)
- 29 CFR Part 1910.269, Electric power generation, transmission, and distribution
- 29 CFR Part 1926, Subpart K, Electrical
- 29 CFR Part 1926, Subpart V, Electrical Power Transmission and Distribution
- DOE Order (O) 232.2, *Occurrence Reporting and Processing of Operations Information*
- DOE-HDBK-1092-2013, *Electrical Safety*
- DOE Guide (G) 440.1-1B, *Worker Safety and Health Program for DOE (Including the National Nuclear Security Administration) Federal and Contractor Employees*
- UCOR-4122, *Configuration Management Program Description for URS | CH2M Oak Ridge LLC, Oak Ridge, Tennessee*
- UCOR-4141, *URS | CH2M Oak Ridge LLC Quality Assurance Program Plan, Oak Ridge, Tennessee*
- UCOR MOU-16-317 R2, UCOR & UTB Interface Agreement
- UCOR MOU-17-320 Rev. 1, UCOR & CNS Interface Agreement
- PPD-EH-1745, *Worker Safety and Health Program*
- PROC-DE-0704, *Project Calculations*
- PROC-DE-1008, *Design Change Notice (DCN), Engineering Instructions (EIs) and Equivalency Evaluations (EEs)*
- PROC-DE-1021, *Material Requisition Package Requirements*
- PROC-DE-1022, *Control of Measuring and Test Equipment*
- PROC-DE-1023, *Preparation and Maintenance of Arc Flash (AF) Hazard Analysis for AC and DC Electrical Systems*
- PROC-DE-1032, *Preparation and Maintenance of UCOR Code of Record (COR) Documentation*
- PROC-DE-1033, *Development of UCOR Requirements Documentation*
- PROC-EH-1013, *Accident Prevention Signs, Barricades, and Other Postings*
- PROC-EH-2000, *General Safety Requirements*

- PROC-EH-2001, *Accident/Incident Reporting*
- PROC-EH-2002, *Hazardous Energy Control (Lockout/Tagout)*
- PROC-ET-1040, *Preventive Maintenance of Low Voltage Fused Disconnects and Molded Case Circuit Breakers at ETTP*
- PROC-ET-3013, *Power Distribution Work Permit*
- PROC-FO-1008, *Hoisting and Rigging Operations*
- PROC-FO-1015, *Scaffolds and Ladders*
- PROC-FO-1059, *Facility Transition*
- PROC-FO-1063, *Issue Review and Investigation Process*
- PROC-FO-1066, *Administrative Tagging*
- PROC-FO-1068, *Equipment and Component Labeling*
- PROC-FO-3030, *UCOR Preventive Maintenance*
- PROC-FO-3033, *Out of Commission Isolation Process for Structures, Systems, and Components*
- PROC-FP-2006, *UCOR Program for Controlling Combustibles and Ignition Sources*
- PROC-FS-1001, *Integrated Work Control Program*
- PROC-MP-2202, *Ground-Fault Circuit Interrupter (GFCI) Periodic Inspection and Testing*
- PROC-OR-2226, *Preventive Maintenance of Low Voltage Fused Disconnects and Molded Case Circuit Breakers*
- PROC-OR-2227, *Preventive Maintenance of Low Voltage Motor Control Centers (MCCs)*
- PROC-OS-1001, *Records Management, Including Document Control*
- PROC-PQ-1170, *Control of Subject Matter Area Designations and Subject Matter Expert Assignments*
- PROC-PQ-1210, *Issues Management Program*
- PROC-PQ-1220, *Occurrence Notification and Reporting*
- PROC-PQ-1440, *Control of Non-conforming Items and Materials*
- PROC-PR-1200, *Requisition Process for Materials and Services*
- PROC-TC-0710, *Training Position Descriptions and Position Assignment Forms*
- Form-2155, Energized Electrical Work Permit
- Form-2155a, Energized Electrical Work Permit Instructions
- Form-2359, Request for Inspection of Electrical Work
- Form-2892, AHJ Interpretation and Guidance Log
- Form-2893, AHJ Interpretations/Guidance Response
- Form-2895, Non-NRTL/Modified NRTL-Listed Electrical Equipment Approval
- Form-2896, UCOR Non-NRTL Electrical Equipment Registration Log
- Form-2907, UCOR Electrical AHJ Approved Equipment to be Energized
- Form-2908, UCOR Electrical AHJ Approved Non-NRTL Equipment

- Form-2957, Grounding System Resistance Test
- Form-2988, Non-NRTL Listed Item Review Request
- Form-2988a, Non-NRTL Listed Item Review Request Instructions
- Form-2995, Attachment Plug Repair for Power-Supply Cords Inspection Checklist
- Form-3090, Overhead Utility Clearance Permit
- Form-3090a, Overhead Utility Clearance Permit Instructions
- Form-3526, Electrical Field Work Audit Checklist
- Form-3528, Insulation Resistance (Megger) Test

RECORDS

All records, including permits and training and forms listed below, shall be maintained in accordance with the UCOR records retention policy and schedule.

- Form-2155, Energized Electrical Work Permit
- Form-2359, Request for Inspection of Electrical Work
- Form-2892, AHJ Interpretation and Guidance Log
- Form-2893, AHJ Interpretations/Guidance Response
- Form-2895, Non-NRTL/Modified NRTL-Listed Electrical Equipment Approval
- Form-2896, UCOR Non-NRTL Electrical Equipment Registration Log
- Form-2907, UCOR Electrical AHJ Approved Equipment to be Energized
- Form-2908, UCOR Electrical AHJ Approved Non-NRTL Equipment
- Form-2957, Grounding System Resistance Test
- Form-2995, Attachment Plug Repair for Power-Supply Cords Inspection Checklist
- Form-3090, Overhead Utility Clearance Permit
- Form-3526, Electrical Field Work Audit Checklist
- Form-3528, Insulation Resistance (Megger) Test

SOURCE DOCUMENTS

NOTE: Additional standards and publications, or portions thereof, are included by reference in the listed source documents.

- IEEE C2, National Electrical Safety Code (NESC)
- IEEE C37.20.6, Standard for 4.76 kV to 38 kV-Rated Ground and Test Devices Used in Enclosure
- NFPA 70, National Electrical Code
- NFPA 70E, Standard for Electrical Safety in the Workplace
- NFPA 70B, Recommended Practice for Electrical Equipment Maintenance
- 10 CFR Part 851, Worker Safety and Health Program

- 29 CFR Part 1910.137, Electrical protective equipment
- 29 CFR Part 1910.268, Telecommunications
- 29 CFR Part 1910.269, Electric power generation, transmission, and distribution
- 29 CFR Part 1910, Subpart S, Electrical
- 29 CFR Part 1926, Subpart K, Electrical
- 29 CFR Part 1926, Subpart V, Electric Power Transmission and Distribution
- DOE-HDBK-1092-2013, Electrical Safety
- DOE O 440.1, *Worker Protection Management for DOE Federal and Contract Employees*
- DOE-STD-1170-2007, *Electrical Systems and Safety Oversight Functional Area Qualification Standard*
- PROC-EH-2001, *Accident/Incident Reporting*
- PROC-FO-1063, *Issue Review and Investigation Process*
- PROC-PQ-1220, *Occurrence Notification and Reporting*

1 DEFINITIONS/ACRONYMS

1.1 DEFINITIONS

NOTE: The explanatory notes related to the definitions in this section follow after the definition term so as to be consistent with the NFPA 70, Article 100, Definitions.

This section contains only those definitions and acronyms essential to the application of this program description. It is not intended to include commonly defined general terms or commonly defined technical terms from other national consensus codes and standards.

Absence of Voltage Test/Absence of Nominal Voltage Test – A test performed by a Qualified Electrical Worker (QEW) to determine if the circuit or device being tested is void of hazardous electrical energy. Induced voltages may result in non-zero voltage readings even when the circuit is verified to be void of hazardous electrical energy.

Accessible (as applied to equipment) – Capable of being reached for operation, renewal, and inspection.

Accessible (as applied to wiring methods) – Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building.

Accessible, Readily (Readily Accessible) – Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions, such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

Appliance – Utilization equipment, generally other than industrial, that is normally built in standardized sizes or types, and is installed or connected as a unit to perform one or more functions, such as clothes washing, air conditioning, food mixing, and deep frying.

Air-gapped – Electrically removed from service by dismantling, cutting and/or disconnecting cable, removing buses, or other equivalent means of disconnecting circuitry, such that power cannot be reintroduced inadvertently or easily without construction-type activities to restore power. Air-gapping is typically used to abandon electrical equipment and deactivate facilities, and does not require a Lock Out/Tag Out (LO/TO) to remain in place after the establishment of the air-gap. Pulling fuses, opening disconnect switches, racking out circuit breakers, or utilizing other operational activities and/or equipment features is not sufficient to be considered air-gapped.

Approved – Acceptable to the Authority Having Jurisdiction (AHJ).

Approved Electrical Equipment – Electrical equipment or components that meets established requirements for safety in their design and construction. Equipment listed, labeled, or recognized by a nationally recognized testing laboratory (NRTL) (e.g., UL LLC [UL], CSA, TUV, ETL Intertek) is considered approved. Equipment not listed, labeled, or recognized, including that fabricated onsite or modified onsite after manufacture, must be approved by the AHJ. “Modified onsite” is defined as any alteration or change to the manufacturer's electrical circuitry.

Arc-Fault Circuit Interrupter (AFCI) – A device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

Arc Flash Hazard – A source of possible injury or damage to health associated with the release of energy caused by an electric arc.

NOTE: The likelihood of occurrence of an arc flash incident increases 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. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained.

Arc Flash Hazard Analysis – A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury mitigation and the determination of safe work practices, arc flash boundary (AFB), and the appropriate levels of personal protective equipment (PPE).

Arc Flash Hazard Analysis Exempt – Electrical equipment that has been determined to meet exception criteria per applicable standards and procedures.

Arc Flash Suit – A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet.

NOTE: An arc flash suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield.

Arc Rating – The value attributed to a material that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm^2 and is derived from the determined value of the arc thermal performance value (ATPV) or energy of break open threshold (EBT) (should a material system exhibit a break open response below the ATPV value). Arc rating is reported as either ATPV or EBT, whichever is the lower value.

NOTE: Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame-resistant (FR) clothing without an arc rating has not been tested for exposure to an electric arc.

Arc Thermal Performance Exposure Value (ATPV) – The incident energy on a material or a multilayer system of materials that results in a 50-percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll curve, cal/cm^2.

Attachment Plug (Plug Cap) (Plug) – A device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

Attendant – A worker stationed to warn and protect persons from electrical hazards. The duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified persons outside a work area where the unqualified persons might be exposed to electrical hazards.

Authority Having Jurisdiction (AHJ) – A person responsible for enforcing the requirements of a code or standard, approving equipment, materials, installations, and procedures. The UCOR Electrical AHJ (EAHJ) and UCOR Fire Protection AHJ (FP AHJ) is an individual who operates with authority formally delegated by the U.S. Department of Energy (DOE).

Automatic – Performing a function without the necessity of human intervention.

Barricade – A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning and to limit access.

Barrier – A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts or to prevent unauthorized access to a work area.

Boundary, Arc Flash – When an Arc Flash Hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

NOTE: According to the Stoll skin burn injury model, the onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm^2 (5 J/cm^2) for one second.

Boundary, Limited Approach – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Boundary, Restricted Approach – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of shock, due to electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

Branch Circuit – The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

Code of Record – The code in effect at the time of design, installation, or major modification. Unless required to correct a known hazard or a major modification is being performed, installations in compliance with the Code of Record do not need to be upgraded to a more recent edition of the code unless so stated in the code.

Conductive – Suitable for carrying electric current.

Dead Front – Without live parts exposed to a person on the operating side of the equipment.

Dedicated Spotter – A person who is specifically trained and assigned to monitor the separation clearance between an overhead utility line and mobile equipment and/or payload.

De-energized – Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

Device – A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function.

Diagnostics/Testing – Making measurements with approved test equipment and making minor adjustments for calibration.

Electrical Hazard – A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or arc blast injury.

Electrical Safety – Identifying hazards associated with the use of electrical energy and taking precautions to reduce the risk associated with those hazards.

Electrical Transmission and Distribution Equipment – Equipment used to transform, switch, and carry electrical power from generating stations and transmissions lines to the various service points of facilities. This equipment is maintained in accordance with 29 Code of Federal Regulations (CFR) Part 1910.269, Electric power generation, transmission, and distribution, and the National Electric Safety Code (NESC).

Electrically Safe Work Condition – A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked, and tagged in accordance with PROC-EH-2002, *Hazardous Energy Control (Lockout/Tagout)*, or PROC-ET-3013, *Power Distribution Work Permit*, and tested to verify the Absence of Nominal Voltage and if necessary, temporarily grounded for personnel protection.

Enclosed – Surrounded by a case, housing, fence, or wall(s) that prevents persons from unintentionally contacting energized electrical conductors or circuit parts.

Enclosure – The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from unintentionally contacting energized electrical conductors or circuit parts, or to protect the equipment from physical damage.

Energized – Electrically connected to, or is a source of voltage.

Equipment – A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation.

Equipment Operator – Someone other than a QEW who is trained and authorized to operate certain electrical equipment and maintains qualification via training.

Evidence of Impending Failure – Evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

Exposed (as applied to energized electrical conductors or circuit parts) – Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated.

Exposed (as applied to wiring methods) – On or attached to the surface or behind panels designed to allow access.

Face Shield (Arc-rated) – An arc-rated polycarbonate or similar non-melting type with a wrap-around guarding to protect the face, forehead, ears, and neck.

Fault – An electrical fault, such as a short circuit or arc to another energized conductor or a short circuit or arc to ground.

NOTE: An overload condition is not necessarily considered an electrical fault.

Field Evaluation Body (FEB) – An organization or part of an organization that performs field evaluations of electrical or other equipment. See National Fire Protection Association (NFPA) 790, Standard for Competency of Third-Party Field Evaluation Bodies, for further information.

Field Labeled (as applied to evaluated products) – Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report.

Finger Safe – A condition where a probe, the approximate size of a *finger*, must not be able to access or make contact with hazardous, energized parts. IEC 60529 IP 2X testing involves pressing a standardised 12-mm diameter test finger with a force of 10 N, and a 12.5-mm sphere with a force of 30 N, against all openings in the enclosure. For acceptance, the sphere must not fully enter the enclosure, and there must be a satisfactory distance between the test finger and dangerous live parts and moving parts.

Free Air (as applied to conductors) – Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor.

Ground – The earth.

Ground Fault – An unintentional, electrically conducting connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth.

Grounded (Grounding) – Connected (connecting) to ground or to a conductive body that extends the ground connection.

Grounded, Solidly – Connected to ground without inserting any resistor or impedance device.

Grounded Conductor – A system or circuit conductor that is intentionally grounded.

NOTE: Although an equipment grounding conductor is grounded, it is not considered a grounded conductor.

Ground-Fault Circuit-Interrupter (GFCI) – Device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device.

Grounding Conductor, Equipment (EGC) – The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

NOTE: It is recognized that the equipment grounding conductor also performs bonding.

Grounding Electrode – A conducting object through which a direct connection to earth is established.

Grounding Electrode Conductor – A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.

Grounding Standards, UCOR – A set of UCOR drawings (Drawing Number E1E700002A106, Sheets 1 and 2) that establishes the grounding methodology and requirements for typical mobile equipment used at UCOR facilities.

Guarded – Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.

Guidance – Advice on issues not requiring an *Interpretation* or exceptions of the specific rules of the NFPA 70 and related codes, rules, and standards that are applicable to electrical safety.

Habitable Room – A room in a building for living, sleeping, eating, or cooking, but excluding bathrooms, toilet rooms, closets, hallways, storage or utility spaces, and similar areas.

Hazard – A source of possible injury or damage to health.

Hazardous – Involving exposure to at least one hazard.

Hazardous (Classified) Location – Any location where fire or explosive hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or materials.

Incident Energy – The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per centimeter squared (cal/cm^2).

Incident Energy Analysis – A component of an arc flash risk assessment used to predict the incident energy of an arc flash for a specified set of conditions.

Insulated – Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

Insulating Protective Equipment – PPE that includes rubber gloves, dielectric footwear insulating blankets, hoods, line hoses, and other PPE devised, normally flexible, having specific dielectric rating, and used for personnel protection against electric shock and burns.

Interpretation – The formal, written answer to a question on the meaning or intent of specific provision(s) of Code of Record processed in accordance with Section 4 of this program description, giving the formal position of the UCOR AHJ on the meaning or intent of NFPA 70 and related codes, rules, and standards that are applicable to electrical safety.

Intrinsic Safety – A design technique applied to electrical equipment and wiring for hazardous locations. The technique is based on limiting energy, electrical and thermal, to a level below that required to ignite a specific hazardous atmospheric mixture.

Intrinsically Safe Equipment – Equipment and wiring which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration.

Isolated (as applied to location) – Not readily accessible to persons unless special means for access are used.

Isolated (as applied to equipment) – De-energized for the purpose of removing from service, but not air-gapped. Typically a facility, system, or piece of equipment scheduled for demolition is isolated before it is air-gapped.

Labeled (for Safety) – Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the AHJ and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

NOTE: If a listed product is of such a size, shape, material, or surface texture that it is not possible to apply legibly the complete label to the product, the complete label may appear on the smallest unit container in which the product is packaged.

Like-for-Like – Replacement components that are:

- Identical components (e.g., same manufacturer, model number, part number). The identical components may not be NRTL listed, labeled, and/or recognized (LLR) as individual components but shall be used as replacement parts to maintain the overall NRTL LLR of the assembly.
- Commodity-type items, such as wire, flexible cord, conduit, fittings, terminal lugs, etc., that conform to the requirements for the parts but may have different manufacturers. This equipment is required to be NRTL LLR.

Like-for-Kind – Replacement components that are:

- Similar in function and critical characteristics but are not identical to the original manufacturer's part.

This includes the original manufacturer's recommended replacement part if not identical.

- Evaluated for equivalency by Engineering and found to be equivalent or better than the original part.
- Manufacturer's recommended replacement parts for permanently installed, non-NRTL legacy equipment.

Listed – Equipment, materials, or services included in a list published by an organization that is acceptable to the AHJ and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. Use of the system employed by the listing organization allows the AHJ to identify a listed product.

Live Parts – Energized conductive components.

1. "Exposed moveable conductor" applies to equipment such as overhead lines.

2. "Exposed fixed conductor" applies to equipment such as control panels, transformers, breakers, and other fixed equipment.

Maintenance, Condition of – The state of the electrical equipment considering the manufacturers' instructions, manufacturers' recommendations, and applicable industry codes, standards, and recommended practices.

Messenger or Messenger Wire – A wire that is run along with or integral with a cable or conductor to provide mechanical support for the cable or conductor.

Minimum Approach Distance – The closest distance a qualified person is permitted to approach an energized or a grounded object as specified by 29 CFR Part 1910.269.

Nationally Recognized Testing Laboratory (NRTL) – An organization that is recognized by Occupational Safety and Health Administration (OSHA) as an acceptable laboratory for product evaluation and that maintains records of periodic examinations of equipment and materials. The NRTL ensures that equipment and materials comply with designated standards or are tested to determine their suitability for use.

Nominal Voltage – A nominal value assigned to a circuit or system for the purpose of conveniently designating a voltage class. The actual voltage at which a circuit operates can vary from the nominal voltage within a range that permits satisfactory operation of equipment.

Outlet – A point on the wiring system at which current is taken to supply utilization equipment.

Overcurrent – Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

NOTE: A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.

Overload – Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity. An overload condition, when it persists for a sufficient length of time, can cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

Panelboard – A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

Portable Electrical Equipment – Electric-powered equipment that is not permanently mounted and not permanently grounded. Portable electric equipment are connected to their power source by flexible cord and plug. Portable electric equipment includes a broad range of devices, such as:

1. Office equipment – Examples include personal computers, printers, and electric staplers.
2. Miscellaneous equipment – Examples include clocks, coffeepots, heaters, extension cords, and power strips.
3. Industrial equipment – Examples include 240- or 480-V welders, air conditioners, swamp coolers, and heaters.

Power Lines – Conductors used to transmit and distribute electric energy and their necessary supporting or containing structures, equipment, and apparatus that are used to provide electric supply service.

Power Production Equipment – Electrical-generating equipment supplied by any source other than a utility service, up to the source system disconnecting means.

NOTE: Examples of power production equipment include such items as generators, solar photovoltaic systems, and fuel cell systems.

Portable Electric Tools – Tools that are not permanently mounted and are not permanently grounded. Portable electric tools are connected to their power source by flexible cord and plug. Portable electric tools include grinders, drills, saws, vacuums, and other equipment used to perform maintenance, construction, and similar activities.

Premises Wiring (System) – Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes (a) wiring from the service point or power source to the outlets, or (b) wiring from and including the power source to the outlets where there is not service point. Such wiring does not include wiring internal to appliances, luminaires, motors, controller, motor control center (MCC), and similar equipment.

Properly Installed – The equipment is installed in accordance with applicable industry codes and standards and the manufacturer's requirements.

Properly Maintained – The equipment has been maintained in accordance with the manufacturer's requirements and applicable industry codes and standards.

Qualified Electrical Worker (QEW) (Qualified Person) – One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations, and has received safety training to identify the hazards and reduce the associated risk.

Receptacle – A receptacle is a contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke or strap. A multiple receptacle is two or more contact devices on the same yoke or strap.

NOTE: A duplex receptacle is an example of a multiple receptacle that has two receptacles on the same yoke or strap.

Reconditioned – Electromechanical systems, equipment, apparatus or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis.

NOTE: The term "reconditioned" is frequently referred to as "rebuilt," "refurbished," or "remanufactured."

Repair – The physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

Requestor – Any individuals who are responsible for purchase of electrical equipment, or are responsible for requesting inspections of new or modified installations.

Risk – A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard.

Risk Assessment – An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.

NOTE: As used in this program description, *arc flash risk assessment* and *shock risk assessment* are types of risk assessments.

Service Drop – The overhead conductors between the serving utility and the service point.

Service Point – The point of connection between the facilities of the serving utility distribution system and premises wiring.

Shock Hazard – A source of possible injury or damage to health associated with current through the body caused by contact or approach to energized electrical conductors or circuit parts.

Shock Hazard Analysis – An analysis performed by a QEW/QEW Supervisor or Engineering that considers the maximum voltage involved and determines the shock protection boundaries (Limited Approach Boundary [LAB] and Restricted Approach Boundary [RAB]) and the correct shock protection PPE.

Special Permission – The written consent of the AHJ.

Step Potential – A ground potential gradient difference that can cause current flow from foot to foot through the body.

Stock – Items that have passed their initial testing and are in use, at the testing lab, or in storage.

Switchboard – A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

Touch Potential – A ground potential gradient difference that can cause current flow from hand to hand, hand to foot, or another path, other than foot to foot, through the body.

Transit – Vehicular and mechanical equipment (e.g., fork trucks, excavators, aerial lifts, track hoes) that is moving under its own power or being transported by trailer or tow vehicle, without load, and with the structure lowered to its lowest stowed position prior to movement.

Troubleshooting – The investigation into the reason(s) for equipment malfunction. Troubleshooting may involve observation, voltage testing, voltage/signal observations (with an oscilloscope, for example), current testing, temperature testing (infrared, for example), and other testing, combined with logic and deduction to determine the source of the problem. Troubleshooting may also include the use of temporary jumpers, but such use is limited to low-voltage (120 V alternating current [VAC] or less) control and instrumentation circuits only, and requires use of the safe work rules contained in this program description and NFPA 70E, 26 CFR Part 1910 Subpart S, and/or 26 CFR Part 1910.269, as applicable.

Ungrounded – Not connected to ground or to a conductive body that extends the ground connection.

Unqualified Person – A person who is not a qualified person.

Utilization Equipment – Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes.

NOTE: Most electrical equipment supplied by premises wiring is Utilization Equipment.

Voltage (of a Circuit) – The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned.

NOTE: Some systems—such as three-phase 4-wire, single-phase 3-wire, and 3-wire direct-current (DC)—may have various circuits of different voltages.

Voltage, Nominal – A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 V, 480Y/277 V).

NOTE 1: The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

NOTE 2: See ANSI C84.1, Electric Power Systems and Equipment — Voltage Ratings (60 Hz).

Working Distance – The distance between a person's face and chest area and a prospective arc source.

NOTE: Incident energy increases as the distance from the arc source decreases. See NFPA 70E 2018 Edition 130.5(G) for further information.

Working On (energized electrical conductors or circuit parts) – Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the PPE a person is wearing. There are two categories of "working on":

Diagnostic (testing) is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment;

Repair is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

NOTE: Normal operations of switches, molded case breakers, disconnects, and other operational equipment with all covers and panels in place is not considered to be working on energized electrical equipment since there is no shock exposure.

1.2 ACRONYMS

AFB – Arc Flash Boundary

AFCI – Arc-Fault Circuit Interrupter

AFHA – Arc Flash Hazard Analysis

AHJ – Authority Having Jurisdiction

ANSI – American National Standards Institute

ASTM – American Society for Testing and Materials

ATPV – Arc Thermal Performance Value

CAMS – Corrective Action Management System

CDP – Code Deficiency Program

CFR – Code of Federal Regulations

D&D – Decontamination and Demolition

DC – Direct current

DCN – Design Change Notice

DOE – U.S. Department of Energy

EAHJ – Electrical Authority Having Jurisdiction

EAHJ FR – EAHJ Field Representative

EBT – Energy of Break Open Threshold

EGC – Equipment Grounding Conductor

EEWP – Energized Electrical Work Permit, Form-2155

EIP – Electrical Inspection Program

ESC – Electrical Safety Committee

ESWO – Emergency Services Watch Office (ETTP)

ETTP – East Tennessee Technology Park

FEB – Field Evaluation Body

FM – Facility Manager

FP AHJ – Fire Protection Authority Having Jurisdiction

FR – Flame resistant

G – Guide

GFCI – Ground-Fault Circuit-Interrupter

IA – Interface Agreement

IA – Interim Agreement

IEEE – Institute of Electrical and Electronics Engineers

ISMS – Integrated Safety Management System

JHA – Job Hazard Analysis

LAB – Limited Approach Boundary

LEARN – Local Education Administrative Requirements Network

LLR – Listed, Labeled, and/or Recognized

LO/TO – Lockout/Tagout

LSS – Laboratory Shift Superintendent (ORNL)

MAD – Minimum Approach Distance

MCC – Motor Control Center(s)

MOU – Memorandum of Understanding

NEC – National Electrical Code

NESC – National Electrical Safety Code

NFPA – National Fire Protection Association

NCR – Nonconformance Report

NRTL – Nationally Recognized Testing Laboratory

OCPD – Overcurrent protective device

OJT – On the job training

OREM – Oak Ridge Office of Environmental Management

ORNL – Oak Ridge National Laboratory

OSHA – Occupational Safety and Health Administration

PDWP – Power Distribution Work Permit

PIG – Power Integration Group

PM – Preventive Maintenance

PM/FM – Project Manager/Facility Manager

PPE – Personal protective equipment

PSS – Plant Shift Superintendent (Y-12)

QA – Quality Assurance

QEW – Qualified Electrical Worker

RAB – Restricted Approach Boundary

S&H – Safety and Health

S&M – Surveillance and Maintenance

SME – Subject Matter Expert

SSS – Safety Systems and Services

TPD – Training Program Description

TSR – Technical Safety Requirement

VAC – V alternating current

WP – Work Package

Y-12 – Y-12 National Security Complex

2 ROLES AND RESPONSIBILITIES

2.1 INTRODUCTION

This section establishes electrical safety-related roles, requirements for the Electrical Safety Committee (ESC), and employee and subcontractor electrical training. This is not intended to be a complete set of roles and responsibilities for the positions and organizations listed, and the titles used in many cases denote function, not official job or organization title.

2.2 ROLES

2.2.1 UCOR President and Chief Executive Officer

1. Appoint in writing the UCOR, an Amentum-led partnership with Jacobs, Electrical Authority Having Jurisdiction (EAHJ) and Deputy EAHJ(s) (when appointed).

2. Submit to the U.S. Department of Energy (DOE), in writing, the names and qualifications of the designated UCOR EAHJ along with the designated Deputy EAHJ (when appointed).

3. Ensure EAHJ personnel have an evaluation and documentation of competency using the criteria such as those established in DOE-STD-1170-2007, *Electrical Systems and Safety Oversight Functional Area Qualification Standard*.

2.2.2 UCOR Technical Services Engineering Manager

1. Appoint a qualified individual to serve as the UCOR Electrical Safety Program Manager.

2.2.3 Electrical Authority Having Jurisdiction

1. See Section 4, Electrical Authority Having Jurisdiction Organization and Activities, for details.

2.2.4 Deputy Electrical Authority Having Jurisdiction

1. See Section 4, Electrical Authority Having Jurisdiction Organization and Activities, for details.

2.2.5 Electrical Authority Having Jurisdiction Field Representatives

1. See Section 4, Electrical Authority Having Jurisdiction Organization and Activities, for details.

2.2.6 Electrical Safety Subject Matter Expert

1. The roles and responsibilities of subject matter experts (SMEs) are defined in procedure PROC-PQ-1170, *Control of Subject Matter Area Designations and Subject Matter Expert Assignments*. The Electrical Safety SME role is performed by the EAHJ and the Deputy EAHJ.

2. Ensure all Electrical Safety Documentation is reviewed and updated when necessary.

2.2.7 Electrical Safety Program Manager

1. Manage the UCOR Electrical Program.

2. Serve as the single point of contact for electrical program issues.

3. Ensure all Electrical Program Procedures are reviewed and updated when necessary

4. Interface with the UCOR EAHJ, Electrical Safety SMEs and others routinely to maintain a close harmonious working relationship to resolve electrical issues.

5. Provide oversight/ assessment of adequacy of all UCOR electrical activities, including electrical engineering.

6. Schedule and perform audits/assessments of the electrical safety program and fieldwork per the administrative requirements of this program description.

7. Review assessment plans, scope, and Lines of Inquiry for application of a "Graded-Approach" to ensure strategic coverage of all priority risks of the program, associated risks of field work activities, and work sites being reviewed.

8. Review and identify required actions associated with electrical lessons learned, to include submission to Issues Management, if required.

9. Service as the Chair of the UCOR Electrical Safety Committee.

10. Review and approve of electrical training requirements.

11. Identify and correct trends within the electrical program.

2.2.8 Engineering Manager(s)

1. Ensure that assigned electrical engineers and designers have access to and knowledge of National Fire Protection Association (NFPA), Institute of Electrical and Electronics Engineers (IEEE), and American National Standards Institute (ANSI) codes and standards applicable to their job duties.

2. Ensure that electrical designs are in compliance with the applicable portions of 29 Code of Federal Regulations (CFR) Part 1910, Subpart S; 29 CFR Part 1926, Subpart K; 29 CFR Part 1926, Subpart V; 29 CFR Part 1910.269; NFPA 70 (NEC); NFPA 70E; and Institute of Electrical and Electronics Engineers (IEEE) C2, National Electrical Safety Code (NESC).

3. Ensure implementation of electrical safety requirements in the designs for new facilities or facility modifications, and for planning technical oversight for fieldwork when required.

4. Maintain the necessary drawings for the energized electrical power systems; the decision on whether to maintain up-to-date electrical drawings for a facility is in accordance with the process described in UCOR-4122, *Configuration Management Program Description for URS | CH2M Oak Ridge LLC, Oak Ridge, Tennessee*.

5. Ensure material requisitions issued for the purchase of materials/equipment/services are generated in accordance with Engineering procedures (refer to Supply Chain Management, formerly Procurement, in Section 2.2.17).

6. Ensure material requisitions issued for electrical conductors or equipment or fire protection equipment are compliant with Nationally Recognized Testing Laboratory (NRTL) Listed, Labeled, and/or Recognized (LLR) requirements per PROC-DE-1021, *Material Requisition Package Requirements*, and PROC-PR-1200, *Requisition Process for Materials and Services.*

7. Oversee development of program and processes for Arc Flash Hazard Analysis.

8. Provide engineering resources to support electrical isolation of facilities per PROC-FO-3033, *Out of Commission Isolation Process for Structures, Systems, and Components*.

9. The Technical Services & Regulatory Officer serves as the Executive Sponsor for the Engineering Safety Committee (ESC).

2.2.9 Electrical Engineers

1. Provide electrical designs in accordance with all applicable codes and standards.

2. Perform Arc Flash Hazard Analysis per PROC-DE-1023, *Preparation and Maintenance of Arc Flash (AF) Hazard Analysis for AC and DC Electrical Systems*, as required to support projects.

3. Assist the Qualified Electrical Worker (QEW)/QEW Supervisor in the development of a Shock Hazard Analysis, as needed.

4. Perform an engineering review in accordance with PROC-DE-1023 whenever an arc flash analysis results in an Arc-Flash Personal Protective Equipment (PPE) Category 3 or 4 or greater than 40 cal/cm^2 at the working distance or the arc flash duration exceeds 2 seconds. Determine whether an engineered solution (e.g., Design Change Notice [DCN]) can be developed to reduce the Arc Flash Hazard to Arc-Flash PPE Category 2 or less, or to reduce the arc flash duration to less than 2 seconds.

5. Use intrinsically safe equipment and employ explosion-proofing techniques to apply intrinsic safety in Hazardous (Classified) Locations (as determined by the Fire Protection (FP) AHJ).

6. Use of Engineering Analysis for Special Situations:

NOTE: An analysis of the hazardous energy available may be used to justify an exception to standard shock protection boundary and PPE requirements. Analysis may be used where imposition of standard requirements is impractical (e.g., electronic circuits that involve high voltage, but low energy).

a. Document the analysis in accordance with PROC-DE-1023 and PROC-DE-0704, *Project Calculations*. The analysis shall include documentation of any tests performed to gather data, conditions of acceptability, standards used for equipment evaluation, and any mitigation or limitations.

b. The analysis must include fault conditions where circuit current could rise above the nominal rated value as explained herein.

c. Values above both the threshold values in Table 1 require shock protection. For values below either threshold, no shock protection is required. A secondary hazard may still exist (e.g., startle reaction) and shall be mitigated.

Table 1. Threshold values for shock protection

Source	Includes	Thresholds
AC	60 Hz	> 50 V and > 5 mA
DC	All	> 100 V and > 40 mA
Capacitors	All	> 100 V and > 1 J, or > 400 V and > 0.25 J
Batteries	All	> 100 V
Sub-RF	1 Hz to 3 kHz	> 50 V and > 5 mA
RF	3 kHz to 100 MHz	A function of frequency

2.2.10 UCOR Safety Systems and Services (SSS) Manager

1. Integrate electrical safety into the UCOR Safety Program, PPD-EH-1745, *Worker Safety and Health Program*, and PROC-EH-2000, *General Safety Requirements*, in accordance with 10 CFR Part 851, Worker Safety and Health Program, requirements.

NOTE: Completion of LEARN Module 31114, NRTL LLR Requirements-Markings Recognition and Verification Training, and LEARN Module 31115, Acquisition Process and Requirements for NRTL Listing and Labeling, satisfy the following training requirement.

2. Provide trained S&H Representative(s) for review and confirmation of Level 3 Consumer Electrical Items confirmed to be compliant with NRTL LLR requirements, which qualify as Level 3 Acquisitions per PROC-DE-1021, *Material Requisition Package Requirements*.

3. Provide trained Field Electrical S&H Representative(s) to conduct field task reviews of ongoing activities. Completion of LEARN Module 31931, Electrical Safety Oversight for the Safety and Health (S&H) Rep, satisfy the training requirement.

2.2.11 Safety and Health (S&H) Representative

1. Perform periodic surveillances and oversight related to electrical safety programmatic and field activities.

2. Review consumer electrical items for approval to confirm them to be compliant with NRTL Listing and/or Labeling requirements and qualify as Level 3 Acquisitions per PROC-DE-1021, *Material Requisition Package Requirements*, and PROC-PR-1200, *Requisition Process for Materials and Services*.

2.2.12 Project Management

1. Project Managers (PMs) are responsible for implementing the UCOR Electrical Program in their organizations (and with subcontractors, as applicable) by integrating electrical safety requirements and practices into their daily project and program work planning, work instructions, and operations.

2. The project S&H Operations Manager(s) provide assistance for implementing the electrical safety aspects of the UCOR Electrical Program. Those related to electrical safety include the following:

- Providing Safety Representatives to perform oversight of UCOR self-performed and subcontractor work activities.
- Integrating electrical safety into an overall safety program. (See PROC-EH-2000.)
- Assisting the Project and Functional Management in the investigation of electrical incidents and accidents.

2.2.13 Functional Management

1. Functional management includes such organizations as Engineering, Labor Relations, Facility Management, Supply Chain Management, Training, and Quality Assurance (QA). Functional managers provide the necessary programs, procedures, trained personnel, and oversight for successful implementation of the UCOR Electrical Program.

2.2.14 Operations/Surveillance and Maintenance Programs

1. The Operations/Surveillance & Maintenance (S&M) Program Manager is responsible for the following:

- Providing the work control process that incorporates electrical design and safety requirements into work packages (WPs) for fieldwork.
- Establishing Preventive Maintenance (PM) activities as required in accordance with PROC-FO-3030, *UCOR Preventive Maintenance*.
- Providing trained electrical workers to the projects.
- Ensuring Operations personnel who operate disconnects/switches complete training requirements of Section 2.4, Employee and Subcontractor Training Requirements.
- Ensuring that personnel responsible for requisitioning tools/materials/equipment/services generate the material requisition(s) in accordance with engineering procedures (refer to Supply Chain Management in Section 2.2.17).

2.2.15 Facility Manager (FM)

1. Alert the EAHJ to electrical incidents that occur during field activities.

2. Report any electrical occurrences, shocks, and discovered hazards to supervision and/or the appropriate Shift Superintendent.

- ETTP / Emergency Services Watch Office (ESWO)
- Oak Ridge National Laboratory (ORNL)/ Laboratory Shift Superintendent (LSS)
- Y-12 National Security Complex (Y-12) / Plant Shift Superintendent (PSS)

3. Assist the Project and Functional Management in investigation of electrical incidents.

4. Control and maintain a current record of hazardous locations within their areas of responsibility.

5. Make employees, subcontractors, and visitors aware of the electrical safety requirements appropriate for the areas they will be visiting.

6. Understand scope and limits of interface agreements UCOR MOU-16-317 R2, UCOR & UTB Interface Agreement, and UCOR MOU-17-320 Rev. 1, UCOR & CNS Interface Agreement.

2.2.16 Supervisor /Superintendent

1. Alert the UCOR EAHJ to electrical incidents that occur during field activities.

2. Report any electrical occurrences, shocks, and discovered hazards to the FM and/or the appropriate ESWO/LSS/PSS.

NOTE: Completion of LEARN Module 29291, Electrical Safety for the Non-Electrical Worker, generally satisfies the following training requirement, although additional training may be required for specific work assignments.

3. Ensure both qualified and unqualified persons are trained in, and familiar with, any electrical safety-related practices necessary for their safety.

4. Make visitors aware of the electrical safety requirements appropriate for the areas they will be visiting.

5. Understand and comply with scope and limits of interface agreements UCOR MOU-16-317 R2, UCOR & UTB Interface Agreement, and UCOR MOU-17-320 Rev. 1, UCOR & CNS Interface Agreement.

6. Obtain energized electrical work permits when necessary.

7. Ensure appropriate safety-related work practices and PPE have been determined before any person is exposed to electrical hazards within the Limited Approach Boundary (LAB) or Arc Flash Boundary (AFB) by using both the results of a Shock Hazard Analysis and Arc Flash Hazard Analysis. The results of the analyses are documented by engineering per PROC-DE-1023, and the results are usually listed on the Arc Flash Hazard label but, if not, should be recorded on Form-2155, Energized Electrical Work Permit (EEWP), the Job Hazard Analysis (JHA), or other work control documents with an approved hazard analysis.

NOTE: Equipment described in the following step can include switchboards, panelboards, industrial control panels, and motor control centers (MCCs). The service procedures can include examination, adjustment, servicing, or maintenance.

8. Ensure electrical equipment that is likely to be energized during servicing is clearly labeled to warn personnel of potential electric arc flash and shock hazards.

9. Ensure that personnel performing electrical work have completed required training in safe electrical work practices as required in the Training section of this document (Section 2.4), as appropriate for their job duties.

10. Ensure that all construction and workplace modifications and/or installations are in compliance with NFPA 70 and/or NESC, as appropriate.

11. Implement safe work procedures, permits, work control documents, lessons learned, and safety-related work practices for work involving electrical hazards.

12. Assist with investigations of electrical incidents and accidents.

13. Contact the EAHJ for required inspections of new or modified electrical installations. See Section 4 for requirements and details.

2.2.17 Supply Chain Management

1. Ensure that purchases of electrical conductors or equipment and consumer electrical items, such as appliances, are in accordance with the material requisition and all specified requirements stated within and/or attached thereto. In particular, stated requirements on the material requisition regarding electrical items must be listed and labeled by an Occupational Safety and Health Administration (OSHA)-recognized NRTL.

2.2.18 Requisitioner

1. Ensure that material requisitions or P-Card requisitions for purchases of electrical equipment, consumer devices, and appliances follow PROC-PR-1200 and PROC-DE-1021.

2.2.19 Training Organization

1. Develop and conduct electrical-related training courses, as required.

2. Provide tracking of training and notification to assist personnel in obtaining and maintaining current qualification status, and to assist supervisory personnel in maintaining awareness of a worker's current training status.

2.2.20 Qualified Electrical Worker (QEW)

1. Follow procedures, work control documents, and training when performing work.

2. Use the appropriate PPE for the work being performed.

3. Ensure electrical equipment is marked with an Arc Flash Hazard label located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

4. Report unsafe or potentially unsafe electrical conditions to supervision and/or Facility Management.

5. Immediately report any electrical shocks to supervision and immediately report to UCOR Health Services for a medical evaluation.

6. Work only on the systems, devices, and activities for which training and authorization have been received.

7. Assess potential electrical hazardous exposures prior to beginning work.

8. Establish protection boundaries for LABs and/or AFBs and prevent Unqualified Persons from entry past boundaries.

2.2.21 Quality Assurance

1. Develop and monitor the UCOR integrated assessment and oversight program. The program is described in UCOR-4141, *URS | CH2M Oak Ridge LLC Quality Assurance Program Plan, Oak Ridge, Tennessee*.

2. Electrical occurrences, including electrical shocks, are reported in accordance with the DOE Order (O) 232.2, *Occurrence Reporting and Processing of Operations Information*, and UCOR procedure PROC-PQ-1220, *Occurrence Notification and Reporting.*

3. Inspect items procured for NRTL compliance to receipt inspection criteria.

2.2.22 Electrical Operations (Power Integration Group)

1. Responsible for implementing the UCOR Electrical Program within the Power Integration Group (PIG) by providing safe work procedures and practices, as required. The manager shall support work on the UCOR-controlled portion of the East Tennessee Technology Park (ETTP) transmission and distribution system. This includes implementing an electrical preventive maintenance (PM) program and providing QEWs to perform the required work and/or maintenance.

2. The manager of the PIG is responsible for ensuring that PIG workers (who could be exposed to electrical hazards) and their immediate supervisors receive general and job-specific training in safe electrical work practices, as required in 29 CFR 1910.269; 29 CFR 1910, Subpart S; and NFPA 70E, Sect. 110.2, Training Requirements.

3. The manager of the PIG is responsible for implementing (within the PIG) other electrical safety work procedures, such as those involving hazardous energy control, testing, and other applicable safety-related work practices (e.g., 29 CFR 1910; NFPA 70E; IEEE C2).

NOTE: Within ETTP, the service point is the connection to service-entrance conductors at the service head for overhead services. For underground services, the service point is the secondary connection at the utility transformer.

4. The manager of the PIG is responsible to understand and comply with scope and limits of interface agreements UCOR MOU-16-317 R2, UCOR & UTB Interface Agreement, and UCOR MOU-17-320 Rev. 1, UCOR & CNS Interface Agreement. These Memorandums of Understanding (MOUs) define interface agreements with outside utilities and describe the Service Point of the serving utility distribution system.

2.2.23 Employees and UCOR Subcontractors

1. Responsible for performing electrical activities safely in accordance with PROC-EH-2000 and PPD-EH-2009, unless the subcontractor has a separate, UCOR-approved electrical safety program.

2. Successfully complete training requirements of Section 2.4, Employee and Subcontractor Training Requirements.

NOTE: Subcontractors shall contact their Subcontract Coordinator (SCC) / Subcontract Technical Representative (STR) for assistance with the safety requirements of this procedure.

2.3 ELECTRICAL SAFETY COMMITTEE

2.3.1 Committee Mission and Scope

The ESC is established to provide UCOR management and the EAHJ / Electrical Safety SME with a competent technical resource for identifying, resolving, and recommending appropriate resolution of electrical safety issues within the company. The ESC promotes an electrically safe workplace that is free from unauthorized exposure to electrical hazards for all persons on UCOR sites.

2.3.2 Roles and Responsibilities

The Electrical Safety Program Manager chairs the ESC. The Chair shall establish the agenda for and conduct the ESC meetings; assign tasks to subcommittees and individual members; and ensure compliance with this section. The ESC will:

1. Monitor program issues and metrics, as warranted, for adverse trends and correlations that might not be readily apparent at the facility, project, or subcommittee level.

2. Ensure appropriate priorities, strategies, resources, and focus are assigned to issues commensurate with the risks associated with a failure to address the issue.

3. Advise senior management on issues related to electrical safety within the company.

4. Advise management of the need to fund and support electrical requirements.

5. Recommend to management improvements and approaches to better implement the Electrical Safety Program.

6. Promote the implementation of the Electrical Safety Program.

7. Provide support and counsel to the EAHJ in fulfilling his/her responsibility and authority for the interpretation of the electrical requirements of DOE orders, criteria and guides, and other codes, standards, and practices.

8. Recommend safety measures and remedial action for eliminating or reducing electrical hazards and/or issues.

9. Review occurrence reports involving electrical issues, and participate in root cause or other analysis as requested by the Chair.

10. Upon request, provide support to Industrial Safety personnel in assessing compliance with UCOR and DOE electrical safety requirements.

11. Upon request, review electrical safety aspects of proposed major facility changes, electrical installations, and operation and maintenance procedures for compliance with UCOR safety requirements. Committee members may participate in building safety inspections.

12. Provide an additional venue for workers to raise electrical concerns and issues.

Committee Structure

The voting membership consists of the following organizations:

- Executive Sponsor (Technical Services & Regulatory Officer)
- Chair (Electrical Safety Program Manager)
- EAHJ (Electrical Safety SME)
- S&H Operations Management Representative
- Power Integration Group Management Representative
- Decontamination and Demolition (D&D) Management Representative
- ORNL Management Representative
- Representatives from each of the electrical trade organizations (United Steel Workers, Building Trades, Atomic Trades and Labor Council)
- The Deputy EAHJ, when appointed, is also a voting member but is not required for a quorum
- Engineering Management Representative

In addition, non-voting advisors from organizations such as Facility Management, Training, QA, Fire Protection, SMEs (e.g., Lockout/Tagout [LO/TO]), and others may be routinely invited to participate. When the need arises, other area experts may be requested to attend the ESC meetings and activities.

Training for ESC Voting Members

Committee members are required to complete either LEARN Module 30985, Electrical Safety for the Electrical Worker, or LEARN Module 29291, Electrical Safety for the Non-Electrical Worker, prior to voting. In addition, voting members are required to complete required reading of PPD-EH-2009, *Electrical Safety Program*, prior to voting.

Meetings

ESC meetings will be held at least quarterly to conduct routine business, such as reviewing electrical safety issues, trends, and incidents, considering regulatory changes, or resolving differences among subcommittees. Meetings may be called more frequently, if needed. Meetings of the ESC or subcommittees shall be open to all members and others having direct and material interest. Minutes and attendance shall be recorded at all meetings, validated (signed) by the Chair, and communicated to the ESC.

Quorum

A quorum of the voting members of the ESC shall include: (a) the Electrical Safety Program Manager; (b) UCOR EAHJ or Alternate; (c) a representative, primary or alternate, from S&H Operations Management; (d) a representative, primary or alternate, from Electrical Engineering; (e) at least one primary representative from D&D, PIG, or ORNL Management; and (f) at least one primary representative from D&D, PIG, or ORNL Trades.

In the absence of a quorum, the ESC may meet, but shall abstain from actions requiring the approval of a majority confirmation vote. Only voting members, or designated alternates, shall be counted in determining if a quorum is present. Where one member fills more than one membership role, that member shall have no more than one vote.

Voting

No member or position (either the primary or alternate, but not both) shall have more than one vote.

Voting members will designate an alternate to the Chair to represent them in the meeting(s) during their absence. An alternate's vote is counted only if the principal member is not present.

Non-ESC members may attend ESC meetings to express concerns, request guidance, or otherwise provide information related to agenda items; however, they have no voting authority.

Subcommittees

The ESC Chair will recommend subcommittee establishment and membership, as needed to advance the business of the ESC. The establishment of a subcommittee will require at least one member of the ESC to serve on the subcommittee, and a quorum approval of the ESC.

Subcommittees may be established to investigate, debate, and recommend electrical safety positions, programs, and/or practices to enhance or improve the UCOR Electrical Safety Program.

When active subcommittees are created, progress reports, either written or oral, will be provided to the Executive Sponsor and the UCOR EAHJ on a frequency established upon the formation of the subcommittee. Progress reports may be in the form of written reports (including email), or oral presentations and/or discussions.

2.4 EMPLOYEE AND SUBCONTRACTOR TRAINING REQUIREMENTS

NOTE: Training requirements are implemented through UCOR-4350, *URS | CH2M LLC (UCOR) Training Requirements Matrix (TRM), Oak Ridge, Tennessee,* and the TPDs for the Training Position Description.

All Employees and Subcontractors

1. Successfully complete Park Worker training which contains a section on basic electrical safety.

NOTE: Completion of LEARN Module 29291, Electrical Safety for the Non-Electrical Worker, provides basic electrical safety training for unqualified persons. However, additional training may be required for specific work assignments that expose the workers to additional hazards.

2. Successfully complete LEARN Module 29291, Electrical Safety for the Non-Electrical Worker.

NOTE: Only a QEW is allowed to operate electrical disconnect breakers > 600 V.

Equipment Operators

1. **IF** required to operate electrical disconnects/breakers (≤ 600 V), **THEN** successfully complete LEARN Module 31009, Electrical Safety for Equipment Operators. Retraining must be completed every 36 months.

NOTE: QEWs are required to complete and maintain training and proficiencies of safety-related work practices and procedures, as specified in NFPA 70E; 29 CFR Part 1910, Subpart S (electric utilization systems); and/or 29 CFR Part 1910.269 (electric power generation, transmission, and distribution).

QEWs and Subcontractor QEWs

1. Complete the training specified in the Training Position Description (TPD) for QEWs.

Lineman

1. Complete the training specified in the TPD for Lineman.

Instrument Mechanics, Electrical Mechanics, and other Electrical Workers (QEWs)

1. Complete training specified in the specific discipline's TPD.

Supervisor/Superintendent

1. Require applicable retraining of a QEW under any of the following conditions:

- If observation during work activities or annual inspections indicates that the worker is not complying with the safety-related work practices.
- If new technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that the worker would normally use.

2. Ensure that additional training (or retraining) is provided to workers, if changes in the workplace, changes in PPE, or other changes render previous training obsolete.

3. Ensure that each worker assigned tasks that may expose that worker to an electrical hazard is appropriately trained in the associated electrical safety-related work practices for those tasks. This requirement exists for all UCOR persons, whether a QEW or not.

4. Supervisors of QEWs shall maintain current QEW training status (as specified in the corresponding TPDs) but are not required to maintain annual proficiency.

3 ELECTRICAL EQUIPMENT AND PORTABLE ELECTRIC TOOLS

3.1 SCOPE

This section covers the general electrical requirements for electrical equipment and portable electric tools. This section is not applicable to battery-powered electric tools. All electrical equipment shall be listed, labeled or recognized by an NRTL (see www.osha.gov/dts/otpca/nrtl/index.html) or built to nationally recognized standards for their intended purpose.

Custom-built equipment can be approved for use by the EAHJ (see Section 4.6, Electrical Inspection Program, for details), if built according to specific standards, i.e., UL LLC (UL) or applicable national consensus standards.

All electrical equipment and portable electric tools shall be used in accordance with the manufacturer's instructions and safety warnings.

3.2 GENERAL REQUIREMENTS

1. Never handle cord-connected plugs with wet hands.

NOTE: The following requirement covers most new industrial electrical equipment installations and modifications (e.g., other than Like-for-Like component replacements, cord-and-plug connected consumer appliances and devices, or transmission and distribution equipment) performed at UCOR facilities.

2. Newly installed or modified electrical utilization equipment (as specified in the installation requirements of 29 CFR Part 1910.302-308 and NFPA 70, National Electrical Code) shall be inspected and approved by the EAHJ. (See Section 4.0.)

3. Electrical utilization equipment, such as cord-and-plug consumer items and appliances, shall be determined to be free from recognized electrical hazards through evidence demonstrated by listing and labeling by an NRTL. The NRTL listing/labeling shall be for the United States of America.

4. Company supplied electrical equipment that is not listed and labeled shall be submitted to the EAHJ for approval. (See Section 4.8 for a description of the Non-NRTL Equipment Approval process.)

5. In-service electrical equipment that visually appears to be in a degraded or unsafe condition shall be removed from service or identified and dispositioned per PROC-PQ-1440, *Control of Non-conforming Items and Materials*.

6. Abandoned electrical equipment should be de-energized and permanently air-gapped to preclude inadvertent re-energization. Isolation for out of commission structures, systems, and components shall be in accordance with PROC-FO-3033, *Out of Commission Isolation Process for Structures, Systems, and Components.*

7. UCOR facilities may contain either grounded or ungrounded systems. Ungrounded systems typically include ground detection devices that indicate when a phase of the system has developed a low resistance to ground. Ungrounded systems that indicate a low resistance to ground should be promptly investigated and worked to remove or repair the grounded component. (See Section 7.0)

8. Compensatory measures found in Section 5.9, Compensatory Measures for Inadequately Maintained Overcurrent Protective Devices, shall be applied to systems with inadequately maintained overcurrent protection devices, including additional PPE, controlled access, use of remote devices, etc.

9. Arc Flash Hazard Warning labels shall be installed on equipment that presents an Arc Flash Hazard to warn Qualified Persons of the potential electrical hazard. PROC-DE-1023 defines the creation, execution, revision, approval, control, and distribution of Arc Flash Hazard Analyses (AFHAs) and arc flash labels.

The arc flash label formats are given in PROC-DE-1023 and typically contain the following information:

(1) Nominal system voltage, shock protection boundaries, shock protection PPE

(2) Arc flash boundary

(3) At least one of the following

a. Available Incident Energy at the corresponding working distance, or Arc-Flash PPE Category for the equipment [Tables Method - Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b)]

b. Minimum arc rating of clothing

c. Site-specific level of PPE

10. Accessible electrical equipment shall always present a Dead Front to passersby unless a work boundary has been established.

11. Open holes and unused openings shall be closed with a suitable and approved means that provides substantially the same protection as the walls of the enclosure.

12. Portable electric tools (except for battery-powered ones) shall either be double-insulated, case-grounded, or low-voltage (i.e., 12-24 V).

13. Temporary wiring installations (including extension cords) supplying power for tools for construction, remodeling, maintenance, and repair, or demolition activities shall require Ground-Fault Circuit-Interrupters (GFCIs).

14. A flexible cord used with grounding type equipment shall contain an equipment grounding conductor.

15. Attachment plugs and receptacles shall not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally, these devices shall not be altered to allow the grounding pole of a plug to be inserted into slots intended or connected to a current-carrying conductor.

16. Adapters that interrupt the continuity of the equipment grounding connection shall not to be used.

17. Portable electric equipment, tools, and flexible cords used in highly conductive work locations, such as areas covered with water or other conductive liquids; or in job locations where persons are likely to contact water or conductive liquids, shall be labeled and listed for those locations.

3.3 PORTABLE ELECTRIC TOOLS AND EQUIPMENT

1. Do not lift or carry portable electric tools by their electrical cords.

2. Visually check the plug and receptacle to ensure that they are compatible and will properly mate before connecting them (including an extension cord). Flexible cord plug and caps are configured differently for different voltages and current ratings.

3. Do not use adapters to connect higher current devices to lower current power sources and/or extension cords (e.g., a 120-V, 20-amp device powered from a 120-V, 15-amp receptacle).

4. Inspect portable electric tools prior to use to ensure there are no visible defects, damage, cracks, missing cover plates, loose parts or wires, or exposed terminals, worn power cords, or other issues that degrade the integrity and safety of the device.

5. Portable electric equipment and flexible cords used in conductive work locations (such as those inundated with water or conductive liquids), or in job locations where persons are likely to contact water or conductive liquids, shall be identified and/or marked for use in those locations.

6. Do not alter plugs and receptacles.

7. Do not use adapters that interrupt the continuity of the equipment grounding conductor (e.g., 3-to-2 prong adapters).

8. All portable electric tools and equipment shall have a 3-prong (grounded) plug unless specifically identified on the tool as "Double Insulated."

9. Follow all manufacturer's instructions and PROC-FP-2006, *UCOR Program for Controlling Combustibles and Ignitions Sources*, to prevent igniting combustible/flammable material with appliances that produce significant heat (e.g., space heaters, coffee pots, hot plates, soldering irons, hot air guns).

NOTE: Electrical installation requirements for locations where flammable materials are present on a regular basis are contained in NFPA 70, National Electrical Code.

10. **Occasional Use of Flammable Materials.** Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be permitted to be used, unless measures are taken to prevent hazardous conditions from developing. Such materials shall include, but are not limited to, flammable gases, vapors, or liquids, combustible dust, and ignitible fibers or flyings. Refer to NFPA 70E 130.6 (J).

3.4 GROUND-FAULT CIRCUIT-INTERRUPTERS

NOTE: The requirements in this section do not pertain to Class B ground-fault equipment protection.

1. Use Class A GFCIs for temporary wiring installations (including extension cords) supplying power for construction, remodeling, maintenance, repair, or demolition activities.

- This includes 125/250-V, single-phase 15A, 20A, 30A rated circuits. Note that this includes most S&M and D&D work done in UCOR Closure Facilities, D&D Facilities, and Inactive Facilities.

- 1910.304(b)(3)(ii)(B)

  Receptacles other than 125 volt, single-phase, 15-, 20-, and 30-ampere receptacles that are not part of the permanent wiring of the building or structure and that are in use by personnel shall have ground-fault circuit-interrupter protection for personnel.

2. Use a GFCI-protected power source for portable electrical equipment and tools.

3. Use GFCIs for outdoor work or work in damp or wet locations.

NOTE: UCOR tests in-service permanently installed GFCIs per PROC-MP-2202, *Ground-Fault Circuit Interrupter (GFCI) Periodic Inspection and Testing*. Successfully tested, permanently installed GFCIs are so designated by a dated label.

4. Do not use a permanently installed GFCI receptacle for GFCI protection unless it has been tested within the past 30 days as evidenced by a current testing label.

5. If a standard 120-V receptacle is marked "GFCI Protected," locate the GFCI receptacle or GFCI breaker and ensure that the dated test tag is current prior to use.

6. Properly listed and labeled and tested temporary GFCIs may be used wherever needed, and in lieu of permanently installed GFCIs if the permanently installed GFCI is Out of Service. If nuisance trips occur while a temporary GFCI is inserted into a permanently installed GFCI-protected receptacle, the temporary GFCI should be relocated to a different (non-GFCI) receptacle.

7. Test portable GFCIs, including those on Power Production Equipment (portable generators), prior to use as follows:

- Ensure GFCI is energized before testing.
- Visually inspect the GFCI device for defects, such as overheating, arcing, or broken parts. (Do not remove the GFCI device for this inspection.)
- Press the reset button and insert load or test meter to ensure that the GFCI is passing voltage to the load side.
- Press the test button on the GFCI and verify no circuit voltage on the load side, using load or test meter.
- Press the reset button on the GFCI and verify circuit voltage is restored using load or test meter.

8. Remove from service and tag or discard any damaged or unusable portable GFCI.

9. Do not reset a tripped GFCI more than one time consecutively.

a. **IF** the GFCI trips after its initial reset, **THEN** the GFCI shall not be reset until the cause has been evaluated and corrected by a QEW.

10. Contact the EAHJ for alternatives to the permanently installed GFCI testing requirements, should hazardous conditions (e.g., high radiation, confined space) be present in specific locations.

11. Receptacles with weatherproof in-use covers shall be used per manufacturer's directions.

GFCIs are not required to be used for office-type equipment, which is not normally used in construction or industrial operations such as computers and associated equipment, typewriters and similar equipment, coffee pots, ovens, refrigerators, clocks, or audio-visual equipment.

3.5 VISUAL INSPECTION

Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket). Cord and plug-connected equipment, tools, and extension cords, which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.

If there is a defect or evidence of damage that might expose a person to injury, the defective or damaged item shall be removed from service. No person shall use it until a person qualified to perform the repairs and tests necessary to render the equipment safe has done so. When an attachment plug is to be connected to a receptacle (including a cord set), the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of the proper mating configuration.

3.6 EXTENSION CORDS (FLEXIBLE CORD SETS)

NOTE: Electrical equipment must be installed and used in accordance with any instructions included in the listing or labeling. This may include prohibition or restriction on the use of extension cords (including power strips) to supply power to the equipment.

1. Extension cords for D&D, construction, outdoor, and other rugged-type work shall be listed as Hard Service and For Wet Locations (i.e., marked as type SOW, SOOW, STW, STOW, STOOW, SEW, SEOW, SEOOW, SJOW, SJOOW, SJTW, SJTOW, SJTOOW, SJEW, SJEOW, OR SJEOOW).

2. Do not use extension cords to connect office equipment or unattended appliances to a receptacle.

3. Do not overload an extension cord, power strip, or surge suppressor by powering loads that collectively exceed the rated amperage or wattage stamped/printed on the cord or device. IF in doubt, THEN have supervision consult a QEW, Engineering, or the UCOR EAHJ.

4. Only use extension cords, power strips and surge suppressors that are equipped with a grounding prong.

5. Visually inspect extension and other flexible cords for external defects and evidence of damage before use. Do not use damaged or frayed cords or cords where the plug has been altered or damaged (e.g., the ground prong removed). Damaged or defective cords shall be immediately removed from service. Inspect extension cords for damage in accordance with Visual Inspection (Section 3.5).

6. Manufactured extension cords, power strips, and surge protectors shall be listed and labeled by an OSHA-recognized NRTL. Follow all instructions that may be affixed to the label or device.

7. Extension cords must be powered from either a GFCI receptacle or a short portable GFCI (i.e., not a GFCI extension cord). They shall not be daisy chained with other extension cords.

8. Do not use extension cords in place of permanent facility wiring. Extension cords are for temporary use to extend the reach of a tool or appliance while that device is in use.

9. Do not use extension cords or other power strips to supply power to power strips and surge suppressors.

10. Protect flexible cords and connectors from all types of traffic, excessive strain, excessive heat, sharp objects/edges, and chemicals or other agents that might cause damage or failure. Cords and connectors used in wet and damp locations shall be listed for that environment.

11. Protect flexible cords from physical damage when run through doorways or windows.

12. Never staple or otherwise attach flexible cords or power strips by means that could damage the outer jacket or insulation.

13. Flexible cord plugs may be repaired or replaced by a QEW, provided the replacement part(s) is properly sized and rated, compatible with the weather and usage requirements of the component, NRTL-listed and -labeled, and Form-2995, Attachment Plug Repair for Power-Supply Cords Inspection Checklist, is completed and forwarded to the EAHJ.

14. Properly secure locking-type plugs and connectors after connection.

3.7 POWER STRIPS

The use of power strips must be controlled to ensure that they are not used for other than their intended purpose. The following requirements apply to the use of power strips:

1. Power strips and surge suppressor strips are intended for indoor use as multiple outlet extensions of a single branch circuit and may be used to provide power for desktop equipment, audio/visual equipment, and other such devices. Do not use power strips in outdoor, construction, D&D, or similar environments.

2. Due to the temporary nature of most office furniture and equipment locations, surge suppressors and power strips may be used to power computer equipment, office equipment, overhead projectors, and other similar equipment in an office environment within the restrictions (protection against overload, damage, strain, follow label requirements, etc.) in this section. Permanently installed equipment, such as large copiers or vending machines, require connection to a receptacle (or short portable GFCI connected to a receptacle) or directly to the facility power system.

3. Only NRTL-listed power strips may be used.

4. Only to be used as intended by their NRTL listing.

5. Only to be used as recommended by the manufacturer; observe all manufacturer limitations (written instructions that come with the multi-outlet electrical box).

6. The power strip must not be permanently mounted. No tools can be used to mount the power strip, and any screws used to hang the strip cannot be accessible for tightening.

7. Do not plug a power strip into another power strip, into an extension cord, or into an uninterruptable power supply.

8. Never exceed the maximum rated load (1800 Watts total for a 120-V, 15A power strip). Add the loads plugged into the power strip to prevent overload situations.

9. Never plug high-current loads such as vacuum cleaners, space heaters, coffeepots, toasters, hot plates, or other heating appliances into power strips.

3.8 HANDLING

Portable equipment and tools shall be handled and stored in a manner that will not cause damage. Flexible electric cords connected to equipment are not to be used for raising or lowering the equipment. Flexible electric cords are not to be fastened with staples or otherwise hung such that damage could occur to the outer jacket or insulation.

3.9 HAZARDOUS LOCATIONS

Portable electric equipment, tools, and flexible cords used in hazardous work locations (i.e., flammable vapors, liquids or gases, or combustible dusts or fibers) shall be labeled and listed for those locations.

3.10 CONNECTING AND DISCONNECTING CORD AND PLUG EQUIPMENT

1. Worker’s hands shall be dry when plugging and unplugging extension cords and cord and plug-connected equipment.

2. Energized plug and receptacle connections shall be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the person's hand (i.e., a cord connection is wet or damaged).

3. Locking-type connectors shall be properly secured after connection. If a disconnecting means is available, open before plugging or unplugging.

3.11 PORTABLE HEATERS

Heaters, which are designed and designated by the manufacturer for household use and are approved by an NRTL, shall only be used for supplemental heat in office environments. Heaters designed and designated by the manufacturer and approved by an NRTL for commercial use shall be used for supplemental heat in facilities. All heaters shall be used in accordance with the manufacturer's instructions. They shall be directly plugged into an outlet. Adequate clearance will be maintained to prevent fires. Prior to use, the cord shall be inspected for physical and heat damage.

3.12 ELECTRICAL TEST INSTRUMENTS AND EQUIPMENT

1. **Use.** Only qualified persons may perform testing work on electric circuits or equipment.

2. **Visual Inspections.** Test instruments, equipment, and their accessories including all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose a person to injury, the defective or damaged item shall be removed from service, and no person may use it until repairs and tests necessary to render the equipment safe have been made in accordance with 29 CFR 1910.334(c)(2).

3. **Rating of Equipment.** Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

4. **Operation Verification.** When test instruments are used for testing the Absence of Nominal Voltage on conductors or circuit parts operating at voltages equal to or greater than 50 volts, the operation of the test instrument shall be verified on any known voltage source before and after an Absence of Nominal Voltage Test is performed.

3.13 ELECTRIC PANELS, MOTOR CONTROL CENTERS (MCCS), AND SWITCHBOARDS

1. Electric panels, MCCs, and switchboards shall be clearly marked with the voltage rating of the equipment.

2. Electric panels shall be marked with a circuit directory or circuit identification clearly indicating each supplied load. Spare breakers shall be marked as such. MCCs and switchboards shall also clearly indicate the load being supplied.

3. Do not block access to electrical panels, MCCs, and switchboards. This includes blocking access with (or by) boxes, janitorial equipment, vending machines, or any other obstructions that prevent clear and quick access to the equipment.

4. Perform preventive maintenance (PM) on overcurrent devices per PROC-ET-1040, *Preventive Maintenance of Low Voltage Fused Disconnects and Molded Case Circuit Breakers at ETTP,* or PROC-OR-2226, *Preventive Maintenance of Low Voltage Fused Disconnects and Molded Case Circuit Breakers.*

5. Perform PM on MCCs per PROC-OR-2227, *Preventive Maintenance of Low Voltage Motor Control Centers (MCCs).*

3.14 CIRCUIT BREAKER AND DISCONNECT SWITCH OPERATION

NOTE: Normal operation of properly maintained electrical equipment, with all covers in place, does not constitute a significant hazard but is not considered hazard free. Operations are normally conducted by QEWs or Equipment Operators who have completed LEARN Module 31009, Electrical Safety for Equipment Operators, (for equipment ≤ 600 V).

Operating Circuit Breakers and Disconnect Switches:

QEW/Equipment Operator:

1. Use the following precautions when operating a circuit breaker or disconnect switch.

- Don the appropriate PPE. For equipment where the upstream overcurrent protective device (OCPD) is properly maintained, PPE consists of a hard hat (where required), safety glasses, leather gloves, and hearing protection. For un-maintained OCPDs, see Section 5.9.
- Check the equipment for damage, missing parts, or signs of deterioration. Do not operate equipment that is suspected of not being in good working order as it may present a higher than normal hazard. Call a QEW for assistance.
- Stand to the side of the enclosure and look away when operating the handle. Avoid reaching across the panel.
- Whenever possible, equipment should be shut down using normal operating procedures and controls, rather than opening feeder breakers/disconnects under load.
- Circuit breakers/disconnects greater than 250 V operated under loaded conditions shall not be operated by an Equipment Operator. Contact a QEW for assistance.

NOTE 1: Overcurrent protective devices may be, but are not limited to, fuses, circuit breakers, and overloads.

NOTE 2: See Section 3.4, Ground Fault Circuit Interrupters, for re-setting tripped GFCI receptacles/in-line GFCI devices.

2. Reclosing (Re-Energizing) Circuits After Protective Device Operation

After a circuit is de-energized by the automatic operation of a circuit protective device (including fuses), the circuit shall not be manually re-energized until it has been determined by an Electrician (qualified person) the cause of the device operation and that the equipment and circuit can be safely re-energized. If it is determined the cause of the trip was caused by an overload rather than a fault condition, examination of the circuit or connected equipment is not required before the circuit is re-energized. Refer to NFPA 70E 130.6(M).

3. Routine Opening and Closing of Circuits

Load-rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions. Cable connectors not of the load-break type, fuses, terminal lugs, and cable splice connections shall not be permitted to be used for such purposes, except in an emergency. Refer to NFPA 70E 130.6(L).

3.15 STATIONARY BATTERIES AND BATTERY SYSTEMS

NOTE: The following requirements apply only to stationary batteries and do not apply to vehicle batteries or devices containing sealed batteries designed for general public use without the need for PPE.

1. Install, maintain, and test stationary batteries and battery systems according to manufacturer requirements.

2. Comply with the following requirements when performing activities on or around stationary batteries or battery systems.

a. To avoid a potential explosion, no sources of ignition, sparks, or flames shall be present.

b. Properly ventilate battery areas.

NOTE: When located in an access-controlled battery room, exposed energized parts are not required to be guarded.

c. All exposed energized parts shall be guarded or insulated to prevent tools or other objects from making accidental contact.

d. Use insulated and/or non-sparking tools as applicable for work on battery systems.

3. The following warning signs shall be displayed on or near the batteries, if applicable:

- Electrical hazard warning signs indicating shock hazard and battery voltage.
- Notice prohibiting sources of ignition, sparks, or flames.
- Chemical hazard warning signs indicating the specific chemical hazards.
- Notice for persons to wear protective equipment and apparel.
- Notice prohibiting access by unauthorized persons.

4 ELECTRICAL AUTHORITY HAVING JURISDICTION ORGANIZATION AND ACTIVITIES

4.1 INTRODUCTION

The UCOR Electrical Authority Having Jurisdiction, herein referred to as EAHJ, is established to provide UCOR guidance and interpretation of NFPA 70, National Electrical Code (NEC), and related codes, rules, and standards that are applicable to the practical safeguarding of persons and property from hazards arising from the use of electricity. In addition, the EAHJ will support UCOR projects and organizations by delegating appropriate authority for personnel to perform specific tasks or examination services. The EAHJ and the Deputy EAHJ (if appointed) serve as the UCOR Electrical Safety SMEs.

4.2 ROLES

The EAHJ operates under authority formally delegated by the DOE Oak Ridge Office of Environmental Management (OREM) in accordance with the UCOR Prime Contract. The delegation may contain instructions and/or restrictions in addition to other requirements of the contract. The UCOR EAHJ performs his/her duties within the authority of that delegation in addition to the duties outlined in this program description.

The EAHJ Field Representative(s), when appointed, are designated by and report to the EAHJ with regard to the responsibilities and tasks assigned under the authority of the EAHJ.

The EAHJ provides personnel with guidance and interpretations of electrical requirements of NFPA 70, NFPA 70E, and other codes, rules, and standards that are applicable to electrical safety. In addition, the EAHJ can perform examinations of electrical equipment and installations to ensure compliance with applicable electrical requirements and to establish the required approvals. The examinations include those required to approve the use of electrical equipment that is not listed and labeled by an NRTL.

The EAHJ does not have design change authority. The UCOR design change processes in PROC-DE-1008, *Design Change Notice (DCN), Engineering Instructions (EIs) and Equivalency Evaluations (EEs)*, will control all changes to the design and as-built configuration.

The EAHJ is the final UCOR authority for interpretation of NFPA 70, NFPA 70E, and other codes, rules, and standards that are applicable to electrical safety, within the limitations set forth in DOE Guide (G) 440.1-1B, *Worker Safety and Health Program for DOE (Including the National Nuclear Security Administration) Federal and Contractor Employees*, Section 6.4.1, Authority Having Jurisdiction (AHJ) and Equivalencies.

4.3 RESPONSIBILITIES

4.3.1 EAHJ

The following are responsibilities of the EAHJ:

1. Provide guidance and interpretations of the rule for the application of electrical regulations, standards, policies, procedures, and state and local codes based on the requirements and guidance from the following:

- 10 CFR Part 851, Worker Safety and Health Program
- OSHA, particularly:
  - — 29 CFR Part 1910.147, The Control of Hazardous Energy (Lockout/Tagout)
  - — 29 CFR Part 1910, Subpart S, Electrical
  - — 29 CFR Part 1926, Subpart K, Electrical
  - — 29 CFR Part 1926, Subpart V, Power Transmission and Distribution

— 29 CFR Part 1910.269, Electric Power Generation, Transmission, and Distribution

- NFPA 70, National Electrical Code
- NFPA 70E, Standard for Electrical Safety in the Workplace
- Institute of Electrical and Electronics Engineers (IEEE) C2, National Electrical Safety Code (NESC)
- Other recognized electrical safety regulations, orders, standards, or guidance (e.g., DOE G 440.1-1B, applicable national building codes, UL LLC [UL] standards, etc.).

2. Maintain Guidance and Interpretation records as specified below:

NOTE: Definitions of guidance and interpretation are found in Section 1 of this program description.

a. Provide the requester (and others as deemed appropriate by the EAHJ) the formal guidance or interpretation using Form-2893, AHJ Interpretation/Guidance Response.

NOTE: Informal guidance on issues, where formal interpretation or exceptions of the specific rules of the code are not required, may be verbal or communicated via email.

b. Maintain a log of formal guidance and interpretations using Form-2892, AHJ Interpretation and Guidance Log.

c. Distribute completed Form-2893 to appropriate organizations and/or projects (e.g., Engineering, Training, Safety), as necessary.

3. Review requests for exemptions to codes and regulations as prescribed below:

a. Interface with DOE for evaluation and approval of any electrical exemptions to codes and regulations.

b. Document the approval or denial of all requests for exemptions to codes and regulations using Form-2893.

4. Perform examination of electrical devices or equipment for approval and document in accordance with PPD-EH-2009, *Electrical Safety Program*, including:

- Site-assembled electrical devices or equipment.
- Electrical conductors or equipment that is not tested as an assembly by an NRTL.
- Legacy electrical equipment or systems that do not meet the listing and labeling requirements.

5. Participate in reviews of project and facility modifications as they relate to electrical safety.

6. Examine for approval electrical installations for compliance to code and document in accordance with PPD-EH-2009.

7. Examine for approval electrical installations of new facilities or those having undergone major modifications and document in accordance with PPD-EH-2009.

8. Permit the interim use of products, constructions, or materials (consistent with NFPA 70, Section 90.4, Enforcement).

NOTE: In most cases, subordinate personnel will be members of other organizations, and deployed to the EAHJ for specific tasks.

9. Provide oversight of subordinate personnel as follows:

a. Subordinate personnel include, but are not limited to, Deputy EAHJ(s) and EAHJ Field Representative(s) (FRs).

b. Designate and appoint EAHJ FRs.

c. Examine credentials and experience of subordinates to ensure that the credentials and experience are adequate for the assigned duty.

d. Identify and communicate in writing the conditions or limits of authority of subordinate EAHJ personnel.

e. Identify any supplemental training or briefings required for subordinate EAHJ personnel (exceeding ordinary UCOR required training).

f. Assign duties to subordinate personnel, but remain solely responsible for all decisions made under the EAHJ's delegated authority.

g. Provide for the necessary instructions, documentation requirements, and briefings required by subordinate personnel in order for them to perform tasks delegated to them.

h. Ensure that the work by subordinate personnel is performed in accordance with the requirements and guidance provided by the EAHJ or Deputy EAHJ, through review and/or witnessing of the work, as deemed necessary by the EAHJ.

10. Assist in the investigation of electrical incidents.

11. Assist in the preparation of lessons learned as required.

12. Recommend the adoption of other applicable documents (and/or revisions), such as NFPA, IEEE, American Society of Testing and Materials (ASTM), and NESC.

13. Evaluate electrical training and its content to ensure that the training material meets the appropriate electrical regulations and standards.

4.3.2 Deputy EAHJ

The following are responsibilities of the Deputy EAHJ:

1. Perform functions as delegated by the EAHJ.

2. Assist the EAHJ in examinations of electrical equipment and installations to ensure compliance with applicable electrical requirements.

3. Ensure the consistency of EAHJ decisions and rulings through ongoing communication and review with the EAHJ.

4. Assume the duties of the EAHJ when the EAHJ is unavailable.

4.3.3 EAHJ Field Representatives (FR)

The following are responsibilities of the EAHJ FRs:

1. Perform the tasks within the limits and authority assigned to them by the EAHJ or Deputy EAHJ.

2. Assist the EAHJ in examinations of electrical equipment and installations to ensure compliance with applicable electrical requirements.

3. Contact the EAHJ or Deputy EAHJ regarding matters involving guidance and interpretations that are outside the delegated authority.

4. Document all work assigned from the EAHJ in the manner required by the EAHJ or Deputy EAHJ.

4.4 QUALIFICATION REQUIREMENTS FOR ELECTRICAL AHJ PERSONNEL

4.4.1 The EAHJ shall (as a minimum):

1. Have a Bachelor of Science degree or higher in electrical engineering (or concentration in electrical engineering) from a nationally accredited university or college.

2. Have working knowledge of the electrical safety requirements, standards, and work practices used in the installation, operations, construction, and maintenance of electrical equipment and systems, including the requirements contained in OSHA, NFPA 70, NFPA 70E, American National Standards Institute (ANSI) C2, and other codes, rules, and standards that are applicable to electrical safety.

3. Have an evaluation and documentation of competency using the criteria such as that established in DOE-STD-1170-2007, *Electrical Systems and Safety Oversight Functional Area Qualification Standards*.

4. Have at least five (5) years field experience in:

- The design, installation, and operation of electrical systems
- Performing examinations of electrical equipment
- Administrative and supervisory experience

4.4.2 The Deputy EAHJ(s) shall (as a minimum):

1. Have a Bachelor of Science degree or higher in electrical engineering (or concentration in electrical engineering) from a nationally accredited university or college.

2. Have working knowledge of the electrical safety requirements, standards, and work practices used in the installation, operations, construction, and maintenance of electrical equipment and systems, including the requirements contained in OSHA, NFPA 70, NFPA 70E, ANSI C2, and other codes, rules, and standards that are applicable to electrical safety.

3. Have an evaluation and documentation of competency using the criteria such as that established in DOE-STD-1170-2007, *Electrical Systems and Safety Oversight Functional Area Qualification Standards*.

4. Have at least five (5) years field experience in:

- The design, installation, and operation of electrical systems
- Performing examinations of electrical equipment
- Administrative and supervisory experience

4.4.3 The EAHJ FR(s) shall (as a minimum):

1. Have a combination of education, credentials, and relevant experience as determined by the EAHJ, based on the task or authority to be delegated.

2. Have a working knowledge of the electrical safety requirements contained in OSHA, NFPA 70, NFPA 70E, ANSI C2, or other codes, rules, and standards that are applicable to the specific task.

4.4.4 Supplemental Training Requirements for EAHJ Personnel

The appointed EAHJ and Deputy EAHJ are presumed to be competent, by virtue of the scrutiny applied in the appointment process and the qualification requirements stated above, and to be adequately trained with respect to contemporary requirements of codes and standards. The EAHJ and Deputy EAHJ should attend training on NFPA 70 and NFPA 70E as needed to remain current on the codes specified in the UCOR-DOE contract, and to stay abreast of new and revised codes.

A Position Assignment Form is generated for the EAHJ, Deputy EAHJ, and EAHJ FRs to track all of the assigned training position descriptions and any individual training requirements assigned. Supplemental training for EAHJ FRs shall be determined by the EAHJ based on the nature of the responsibilities and tasks assigned. Supplemental training identified will be assigned in accordance with PROC-TC-0710, *Training Position Descriptions and Position Assignment Forms.*

4.5 RECORDS

Guidance and interpretation records shall be maintained in accordance with the requirements of PROC-OS-1001, *Records Management, Including Document Control.*

4.6 ELECTRICAL INSPECTION PROGRAM

4.6.1 Purpose

The NEC and OSHA (29 CFR Part 1910 Subpart S) specify that electrical utilization installations and equipment are acceptable for use only if approved by the EAHJ. In order to meet this requirement, UCOR will implement the Electrical Inspection Program (EIP) to ensure electrical equipment, electrical equipment installations, and electrical construction activities meet the NEC and OSHA safety standards. Note that these inspection activities are applicable to all equipment and systems covered by the NEC, including low-voltage systems.

Note also that electrical power generation, transmission, and distribution equipment, as described in 29 CFR Part 1910.269, are not subject to these same approval requirements.

4.6.2 Scope

This attachment describes the Electrical Installation Inspection Program and provides guidelines for the UCOR EAHJ and designees to ensure that electrical equipment complies with applicable electrical standards and safety codes. Form-2359, Request for Inspection of Electrical Work, shall be used by personnel to request an electrical inspection or NEC plan review of an electrical installation.

NOTE: The EAHJ may appoint EAHJ FRs to perform inspections and assessment activities for a specific scope. Appointments and qualifications of EAHJ FRs shall be in accordance with this program description.

4.6.3 Electrical Inspection Process

For a new electrical installation, or a legacy electrical installation that will be altered from the original installation (e.g., a repair with other than Like-for-Like replacement parts, a system replacement with different equipment, an addition of options or other circuits), a determination must be made as to whether it will be necessary to request an electrical inspection by the EAHJ. Not all electrical work will require an electrical inspection or completing Form-2359.

In general, EAHJ inspections are required for new electrical installations other than:

- NRTL-listed and -labeled (or previously EAHJ-approved Non-NRTL equipment) cord-and-plug connected equipment that does not require other electrical connections. Note that some equipment (e.g., temporary power carts, foaming trailers) may be powered through a cord-and-plug, but may require a secondary grounding connection or grounding rod. Such equipment must be inspected by the EAHJ for compliance to the NEC, manufacturer's installation instructions, and/or the UCOR Grounding Standards.
- Cord-and-plug NRTL-Listed and -Labeled consumer devices or appliances; or
- Like-for-Like component and/or equipment replacements that return existing installations to its original state. Note that manufacturer's recommended replacement parts may or may not be NRTL LLR components, but should be used to maintain the NRTL LLR of the overall assembly.

UCOR facilities were designed and built according to the codes and standards applicable during the time of installation (the Code of Record). As a general rule, in-service UCOR facilities and systems are expected to be code-compliant, either with the Code of Record, or with current codes and standards.

In general, EAHJ inspections are required any time systems and/or equipment are modified in some way such that:

- The components, equipment, or assemblies differ from what was originally tested, listed, and labeled by the NRTL; or
- The system differs from what was originally installed, inspected, and approved by an EAHJ; or
- New sections or options are installed on existing NRTL or EAHJ-approved equipment.
- The components, equipment, or assembly are reconditioned to restore to operating condition. This process differs from normal servicing of equipment within a facility, or replacement of listed equipment or parts on a like-for-like basis.

If there are any questions regarding this determination, the EAHJ shall be consulted.

When it is determined that an inspection is necessary, a completed Form-2359 must be submitted, electronically or as hard copy to the EAHJ. Final dates and times for inspections should be coordinated with the EAHJ at least 24 hours in advance.

Electrical equipment or components that are Listed and Labeled by an NRTL are not required to be individually inspected by the EAHJ when being inspected as a part of a system or facility, but the interconnections, grounding, and other required aspects of the integrated installation will require inspection. When an inspected installation is determined compliant to the NEC, Form-2359 shall be signed by the EAHJ FR and approved by the EAHJ or the Deputy EAHJ. The approved Form-2359 is the authorization to the energization of the system. Form-2907, UCOR

Electrical AHJ Approved Equipment to be Energized, (label), signed by the EAHJ or delegate will be affixed to the electrical equipment as a field indicator that Form-2359 has authorized the energization of the system.

4.6.4 Approving Electrical Equipment, Installation, and Work

The EAHJ shall review and approve electrical equipment, installations, and any habitable room at UCOR based on any of the following three criteria:

1. An electrical installation shall be approved and acceptable for use if it has been inspected by the EAHJ, the Deputy EAHJ, or the EAHJ FRs, found compliant with the NEC and/or 29 CFR Part 1910 Part S, documented accordingly using Form-2359 and approved by the EAHJ or Deputy EAHJ.

2. Electrical equipment shall be approved and acceptable for use if it has been accepted, certified, listed and labeled, or otherwise determined to be safe by an OSHA NRTL as an assembly, as indicated by an NRTL label applied by the manufacturer. Note that this may include equipment assembled by a certified UL assembly shop under the purview of the UL field inspection program, and UL labeled accordingly. Equipment that is assembled by a vendor or in the field with NRTL components may not necessarily be listed and labeled as an assembly and must therefore be evaluated per Step 4.6.4.3 below, or replaced with an NRTL-tested assembly.

NOTE: See the OSHA website (http://www.osha.gov/dts/otpca/nrtl/index.html) for a list of OSHA-recognized NRTLs.

3. Electrical equipment that is not NRTL-listed and -labeled or built to nationally recognized standards may be acceptable if examined by the UCOR EAHJ in accordance with the provisions of the Legacy Non-NRTL Equipment Program.

NOTE: All efforts should be made to use listed and labeled equipment whenever available. Non-NRTL equipment that was accepted and documented by a previous EAHJ may be acceptable for use providing a sufficient historical basis exists to support the previous EAHJ's determination. The acceptability of the historical basis will be determined by the current EAHJ. Otherwise, the Non-NRTL Legacy Equipment Program should be used to ascertain the safety of the non-NRTL legacy equipment.

All modifications to NRTL-listed electrical equipment or non-NRTL equipment previously approved by the EAHJ shall be examined and approved by the EAHJ prior to being energized. For the intent of this program, modifications shall include repairs made using parts other than the manufacturer's recommended components, or Like-for-Like components. The equipment shall be inspected and demonstrated that equivalent safety can be achieved through evidence of compliance with a standard acceptable to the EAHJ and documented using Form-2895, Non-NRTL/Modified NRTL-Listed Electrical Equipment Approval, and labeled using the Form-2908, UCOR Electrical AHJ Approved Non-NRTL Equipment. The EAHJ equipment evaluation, acceptance criteria, and opinion shall be compiled in an EAHJ report attached to Form-2895. Modifications to NRTL-listed electrical equipment that were accepted and documented by the previous EAHJ are acceptable for use providing a basis for the approval that is acceptable to the current EAHJ exists.

4.6.5 Documentation

For electrical installation and modification inspections, Form-2359 will be maintained as a record of the satisfactory completion of the inspections.

4.7 METHODS TO ACHIEVE OSHA ACCEPTABILITY

There are three different methods to achieve OSHA-acceptable electrical equipment, as defined in 29 CFR Part 1910.399, all of which are incorporated in this program as discussed in Section 4.6.4. These three methods now follow.

4.7.1 NRTL Listed

If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by an NRTL pursuant to 29 CFR Part 1910.7.

4.7.2 EAHJ Inspection

With respect to an installation or equipment of a kind that no NRTL accepts, certifies, lists, labels, or determines to be safe (e.g., systems and assemblies, even if composed of NRTL components but not tested by an NRTL as an assembly), if it is inspected or tested by the UCOR authority responsible for enforcing occupational safety provisions of the NEC, and found in compliance with the provisions of the NEC.

4.7.3 Custom equipment or installations

With respect to custom-made equipment or related installations that are designed, fabricated for, and intended for use by UCOR, if it is determined to be safe for its intended use by its manufacturer on the basis of test data, which the manufacturer keeps and makes available for inspection by authorized representatives, including the UCOR EAHJ.

4.7.4 Inspection Elements

Equipment shall be examined for safety as extensively as possible. Areas of consideration should include but are not limited to:

- Failure modes
- Heat effects
- Magnetic effects
- Grounding and bonding (refer to Form-2957, Grounding System Resistance Test, for details)
- Guarding of energized parts
- Leakage currents
- Insulation and Dielectric testing (refer to Form-3528, Insulation Resistance (Megger) Test, for details)
- Access to serviceable parts
- Overcurrent and over temperature protection
- Clearances and spacing
- Interlocks
- Design and procedural documentation
- Signage, labels, and administrative controls
- Mechanical motion
- Stored energy

This inspection shall be documented and shall include, but not be limited to:

- Tests performed
- Conditions of acceptability
- Applicable standards to which the equipment was evaluated
- Limitations of approved use, if any
- Date of inspection
- Signature of reviewer
- Reason for approval or rejection

4.7.5 Documentation

For other than Section 4.7.1, acceptance of installation or equipment shall be documented by the EAHJ. An NEC inspection or plan review report will be completed and a copy provided to the requestor. Any corrections noted during the inspections will be documented. The report will include conditions for continued service and allowable time for correction, appeal, and reinspection, if necessary.

4.8 LEGACY NON-NRTL EQUIPMENT PROGRAM

4.8.1 Purpose

UCOR is obligated and directed to provide a safe working environment for its employees and subcontractors. Numerous federal laws and national standards (e.g., 29 CFR Part 1910 Parts S and K; NFPA 70) require that electrical equipment be approved by the EAHJ. The primary basis for that approval is a testing and certification process conducted by an NRTL authorized by OSHA for use within the United States. Equipment that has been tested and found to be safe for use in the workplace is then listed and labeled by the NRTL to provide assurance to the public that the equipment conforms to national standards for safety.

Not all equipment is submitted to an NRTL for testing. Some equipment is legacy equipment and pre-dates the OSHA requirements for NRTL testing and certification. Other equipment is esoteric equipment, sold in relatively small quantities by a specific manufacturer or to a limited customer base for specialized applications. Moreover, sometimes a manufacturer will offer non-listed equipment at a price discount to its fully tested, listed, and labeled equipment.

While the UCOR Supply Chain Management Program is very specific that only NRTL equipment be purchased when available, occasionally legacy non-NRTL, non-permanently installed equipment (e.g., temporary power carts, foaming trailers, portable HEPA units, and other cord-and-plug and/or appliance-type devices) is identified and being used at a UCOR facility. The purpose of this section is to establish the programmatic elements necessary to document, evaluate, and ultimately provide a basis for the UCOR EAHJ to determine whether or not a non-NRTL piece of equipment is safe to use.

If procurement of non-NRTL equipment is required (e.g., a specific piece or type of equipment that is not available with an NRTL LLR certification), see PROC-PR-1200, *Requisition Process for Materials and Services*, and PROC-DE-1021, *Material Requisition Package Requirements*, for requirements.

4.8.2 Scope

This process is intended to be used to establish a basis for the UCOR EAHJ to determine whether or not a legacy piece of equipment is safe to use. This process is very detailed and requires a significant effort in order to identify, read, and understand the correct national standards to be used; perform intrusive field inspections for compliance

to the applicable standards; and document any findings and/or corrective actions required to bring the equipment in conformance with those standards.

No field inspection program, including this one, can establish an actual NRTL LLR certification for a piece of equipment. NRTL testing and certification offers a higher standard than that offered by a field inspection program. Therefore, this program may not be used as a substitute for purchasing NRTL-listed and -labeled equipment when that equipment is available.

This section (and the nonconformance report [NCR] process) is not intended to be used for Like-for-Like component replacement of legacy permanently installed equipment. That equipment was installed subject to the codes and inspections of the Code of Record at the time of installation, and is not required to be upgraded or altered unless a specific hazard is identified or a Design Change/Modification is implemented. However, the procurement of the non-NRTL replacement part will still need to be approved by the EAHJ and procured in accordance with PROC-DE-1021.

4.8.3 Discovery of Non-NRTL Legacy Equipment

4.8.3.1 Document the discovery with a Nonconformance Report (NCR)

The identifier of the non-conforming condition should use the NCR process per PROC-PQ-1440, *Control of Non-conforming Items and Materials,* to document and resolve the condition.

4.8.3.2 Approaches to resolving non-conforming equipment

There are two basic approaches to resolving the non-NRTL legacy equipment.

The first approach is to replace the equipment with NRTL-listed and -labeled equipment or other suitable equipment (e.g., battery-powered). The non-conforming equipment should be retired and properly disposed when suitable replacement equipment is obtained. Should this path be chosen, UCOR is obligated to pursue replacement equipment on a “best effort” priority.

The second approach is to use the evaluation of non-NRTL equipment process to develop a basis for EAHJ approval. This process requires the Office of the EAHJ to determine, obtain, and review the appropriate national standards, intrusively inspect the equipment, and determine whether or not the equipment is safe and acceptable for continued use at UCOR facilities.

Recommendations may be developed to bring the equipment into compliance if possible. The UCOR EAHJ may also utilize other resources, such as certified (third party) Field Inspection Bodies, to conduct inspections as tools to assist in their determination, but ultimately the determination of safety and decision for approval lies fully on the UCOR EAHJ (subject to the approval authority delegated by the DOE). Finally, the EAHJ may determine that the equipment is not and cannot be made to conform sufficiently to safety standards. If such a determination is made, the equipment is not safe to use and must be promptly removed from service.

4.8.4 Evaluation of Non-NRTL Equipment Process

The primary tool to assist the UCOR EAHJ in their evaluation of the safety of a non-NRTL piece of equipment is Form-2895. This process requires the Office of the AHJ to determine, obtain, and review the appropriate national standards, intrusively inspect the equipment, and determine whether or not the equipment is safe and acceptable for use at UCOR facilities. Recommendations may be developed to bring the equipment into compliance if possible and necessary. The UCOR EAHJ may also utilize other resources, such as certified (third party) Field Inspection Bodies, to conduct inspections as tools to assist in their determination, but ultimately the determination of safety and decision for approval lies fully on the UCOR EAHJ (subject to the approval authority being delegated by DOE).

Alternatively, the EAHJ may determine that the equipment is not and cannot be made to conform sufficiently to national safety standards. If such a determination is made, the equipment is not safe to use and must be promptly removed from service.

4.8.4.1 Determine the appropriate standards

National standards exist for hundreds of types of components and assemblies. Often, separate standards will exist for the equipment, the power supplies, power cords and plugs, workmanship, circuit boards, and other pertinent qualities. Select the appropriate standards for the device being evaluated.

4.8.4.2 Perform an intrusive inspection

Conformance to the applicable standards can only be determined by an actual field inspection and internal characteristics can only be determined by internal inspections. Often equipment is assembled using NRTL listed, labeled, or recognized parts. Such parts can be assumed to conform to standards. However, the mounting and interconnection of those parts and pieces must be inspected to ensure that the assembly as a whole can be considered safe to use.

Several OSHA-recognized NRTLs also offer field inspection services. National standards and other guidance documents exist (DOE-HDBK-1092-2013, *Electrical Safety*; NFPA 790, Standard for Competency of Third-Party Field Evaluation Bodies; and NFPA 791, Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation) for the performance of field inspections and the qualifications of personnel and companies performing those inspections. Such services offer an alternative to having UCOR personnel perform the research and inspection of specific components, and may be used as a tool. However, whether the inspection is outsourced or conducted in-house, the UCOR evaluation process is performed and documented using the following Forms approved by the UCOR EAHJ and/or UCOR FP AHJ when required.

- Form-2988, Non-NRTL Listed Item Review Request (Outsourced item)
- Form-2895, Non-NRTL/Modified NRTL-Listed Electrical Equipment Approval (In-house item)

Note that each piece or model of equipment must be separately inspected and evaluated unless it can be demonstrated that each piece of equipment is identical to the one undergoing inspection. Even then, spot checking may be prudent to ascertain that each piece of equipment is in fact identical and has not been modified in any way.

4.8.4.3 Evaluate the Non-NRTL Equipment

The overall objective of the UCOR Legacy Non-NRTL Equipment Program is to ensure that equipment being used at UCOR facilities is safe for personnel to use. To that end, the UCOR EAHJ shall consider the construction, use, and safety of the equipment and determine whether or not its use will allow UCOR personnel to be provided with the safe work environment stipulated by federal regulations. Upon consideration of all evidence, the AHJ may approve the non-NRTL equipment for use at UCOR facilities (subject to the approval authority being delegated by DOE). That approval may be immediate, or may be contingent on the completion of recommendations. The approval may also contain certain restrictions on use, location, or other restrictions needed to ensure the safety of the component. The approval should also stipulate that modification to the evaluated equipment or changes in the intended use of such equipment shall require additional review to determine if reinspection and reevaluation is necessary.

4.8.4.4 Execute any EAHJ recommendations

During the evaluation, the EAHJ may determine that certain components or aspects should be changed, altered, or upgraded in order for the legacy equipment to fully conform to the national standards, and may provide recommendations accordingly. Those recommendations must be fully executed, complete with closure evidence.

4.8.5 Install an EAHJ Non-NRTL Equipment Approval Label

After evaluation and approval for use by the EAHJ, install an EAHJ Approval Label, using Form-2908, on the piece of equipment. The EAHJ shall maintain a Form-2896, UCOR Non-NRTL Electrical Equipment Registration Log, for all non-NRTL/ modified NRTL-listed electrical equipment evaluated and approved.

4.9 LEGACY INSTALLED CODE-DEFICIENT EQUIPMENT PROGRAM

4.9.1 Purpose

UCOR controlled legacy facilities contain electrical systems that are assumed to be installed per the Electrical Code of Record at the time of installation or modification per requirements of PROC-DE-1032, *Preparation and Maintenance of UCOR Code of Record (COR) Documentation*, and PROC-DE-1033, *Development of UCOR Requirements Documentation*. UCOR ensures this compliance with new or modified installations via the EIP, which requires the UCOR EAHJ or designee to inspect all new installations and modifications for compliance with the NEC. Previous managing contractors of these UCOR-controlled facilities may not have operated under the same EIP requirements, so the possibility exists for installations that are not code-compliant. This includes the use of equipment not listed and labeled by an NRTL or not used within its listing. Because of these possible deficiencies, a program is required to describe how to respond to this condition.

4.9.2 Scope

It is possible that code deficiencies may be discovered during normal maintenance activities and design modifications at any and all active and inactive, UCOR-controlled facilities, as defined by PROC-FO-1059, *Facility Transition*. This Code Deficiency Program (CDP) will establish a basis for the EAHJ to determine whether or not a legacy code-deficient installation is safe for continued use as is or requires repair.

4.9.3 Discovery of Code Deficiency

Upon discovery of a code deficiency, the person shall notify the deployed electrical engineer for their project. The electrical engineer shall use the NCR process per PROC-PQ-1440, *Control of Non-conforming Items and Materials*, to document and resolve the condition. Included in the description should be information on the deficiency as well as what facility equipment the non-conforming electrical equipment services. If possible, photographs of the non-conforming equipment should be taken at the time of discovery to aid in the disposition of the NCR.

NOTE: If the code deficiency represents an imminent hazard, the discoverer shall immediately contact the FM and EAHJ, and steps shall be taken to mitigate the hazard (de-energize equipment, flag area, etc.).

4.9.3.1 Evaluate the Code-deficient Equipment

The EAHJ may support Engineering with recommendations in the evaluation and disposition of the NCR per PROC-PQ-1440, *Control of Non-conforming Items and Materials*.

The NEC is not retroactive; therefore, legacy installations should be evaluated to the Code of Record at the time of installation or modification.

5 QUALIFIED ELECTRICAL WORKERS AND UNQUALIFIED PERSONS

5.1 INTRODUCTION

This section covers the actions, required for qualified personnel while working in areas of exposed energized components. Energized electrical conductors and circuit parts that operate at less than 50 V **AND** do not increase worker exposure to electrical burns or to explosion due to electrical arc are exempt from this section. The capacity of the source and any overcurrent protection between the energy source and the worker are to be considered in order to determine that there will be no increased exposure to electrical burns or to explosion due to electrical arcs. Deviation from prescribed clothing and PPE may be allowed if approved by the EAHJ/Electrical Safety SME.

Operation and maintenance of equipment for control, transformation, transmission, and distribution of electrical energy, including related equipment for the purpose of communication and metering, shall be conducted in accordance with OSHA 29 CFR 1910.269.

*******WARNING*******
Energized electrical conductors and circuit parts to which personnel may be exposed shall be de-energized before the person works within the Limited Approach Boundary, unless de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

*******WARNING*******
Until confirmation of isolation and application of locks/tags has been completed during the Lockout/Tagout process, the act of checking for presence of voltage (which includes confirming isolation) is considered to be "working on," and the requirements of this section apply.

5.2 QUALIFIED ELECTRICAL WORKER (QEW) QUALIFICATIONS

1. Only those persons who are both qualified and authorized may install, fabricate, repair, test, calibrate, or modify electrical or electronics wiring, devices, systems, or equipment.

2. A qualified person is an individual who:

- Has completed classroom and on-the-job (OTJ) training related to assigned work; and
- Has skills and knowledge related to the construction and operation of the electric systems, equipment, and installations; and
- Has received safety training to be able to recognize and positively control or avoid the hazards involved; and
- Has completed site-, area-, facility-, process-, equipment- and apparatus-specific training as required.

3. A person can be considered qualified and authorized with respect to certain equipment and methods but not authorized for others. For example, an Instrument Mechanic is not qualified to perform the distribution work of a Lineman even though both are QEWs.

4. An authorized person is one who has been assigned a task by their supervisor subject to the Task-Specific Training Criteria.

Guidelines for Qualification

1. Qualification for electrical work is determined by the employer, and is based on a combination of classroom training; formal electrical trade, military, college or other training; work experience; and OTJ training. Experience may be a combination of or include formal technical-related education courses, hands-on fieldwork, or classroom lab work that may or may not have resulted in licenses or certifications.

Task-Specific Training Criteria

1. Supervisors shall use the following guidelines to determine whether an individual is qualified to perform specific electrical work. Different subsets of these criteria shall be selected according to the exact nature of the task; however, some analysis must always be performed, no matter how minor the job.

- A description, in detail, of the scope of the work task being considered.
- The person's ability to identify relevant hazards associated with this task.
- The person's experience in the selection and use of test equipment for this task.
- The person's ability to read the appropriate Engineering documents for the equipment.
- The person's knowledge of how to check the equipment calibration, condition, and operation.
- The person's knowledge of how to shut down, isolate, and verify all sources of hazardous energy.
- The person's knowledge of LO/TO and/or Power Distribution Work Permit (PDWP) requirements, and training in LO/TO and/or PDWP, as applicable.
- The person's ability to identify, understand, and implement applicable codes and standards pertaining to the task.
- The person's experience and training to independently distinguish correct construction and maintenance techniques from incorrect techniques.
- The person's experience and training to select the correct materials and components, and to use them in a manner consistent with their manufacture and/or listing.
- The person's ability to distinguish between appropriate and inappropriate equipment-grounding techniques.
- The person's experience, training, and ability to predict likely failure modes of a particular construction, and to properly mitigate the effects of such failures.
- The person's familiarity with the proper use of the safe work rules, special precautionary techniques, PPE, insulating and shielding materials, insulated tools, and test equipment.

2. If the individual will be permitted to work within the LAB of exposed energized parts operating at 50 V or more, the individual shall, at a minimum, be additionally trained in all the following:

- The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.
- The skills and techniques necessary to determine the nominal voltage of exposed energized parts.
- Skills and techniques to determine if inadvertently induced voltage or unrelated voltage backfeed is present resulting in non-zero voltage readings even when the circuit is verified to be void of hazardous electrical energy.
- All approach boundaries/distances specified in NFPA 70E and/or 29 CFR Part 1910.269 and the corresponding voltages to which the qualified person will be exposed.
- The decision-making process necessary to determine the degree and extent of the hazard, and the PPE and job planning necessary to perform the task safely.
- The methods of safe release of victims from contact with exposed energized electrical conductors or circuit parts.

5.3 GENERAL REQUIREMENTS

1. Normally current-carrying conductors shall be considered energized and hazardous until they have been positively proven otherwise by a QEW and positively controlled by LO/TO, PDWP, or air-gap.

2. An Electrically Safe Work Condition, defined in NFPA 70E, shall be established before a person performs work within the LAB of energized electrical conductors or circuit parts to which a person might be exposed. Energized electrical work, when required, is addressed in Section 5.4, Energized Electrical Activities – General Requirements.

3. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment as directed by Engineering. IF induced voltage or unrelated voltage feedback is present resulting in an unsatisfactory Absence of Nominal Voltage Test, THEN contact Engineering for assistance.

4. Voltages less than 50 volts AC/DC, while not considered to be electrically hazardous (i.e., shock, arc flash, arc blast), can present other industrial hazards (e.g., overheating, fire, arcing, and welding) particularly when the power source has significant current capacity (e.g., 12-V DC auto battery, 48-V arc welders). These hazards should be addressed and controlled along with other industrial hazards during the JHA and subsequent work control document development.

5. Appropriate PPE shall be worn when working within the AFB or the Limited, and Restricted, Approach Boundaries of exposed energized parts as required by NFPA 70E. Normally, the PPE is indicated on the Arc Flash Hazard label or work package.

6. Positive removal and control of the source of power via a proper LO/TO, a successful Absence of Nominal Voltage Test, and protective grounds (if required) are all necessary to establish an Electrically Safe Work Condition.

7. AFBs and LABs shall be established to restrict proximity to equipment that presents arc flash and shock hazards. Follow all directions and postings.

8. Appropriate Arc Flash PPE shall be worn whenever a worker is working within the AFB and the boundary is in effect. FR clothing used as Arc Flash PPE shall have an appropriate arc thermal performance value (ATPV) or energy of break open threshold (EBT) rating.

9. Do not use or allow electrically conductive cleaning materials within the LAB.

10. To prevent arcs, arc faults, and inadvertent equipment starts, verify that a switchgear circuit breaker is in the open or disconnected position prior to removing or installing the circuit breaker (racking) into the switchgear.

11. If potential NEC deficiencies are discovered during the course of normal work, alert the appropriate personnel per Section 4.9, Legacy Installed Code-Deficient Equipment Program.

5.4 ENERGIZED ELECTRICAL ACTIVITIES – GENERAL REQUIREMENTS

1. Do not perform activities within the Minimum Approach Distance of transmission or distribution equipment until hazardous energy is controlled per PROC-ET-3013, *Power Distribution Work Permit*, except as provided for in PROC-ET-3013 and/or 29 CFR Part 1910.269, Electric Power Generation, Transmission, and Distribution.

NOTE: Contacting energized exposed conductors or parts or crossing the Restricted Approach Boundary (RAB) with body parts or tools including test leads is considered energized electrical work. See Section 5.8, Energized Electrical Work Permit, for permit requirements.

2. Follow Shock Hazard and Arc Flash Hazard requirements.

a. Determine the boundary from the exposed energized part to the person and/or the longest conductive object with which the person may contact the exposed energized part for the specific task to be performed.

b. Establish shock protection boundaries to exposed energized parts in accordance with NFPA 70E-2018, Table 130.4(D)(a) and Table 130.4(D)(b) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Shock Protection, or 29 CFR Part 1910.269, Table R-6, Alternative Minimum Approach Distances for Voltages 72.5 kV and Less.

3. Select shock protection PPE as follows:

a. Evaluate the exposure to electrical shock. Shock protection PPE shall be used if hands or any uninsulated conductive objects in contact with the hands could approach exposed energized parts within the RAB.

b. Insulated tools and equipment shall be used when working inside the RAB. Insulated tools shall be rated, designed, and constructed for the environment to be used and visibly inspected prior to each use. Insulated tools and equipment shall also be stored, maintained, and tested according to the manufacturer's instructions or industry standards. Refer to NFPA 70E 130.7 (D)(1).

c. Use tested rubber goods with a rated voltage that is equal to or greater than the voltage of the energized electrical equipment.

d. If body parts other than the hands could enter the RAB, use rated PPE on the affected body part or rated insulated shielding material over the conductor to protect these areas.

e. Some equipment (e.g., specific Radiation/Criticality Accident Alarm System [RCAAS] parts, 120-VAC wall receptacles, equipment designated as Finger Safe) is designed to guard against inadvertent contact. NFPA 70E allows energized equipment to be guarded as an alternative to wearing shock protection PPE. Shock protection PPE is not required when taking voltage readings on guarded equipment where there is no chance of inadvertent bodily contact with energized equipment.

f. Portable ladders shall have nonconductive side rails when used within the LAB or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders (i.e., fiberglass, wood) shall meet the requirements of applicable state, federal, or local codes and standards. Refer to NFPA 70E 130.7 (D)(1)(e).

4. Select arc flash protective PPE.

a. Any work within the AFB creates a risk of receiving a second-degree burn or more serious injury. Any worker who crosses the AFB is required to wear the appropriate level of PPE for the evaluated Arc Flash Hazard.

b. Arc flash PPE requirements are either specified directly on the Arc Flash Hazard label, or indirectly by the Arc-Flash PPE Category listed on the Arc Flash Hazard label. If no label is present, consult your supervisor to determine whether the equipment is exempt per this program description. If not, contact Engineering for determination of the Arc Flash Hazard, appropriate PPE, and Arc Flash Hazard label before proceeding with the work.

c. The label will describe the Arc Flash Hazard with an incident energy exposure value at the assumed working distance, or alternately the Arc-Flash PPE Category required to work within the AFB of the equipment while energized. NFPA 70E Table 130.7(C)(15)(c) lists the appropriate PPE to be worn per Arc-Flash PPE Category. This is in addition to any required shock-protective PPE. No synthetic or synthetic blend articles are permitted inside or outside of FR clothing that has an arc rating.

5. **IF** work (including Absence of Nominal Voltage Tests) must be performed on equipment with an arc flash incident energy exposure level above 40 cal/cm^2 (i.e., requiring additional arc flash PPE beyond Arc-Flash PPE Category 4), **THEN** Form-2155, Energized Electrical Work Permit (EEWP), shall be used to document the precautions, additional controls, PPE to be used, and management approval. In general, work on equipment with an arc flash incident energy level above 40 cal/cm^2 is considered extremely dangerous because of the tremendous pressure generated by the possible arc blast and should be avoided whenever possible. Determine whether an engineered solution (e.g., DCN) can be developed to reduce the Arc Flash Hazard.

6. Any tools taken inside the LAB that could make unintentional contact with exposed energized equipment must be insulated for the highest voltage present. Insulated tools bear a “double triangle” mark. Inspect insulated tools for damage to the insulation before each use. Look for damage to the insulation or damage that may impede the tool from performing its intended function, or that increases the potential for an incident. Remove tools with damaged insulation from service.

7. **Conductive Articles Being Worn.** Do not wear conductive articles of jewelry and clothing while performing activities within the LAB if the articles may contact energized components. Conductive articles include (but are not limited to) watchbands, zippers, bracelets, belt buckles, rings, key chains, necklaces, earrings, metal badge clips, thermo-luminescent dosimeters, metalized aprons, metal safety glasses, cloth with conductive thread, or metal headgear. Contact the EAHJ/Electrical Safety SME to determine how to comply when dosimeters or badges cannot be covered.

8. All participating QEWs shall be in agreement regarding the exact activity and the sequence of steps before activity starts within the RAB.

9. **Confined or Enclosed Work Spaces.** When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized electrical conductors or circuit parts operating at voltages equal to or greater than 50 volts or where an electrical hazard exists, protective measures such as the use of protective shields, protective barriers, or insulating materials as necessary shall be utilized to avoid inadvertent contact with these parts and the effects of the electrical hazards. Refer to NFPA 70E 130.6 (F).

10. **Doors and Hinged Panels.** Before the activity begins, doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized electrical conductors or circuit parts operating at voltages equal to or greater than 50 volts or where an electrical hazard exists if movement of the door, hinged panel, and the like is likely to create a hazard. If necessary, remove the door or panel before starting work. Refer to NFPA 70E 130.6 (G).

11. **Illumination.** Provide sufficient lighting to perform the work safely before entering spaces containing exposed energized parts or where electrical hazards exits. Refer to NFPA 70E 130.6(C)(1).

12. **Obstructed View of Work Area.** Where lack of illumination or an obstruction precludes observation of the work to be performed, employees shall not perform any task within the LAB of energized electrical conductors or circuit parts operating at voltages equal or greater than 50 volts or where an electrical hazard exits. Refer to NFPA 70E 130.6(C)(2).

13. **Safety Interlocks.** Only qualified persons following the requirements for working inside the restricted approach boundary as covered by Section 5.8, Energized Electrical Work Permit, shall be permitted to defeat or bypass an electrical safety interlock over which the person has sole control, and then only temporarily while

the qualified person is working on the equipment. The safety interlock system shall be returned to its operable condition when the work is completed. Refer to NFPA 70E 130.6(N).

14. **Housekeeping Duties.** Employees shall not perform housekeeping duties inside the LAB where there is a possibility of contact with energized electrical conductors or circuit parts, unless adequate safeguards (such as insulating equipment or barriers) are provided to prevent contact. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) shall not be used inside the LAB unless procedures to prevent electrical contact are followed. Refer to NFPA 70E 130.6(I).

5.5 ALERTING TECHNIQUES

NOTE: Alerting Techniques are placed in the applicable work control documents in the prerequisite section or at the step to which they apply to ensure they are in place prior to the work starting. PROC-EH-1013, *Accident Prevention Signs, Barricades, and Other Postings*, governs the use of the following alerting techniques.

1. Guard-exposed electrical parts of equipment that operate at greater than 50 V against unintentional contact using appropriate cabinets, insulated shields, location, barricades, and/or warning labels.

2. Use safety signs, safety symbols, or accident prevention tags where it is necessary to warn persons about electrical hazards that might endanger them.

3. Use nonconductive barricades (e.g., barricade tape, rope, or fencing) in conjunction with safety signs where it is necessary to prevent or limit personnel access to work areas containing energized conductors or circuit parts. These barricades shall not be placed closer than the established LAB or AFB (whichever is greater). When multiple barricades are used, clearly indicate the purpose of each barricade.

4. Station an attendant to warn and protect persons from the electrical hazards where signs and barricades do not provide sufficient warning and protection from electrical hazards. The only duty and responsibility of the attendant shall be to warn and keep passersby outside of the work area of the localized hazards. The attendant shall remain in the area as long as there is a potential for persons to be exposed to the electrical hazards.

5. The attendant is not required to be a QEW as long as he/she also remains outside of the LAB and AFB.

6. Keep Unqualified Persons outside of a work area where the Unqualified Person might be exposed to electrical hazards. Remain in the area as long as there is a potential for Unqualified Persons to be exposed to the electrical hazards.

7. **WHEN** work is performed on equipment that is de-energized and placed in an electrically safe condition in a work area with other energized equipment that is similar in size, shape, and construction, **THEN** one of the alerting methods listed below shall be employed to establish definite positive controls to prevent a person from inadvertently accessing the energized look-alike equipment.

a. Safety signs, safety symbols, and/or tags

b. Barricades (used to prevent or limit employee access)

c. Attendant(s)

5.6 ELECTRICAL MEASURING AND TESTING

NOTE: Taking voltage measurements in the 50-150 V range constitutes contact with energized exposed conductors and is considered work within the RAB (i.e., Crosses the "Avoid Contact" boundary. Consequently, appropriate shock protection PPE [and arc-protection PPE if applicable] must be worn unless the equipment is properly guarded [e.g., finger safe, wall receptacles]).

1. Electrical measuring and testing of circuits and equipment 50 V or greater is considered to be energized electrical work and shall only be performed by a QEW. This includes Absence of Nominal Voltage testing for LO/TO.

2. Visually inspect test instruments and equipment and associated leads and connectors for the following before each use:

- External physical defects and damage
- Electrically rated and approved for the intended use
- Inappropriate voltage and energy rating (category) of the test equipment for the intended use

3. Check test instruments are operating satisfactorily on any known voltage source before and after performing Absence of Nominal Voltage Tests.

4. Tag and remove from service any defective or damaged instruments or equipment, test leads, probes, connectors, or accessories. Return defective or damaged equipment to the supervisor. Test instruments are controlled per PROC-DE-1022, *Control of Measuring and Test Equipment.*

NOTE: The Project Industrial Hygienist should be consulted if a potentially hazardous atmosphere exists.

5. **IF** working in hazardous atmospheres, **THEN** use test instruments that are specifically designed for that purpose. Alternately, have the atmosphere tested and proved to verify the absence of hazardous matter, such as flammable vapors, dust, fibers, etc.

5.7 PERSONAL PROTECTIVE EQUIPMENT

All shock and arc-protective PPE must be properly stored, maintained, and inspected.

Documented procedure for storage, maintenance, and testing of protective equipment shall be maintained.

Do not use rubber insulating gloves or dielectric footwear that has not been tested within the last six months.

Visually inspect shock protection PPE for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Return damaged goods for removal from service.

Perform an air inflation test on insulating gloves to detect any holes or leaks each day that the gloves are used. Use glove powder recommended by the manufacturer.

Clean rubber goods as needed to remove foreign substances, per the manufacturer's instructions.

Store rubber goods in the appropriate manufacturer-recommended containers.

Rubber blankets may be stored in a roll, as long as the inner diameter of the roll is at least two inches.

Store rubber goods in a location and manner to protect them from light, temperature extremes, excessive humidity, ozone (such as in switchgear rooms), and other harmful substances and conditions.

Visually inspect protective grounding equipment, cables, clusters, and sticks for damage prior to use.

5.8 ENERGIZED ELECTRICAL WORK PERMIT

NOTE: This section does not apply to work governed by 29 CFR Part 1910.269 and the NESC.

Energized Work shall be permitted under the following conditions:

1. **Additional Hazard or Increased Risk**. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

NOTE: Removing the source of electrical energy from unique equipment can result in a greater hazard existing at a different location in the facility. The additional or greater hazard could be from an electrical energy source or from a different type of energy source, such as a chemical or environmental hazard.

2. **Infeasibility.** Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

NOTE: If the work task is to measure voltage or load current, for instance, the task can only be performed with the circuit energized and operating. In general, diagnostic analysis requires the circuit or equipment to be energized. Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment could also be considered infeasible.

3. **Less Than 50 volts AC/DC.** Energized electrical conductors and circuit parts that operate at less than 50 V shall not be required to be de-energized where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs.

NOTE: Control circuits that are energized at less than 50 V might be hazardous. For instance, disconnecting or shorting a control circuit could create an interruption or other unintended condition within an industrial process that results in releasing another type of energy. Even if the capacity of the electrical energy source is limited, the integrity of the circuit might be critical to the system as a whole.

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

- **a.** The equipment is properly installed.
- **b.** The equipment is properly maintained.
- **c.** The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
- **d.** The equipment doors are closed and secured.
- **e.** All equipment covers are in place and secured.
- **f.** There is no evidence of impending failure.

NOTE 1: The phrase *properly installed* means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained* means that the equipment has been maintained in accordance with the manufacturer's

recommendations and applicable industry codes and standards. The phrase *evidence of impending failure* means that there is evidence, such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

NOTE 2: Even under a normal operating condition there is a likelihood of occurrence of an Arc Flash Incident for both ac and dc systems under any conditions for:

a. Insertion or removal of individual starter buckets from MCC.

b. Insertion or removal (racking) of circuit breakers (CBs) or starters from cubicles, doors open or closed.

c. Insertion or removal of plug-in devices into or from busways.

NFPA 70E Table 130.5(C) is applicable to both PPE category and incident energy analysis methods of arc flash assessment. It can aid in determining the likelihood of an arc flash incident occurring for the specific task based on the equipment condition.

5. Do not perform activities within the LAB of electrical utilization equipment, components, and conductors with exposed energized parts of 50 V or greater until hazardous energy is controlled according to PROC-EH-2002, *Hazardous Energy Control (Lock Out/Tag Out)*, or an EEWP is approved.

6. Energized work shall be permitted only as follows:

- Where the Project Manager/Facility Manager (PM/FM) can justify that de-energizing introduces additional hazards or increased risk, or
- Where the PM/FM can justify that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations (e.g., troubleshooting).
- Energized work approval signatures including responsible Supervisor, Electrical Safety SME, Technical Services Manager, and Chief Operating Officer.

7. **Exemptions to EEWP.** A Form-2155, Energized Electrical Work Permit (EEWP), is not required if the activity on exposed energized electrical conductors or circuit parts meets at least one of the following criteria:

- Testing or performing an Absence of Nominal Voltage Test on exposed energized or potentially energized parts; or
- Testing to determine a precise electrical measurement on exposed energized parts; or

NOTE: Troubleshooting as used below only includes troubleshooting techniques that cannot be performed in a de-energized state.

- Troubleshooting to determine the specific location of the problem on exposed energized parts using the required PPE. However, if the Arc Flash Incident Energy exceeds 40 cal/cm^2, an EEWP (Form-2155) is still required.

8. Do not use Form-2155 for UCOR power distribution work. Power distribution work is controlled by PROC-ET-3013.

9. If the work within the RAB of an energized exposed conductor or circuit part does not fall under one of the above exceptions, an EEWP (Form-2155) is required. EEWP preparation shall be in accordance with the instructions included with Form-2155a, Energized Electrical Work Permit Instructions, and as follows:

NOTE: If there is a need for control of hazardous electrical sources in which a LO/TO cannot be verified, an EEWP is required. The EEWP shall detail the control measures for those sources.

a. The EEWP is prepared, reviewed, and approved before the start of any activity within the RAB of exposed energized equipment, components, or conductors.

b. Review the necessity of the exposed energized electrical activities with the responsible PM/FM.

c. Achieve consensus with the FM that the circuit/equipment cannot be de-energized.

d. Initiate an EEWP and confirm that the work control document includes a complete job description of the activity on exposed energized conductors and/or circuit parts.

e. Ensure the EEWP is approved as evidenced by all signatures complete in Section 5 of Form-2155, before the energized work is performed.

f. Include a copy of the EEWP in the work control document and have it available at the jobsite for the duration of the energized activity.

g. The EEWP shall be briefed as part of the work Package briefings required by PROC-FS-1001, *Integrated Work Control Program*.

h. The EEWP is valid for the duration of the specific job as long as the conditions defined in the permit are not changed and the EEWP and specific job requirements are reviewed with any new QEWs brought onto the job. If conditions defined in the permit change or revisions need to be made to controls, STOP. A new EEWP will be required.

10. **WHEN** the result of the electrical hazard analysis documented in the EEWP determines that a dedicated safety observer is necessary, **THEN** at least two QEWs must be present. One of the QEWs must function as an attendant and be stationed to warn and protect personnel.

5.9 COMPENSATORY MEASURES FOR INADEQUATELY MAINTAINED OVERCURRENT PROTECTIVE DEVICES

These compensatory actions only apply to facility systems and equipment **fed** by overcurrent protective devices (OCPDs) that have not been maintained (either deferred PM or PM that have not been established within the UCOR PM Program). For transmission or distribution systems governed by 29 CFR Part 1910.269, an assessment per 1910.269(I)(8)(i) shall be performed.

1. Facility Management, Operations, and Engineering shall evaluate facility electrical distribution systems and develop approved work documents to de-energize and administratively tag and control those systems and/or circuits that are no longer required per PROC-FO-1066.

2. FMs shall strictly control access to equipment energized at > 1000 VAC or greater.

3. For all work on exposed energized electrical equipment greater than 240 V, an Engineering Risk Assessment per PROC-DE-1023, *Preparation and Maintenance of Arc Flash (AF) Hazard Analysis for AC and DC Electrical Systems*, shall be completed prior to performing work.

4. Switchgear shall be de-energized prior to racking in/out any circuit breakers where the upstream OCPD has not been maintained.

5. For operation of equipment where the upstream OCPD has not been maintained, the PPE level shown on the Arc Flash Hazard Label of the equipment being operated shall be worn.

6. QEW Supervisors should consider utilizing appropriate remote operating devices, extension handles, safety shields, hot sticks, or any other appropriate, approved (by engineering) tool available to increase the working distance when operating or manipulating a protective device. (Note that doubling the working distance from 18 to 36 inches reduces the incident energy to a quarter of the calculated value.)

5.10 UNQUALIFIED PERSONS

5.10.1 Approach Distances for Unqualified Persons

NOTE: See Section 6, Overhead Utilities, for requirements where mobile equipment or equipment structure will be elevated near energized overhead lines.

1. **WHEN** an unqualified person is working on the ground or in an elevated position near uninsulated energized overhead lines, **THEN** the location shall be such that the person and the longest conductive object the person might contact does not come closer to any unguarded, energized overhead power line than the LAB.

2. Where work is performed in locations containing uninsulated energized overhead lines that are not guarded or isolated, precautions shall be taken to prevent personnel from contacting such lines directly with any unguarded parts of their body or indirectly through conductive materials, tools, or equipment. The protective measures shall prevent coming closer to any unguarded, energized overhead line than the LAB.

3. If protective measures are used, such as guarding, isolating, or insulation, these precautions shall prevent each person from contacting such lines directly with any part of his or her body or indirectly through conductive materials, tools, or equipment. The protective measures shall prevent coming closer to any unguarded, energized overhead line than the LAB.

4. Scaffolds shall not be erected, used, dismantled, altered, or moved such that they or any conductive material handled on them might come closer to energized power lines than the minimum safe working distance specified in PROC-FO-1015, *Scaffolds and Ladders*. Contact supervision, Safety & Health (S&H), Utility Power Distribution SME, and the EAHJ for input in scaffold placement and protection as needed.

5. Overhead lines shall be de-energized when work by unqualified persons is planned to be performed in the LAB or when work activities/equipment have the potential to enter the LAB, unless it is determined that de-energizing creates a greater hazard or unacceptable operational impact, in which case Safety, Engineering, the PM, and the EAHJ/Electrical Safety SME shall approve the work scope activity, and a work package with the appropriate controls is required.

6. Work by unqualified persons that has the potential to come within the LAB of overhead lines shall implement the following controls:

a. The facility electrical maintenance, engineering organization, electrical utility, equipment operators, line watch, spotters, and supervisors directly involved in the work shall be involved in planning work.

b. The work zone and all paths of travel shall be walked down to identify clearances, potential electrical hazards and controls where any load or equipment component has the capability of entering the LAB. The location and clearances from utility poles shall also be reviewed. The use of Form-3090, Overhead

Utility Clearance Permit, is required for all work evolutions where potential exists to come within the LAB of overhead lines.

c. In the event that the LAB cannot be maintained, then there shall be special planning with engineering and the electrical utility for clearances to be reduced to the design working dimensions of an insulating barrier.

7. If energized overhead lines are to be de-energized, arrangements shall be made with the electrical utility to de-energize them and visibly ground them at the point of work implementing appropriate hazardous energy control measures in accordance with both parties Lockout/Tagout (LO/TO), PDWP Program, and/or interface agreement (IA). Unless permitted by one of the exceptions below, no unqualified person shall be permitted to approach nearer than the LAB of exposed energized conductors and circuit parts.

Exception 1: Working at or Close to the LAB.

Where one or more unqualified persons are working at or close to the LAB, the designated person in charge of the work space where the electrical hazard exists shall advise the unqualified person(s) of the electrical hazard and warn him or her to stay outside of the LAB.

Exception 2: Entering the LAB.

Where there is a need for an unqualified person(s) to cross the LAB, a qualified person shall advise him or her of the possible hazards and continuously escort the unqualified person(s) while inside the LAB. The qualified person escorting the unqualified person(s) shall have no unrelated duties. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the RAB.

6 OVERHEAD UTILITIES

NOTE 1: This section does not apply to cranes (in transit or working) near overhead utilities. Hoisting and rigging operation requirements near overhead utilities are defined in PROC-FO-1008, *Hoisting and Rigging Operations*.

NOTE 2: This section does not apply to work governed by 29 CFR Part 1926.451 for scaffolds or 1926.1053 for ladders.

1. For overhead lines under UCOR's control, grade elevation shall be maintained to preserve no less than the minimum designed vertical and horizontal clearances necessary to minimize risk of unintentional contact. Earth and other materials shall not be placed under or beside an overhead line if doing so reduces the safe clearance to less than the safe limit of approach distance.

6.1 MOBILE EQUIPMENT PERFORMING WORK NEAR ENERGIZED OVERHEAD LINES

NOTE: This section is applicable to all outdoor work involving mobile equipment near energized overhead utility lines in Free Air (e.g., mobile elevated work platforms, excavators, backhoes, drilling rigs, dump trucks, and powered industrial trucks).

6.1.1 Insulated and Energized

NOTE: Objects that are not insulated for the voltage involved should be considered to be conductive/uninsulated.

1. **Determination of Insulation Rating and Integrity.** A qualified person associated with the owner of the overhead line or Utility Power Distribution SME shall determine if the overhead electrical lines are insulated for the lines' operating voltage and insulation integrity is satisfactory to support the voltage impressed.

2. **IF** any part of the equipment performing work has the potential to come within 20 feet of insulated energized overhead lines, **THEN** the use of Form-3090, Overhead Utility Clearance Permit, is required.

3. Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized insulated overhead lines, shall be operated so that the Minimum Approach Distance (MAD) for overhead lines is not encroached upon. The line's voltage and the MAD will be documented on Form-3090, Overhead Utility Clearance Permit.

4. **IF** any part of the equipment working near insulated energized overhead lines has the potential to encroach within the MAD, **THEN** a walkdown shall be conducted with the operator and the other workers who will be in the area of the equipment to review the location of the power line(s), safe limit of approach distances, and ensure mitigating controls documented on Form-3090 (e.g., de-energized the line, relocated the lines, or installed protective coverings) are implemented before such work is permitted.

5. Equipment in the work zone shall be considered to have the potential to come within the MAD for insulated overhead lines if the area around the equipment's maximum working radius crosses the MAD.

6. Where any mobile equipment structure will be elevated near communication lines, they shall be operated to avoid contact.

6.1.2 Uninsulated and Energized

1. The preferred condition under which mobile equipment, including its maximum work radius, is to operate, is no closer than 20 feet to overhead lines.

2. **IF** any part of the equipment performing work has the potential to come within 20 feet of uninsulated overhead energized lines, **THEN** the use of Form-3090, Overhead Utility Clearance Permit, is required.

3. Equipment in the work zone shall be considered to have the potential to come within the LAB for uninsulated overhead lines if the area around the equipment, up to the equipment's maximum working radius, intersects the LAB.

6.1.3 De-energizing or Guarding

1. Where the work to be performed is such that contact with uninsulated energized overhead lines is possible, the lines shall be de-energized and visibly grounded at the point of work or suitably guarded.

2. If equipment operations have the potential to enter the LAB of energized overhead lines under the exclusive control of the electrical utility, it is the responsibility of the organization performing the work to implement the mandatory barrier control and at least one of the secondary barrier controls per Section 6.3, Step 8.

3. If an intentionally grounded vehicle is located near energized overhead lines, take additional precautions, such as the use of barricades or insulation, to protect personnel from hazardous step and touch potentials that can develop outward from the grounding point. Establish a minimum boundary of 10 feet from the grounding point.

6.2 MOBILE EQUIPMENT IN TRANSIT UNDER OR NEAR OVERHEAD LINES

NOTE: For the purposes of this section, vehicular and mechanical equipment are considered in transit at all times as long as the combined height of the equipment and load (or worker) are less than 13 feet 6 inches.

1. This section establishes criteria that must be met for equipment "in transit" under or near energized overhead utility lines in Free Air.

2. In this section, the term "in transit" refers to vehicular and mechanical equipment (e.g., mobile elevated work platforms, excavators, backhoes, drilling rigs, dump trucks, powered industrial trucks) that is moving under its own power or being transported by trailer, without load, and the structure lowered to its lowest practical stowed position prior to movement. Any mobile equipment not in this configuration is considered to be performing work. Controls shall be implemented to ensure the equipment is configured in the lowest practical stowed position prior to movement.

3. Mobile equipment in transit with its structure lowered to its lowest practical stowed travel position must be operated to ensure the clearances specified in Table 2, In Transit LAB for overhead lines, are maintained.

4. **IF** movement/transport of vehicular and mechanical equipment or oversize loads with a transit height exceeding 13 feet 6 inches is planned which have the potential to be within 20 feet of overhead lines, **THEN** the use of Form-3090, Overhead Utility Clearance Permit, is required.

5. Mobile equipment is considered in transit when moving under its own power with the structure lowered to its lowest practical stowed travel position. Form-3090 is NOT required if the combined height of the mobile equipment, including the load, is less than or equal to 13 feet 6 inches. It is the responsibility of the equipment operator and UCOR STR performing oversight of UCOR Subcontractors to ensure a safe travel path is

identified and used. The use of Form-3090 is required for all paths of travel where potential contact exists with overhead lines.

6. A dump truck is considered in transit when moving under its own power with the structure lowered to its lowest stowed position. If the truck is carrying a load, the combined height of the truck and load shall be less than or equal to 13 feet 6 inches. After a truck bed has been raised, the truck bed shall be verified as fully lowered prior to traveling. Methods of verification include: audible alarm, visual indication, or trained spotter verification.

7. Moving a lift truck is considered in transit and requires the clearance between the top of the mast or the load, whichever is higher, be less than or equal to 13 feet 6 inches. Lift trucks must be operated such that the vehicle is not moved with the forks raised to encroach on the Table 2, In Transit LAB for overhead lines.

8. The minimum "in transit" clearance distances that must be met for equipment traveling under or near overhead lines is shown in Table 2.

Table 2. In Transit LAB for overhead lines

Minimum Clearance Distances for equipment in transit near energized overhead lines	
Nominal AC System Voltage Range (phase to phase)	**Minimum Clearance Distance (feet)**
Insulated communication or public address (PA) Lines	Avoid Contact
Insulated service supply lines 50 V up to and including 600 V (e.g., Triplex or Quadruplex, including bare messenger cable)	3
Insulated primary Up to and including 15 kV	4
Uninsulated 50 V Up to and including 750 V	4
Uninsulated Over 750 V up to and including 50 kV	6
Uninsulated Over 50 kV up to and including 345 kV	10

9. **IF** any part of the equipment while traveling could encroach on the Table 2, In Transit LAB for overhead lines, **THEN** the use of Form-3090, Overhead Utility Clearance Permit, is required. Allow a minimum of 48 hours prior to equipment operations for walk downs and permit processing.

10. If insulated barriers, rated for the voltages involved, are installed and they are not part of an attachment to the vehicle, the clearance shall be permitted to be reduced to the design working dimensions of the insulating barrier.

11. A signal or flag person shall be designated to guide equipment in transit and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.

6.3 MOBILE EQUIPMENT PERFORMING WORK WITH THE POTENTIAL TO ENTER THE LAB

NOTE: This section is applicable to all outdoor work involving mobile equipment (e.g., mobile elevated work platforms, excavators, backhoes, drilling rigs, dump trucks, powered industrial trucks), excluding hoisting and rigging operations, as defined in PROC-FO-1008.

1. **IF** any part of the equipment performing work has the potential to come within 20 feet of uninsulated overhead energized lines, **THEN** the use of Form-3090, Overhead Utility Clearance Permit, is required.

2. Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines, shall be operated so that the LAB for exposed overhead lines is not encroached upon.

3. **IF** any part of the equipment working outside the LAB of uninsulated energized overhead lines has the potential to encroach within the LAB, **THEN** a formal JHA shall be conducted with the operator and the other workers who will be in the area of the equipment to review the location of the power line(s), safe limit of approach distances, and ensure the mitigating controls indicated on Form-3090 are part of the JHA and implemented before such work is permitted.

4. The preferred condition under which mobile equipment is allowed to operate within the LAB is:

a. The power line owner or Utility Power Distribution SME and EAHJ are consulted, preferably a minimum of 48 hours prior to the start of work, to determine effective controls, standby support, and outage support that may affect equipment or facilities.

b. The overhead lines are de-energized and grounded.

c. The line is adequately insulated or effectively guarded against contact.

d. Alternate methods of protecting workers such as relocation or rerouting the line.

5. Power lines are presumed to be energized unless the utility owner or Utility Power Distribution SME confirms that the power line has been and continues to be de-energized and grounded at the work site.

6. All overhead lines are presumed to be uninsulated unless the owner of the overhead line or Utility Power Distribution SME confirms that a line is insulated for the lines' operating voltage and insulation integrity is satisfactory to support the voltage impressed.

7. Any vehicle or mechanical equipment capable of having parts of its structure elevated near uninsulated energized overhead lines, 50 kV or less, shall be operated so that a clearance of 10 feet is maintained. **IF** the voltage is higher than 50 kV, **THEN** the clearance shall be increased by 4 inches for every 10 kV over 50 kV. The clearance may be reduced in accordance with 29 CFR Part 1910.333(c)(3)(iii)(A) and/or 29 CFR Part 1910.269, as applicable.

8. Mobile equipment working outside the LAB of uninsulated energized overhead lines with the potential to encroach within the LAB shall utilize a two-barrier control system.

<u>Mandatory Barrier Control</u> – Trained operators and dedicated spotters shall be used and shall meet the following requirements:

a. The dedicated spotter shall be in place prior to movement of the equipment and must be positioned to effectively gauge the clearance distance.

b. Dedicated spotters shall have no other duties and direct communication with the equipment operator.

c. Dedicated spotters shall wear high-visibility apparel to enhance their visual identification by the equipment operator.

d. Must provide timely information to the operator so the required clearance distance will be maintained.

Secondary Barrier Control – As a minimum, one of the following secondary barrier controls shall be used in addition to a dedicated spotter:

a. Install physical barriers to prevent encroachment into the LAB.

b. Use barricades, stakes, cones, or painted lines to demark the work zone and provide visual reminders to operators and spotters of the proximity to energized overhead lines.

c. Use materials such as warning lines or flagging to enhance visibility of energized overhead lines for dedicated spotters and operators.

Other control(s) may be permitted following review and approval by Engineering and Safety. This review shall verify that the alternate controls are as effective as the controls listed above.

9. In the event the mobile equipment becomes electrified, the operator shall make an attempt to immediately move the equipment away from the electrical source, if possible, without compromising their safety. The operator should remain in the cab of the vehicle if possible. If required to exit, jump completely clear, so that no part of the body touches the equipment and the ground at the same time. To avoid any ground potential voltage gradient, land with both feet together and shuffle feet never exceeding the length of the foot until safely away from the equipment. Stay at least 35 feet away from downed lines or electrified equipment. Warn ground support personnel to stay away from the equipment until it has been confirmed that the electrical hazard has been eliminated.

7 ELECTRICAL REQUIREMENTS FOR BUILDINGS/FACILITIES

7.1 SCOPE

This section provides guidance for electrical requirements for UCOR-owned facilities/buildings at ORNL, ETTP, and the Y-12 National Security Complex. Facility Managers are responsible for ensuring that their areas of responsibility comply with this section.

Only qualified and authorized individuals are permitted to perform electrical work at UCOR. Such individuals must be aware of the hazards associated with electrical work and the methods for reducing the risk of electrical accidents that can result from unsafe equipment, adverse environmental conditions, and unsafe acts. Whenever possible, all circuits or equipment shall be de-energized and locked/tagged out per PROC-EH-2002, *Hazardous Energy Control (Lockout/Tagout),* and/or PROC-ET-3013, *Power Distribution Work Permit.* Work on energized circuits shall be performed only by authorized workers in accordance with Section 5, Qualified Electrical Workers and Unqualified Persons.

7.2 ELECTRICAL EQUIPMENT CONDITIONS OF APPROVAL AND USE

7.2.1 Approval

All electrical equipment, components, and conductors should be listed, labeled, and approved by an NRTL for their intended purpose. Custom-built and installed equipment can be approved for use by the EAHJ, if built according to specific standards (e.g., UL or applicable national consensus standards). Appropriate documentation for such equipment shall be maintained on file (see Section 4.6, Electrical Inspection Program).

When building, repairing, or modifying electrical systems, NRTL-approved equipment should be used and modified equipment shall be approved by the EAHJ. Non-NRTL equipment shall be approved by the EAHJ.

7.2.2 Installation and Use of Electrical Equipment

Listed and labeled equipment shall be used and installed in accordance with any instructions included in the listings or labeling. All wiring shall be installed so that, when completed, the system will be free from short circuits and from grounds other than required or permitted.

Equipment intended to break current at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage and current that is available at the line terminals of the equipment. Equipment intended to break current at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

Electrical equipment shall be installed in a neat and workman-like manner. Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases, or housings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.

Ground-fault circuit-interrupter protection for personnel – either circuit breakers or receptacles – shall be provided. All 125-volt through 250-volt receptacles supplied by single-phase branch circuits rated 150 volts or less to ground, 50 amperes or less, and all receptacles supplied by three-phase branch circuits rated 150 volts or less to ground, 100 amperes or less, installed in the locations specified in 1 through 12 shall have ground-fault circuit-interrupter protection for personnel. The ground-fault circuit interrupter shall be installed in a readily accessible location.

NOTE 1: See NFPA 70 National Electrical Code Section 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

NOTE2: See NFPA 70 National Electrical Code Section 422.5(A) for GFCI requirements for specific appliances.

When determining the distance from receptacles, the distance shall be measured as the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or the shortest path without passing through a window.

1. Bathrooms

2. Kitchens or areas with a sink and permanent provisions for either food preparation or cooking.

3. Rooftops

Exception: Receptacles on rooftops shall not be required to be readily accessible other than from the rooftop.

4. Outdoors

Exception: In industrial establishments only, where the conditions of maintenance and supervision ensure that only qualified personnel are involved, an assured equipment grounding conductor program shall be permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power is interrupted or having a design that is not compatible with GFCI protection.

5. Sinks — where receptacles are installed within 1.8 m (6 ft) from the top inside edge of the bowl of the sink

Exception: In industrial laboratories, receptacles used to supply equipment where removal of power would introduce a greater hazard shall be permitted to be installed without GFCI protection.

6. Indoor damp and wet damp locations.

7. Locker rooms with associated showering facilities.

8. Garages, accessory buildings, service bays, and similar areas other than vehicle exhibition halls and showrooms.

9. Crawl spaces — at or below grade level.

10. Unfinished areas of basements.

11. Laundry areas.

12. Bathtubs and shower stalls — where receptacles are installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall.

7.2.3 Equipment Labeling

Electrical equipment shall be labeled in accordance with PROC-FO-1068, *Equipment and Component Labeling*. In addition, circuit schedules in power, lighting, and appliance circuit panels shall be legibly identified as to their clear, evident, and specific purpose or use. The identification shall include sufficient detail to allow each circuit to be distinguished from all others. The marking shall include the identification of the circuit source that supplies the disconnecting means. Spare positions that contain unused overcurrent devices or switches shall be labeled as “spare” or equivalent. The marking shall be of sufficient durability to withstand the environment involved.

7.2.4 Arc-Flash Hazard Warning Label

All electrical equipment that are likely to require examination, adjustment, servicing, or maintenance while energized shall have Arc-Flash Hazard Warning Label installed per PROC-DE-1023, *Preparation and Maintenance of Arc Flash (AF) Hazard Analysis for AC and DC Electrical Systems*.

7.2.5 New Installations and Modifications

All new and modified electrical installation designs will be reviewed and approved for electrical code compliance by the designing organization or EAHJ. The EAHJ will inspect and approve new and modified installations for electrical code compliance.

7.3 EQUIPMENT INSTALLATIONS 1000 VOLTS, NOMINAL OR LESS

7.3.1 Working Space and Guarding

Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment. Working space required shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working spaces, if in a passageway or general open space shall be suitably guarded.

Live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved enclosures or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- By suitable permanent, substantial partitions or screens arranged so that only qualified persons would have access to the space within reach of the live parts. Any openings in such partitions or screens shall be sized and located so that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.
- By location on a suitable balcony, galley, or platform elevated and arranged so as to exclude unqualified persons.
- By elevation of 8 feet or more above the floor or other working surface.

Where electric equipment is likely to be exposed to physical damage (including damage from vehicle traffic), enclosures or guards shall be so arranged and of such strength as to prevent such damage.

Entrances to rooms and other guarded locations that contain exposed live parts shall be marked with a conspicuous warning sign forbidding unqualified persons to enter. An example would be “DANGER – ELECTRICAL HAZARD – QUALIFIED PERSONNEL ONLY.”

7.3.2 Working Clearances

NOTE: The 30-inches-wide rule effective 1971, before that date there was no requirement.

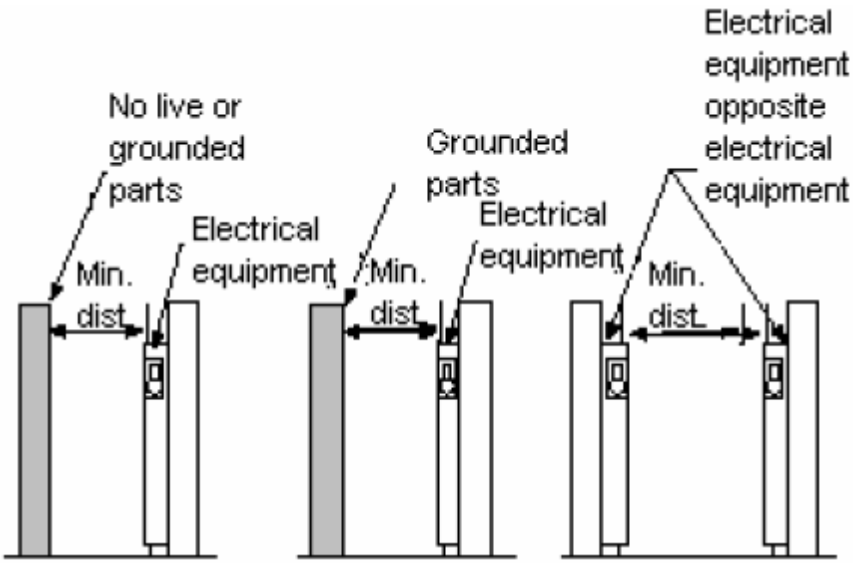
The width of the working space in front of electric equipment shall be the width of the equipment or 30-inches, whichever is greater, to provide room for examination, adjustment, servicing, or maintenance of equipment. The 30-inch-wide space may be centered in front of the equipment or can be offset. There shall be clearance in the work area to allow at least a 90-degree opening of equipment doors or hinged panels. The depth of the working space shall be 2 feet, 3 feet, 3 ½ feet, or 4 feet, depending upon existing conditions. The conditions are as follows:

NOTE: Installations built before 1978 require a minimum clearance of only 2 feet in front of electrical equipment for Condition 1.

Condition 1: There are exposed live components on one side of a space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated bus bars operating at not over 300 volts shall not be considered live parts.

Condition 2: Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls shall be considered as grounded.

Condition 3: Exposed live parts on both sides of the work space (see Figure 1, Clearance Requirements In Front of Electrical Equipment (1000 V or less), for the clearance requirements in front of electrical equipment rated 1000 volt or less).



Condition 1		Condition 2		Condition 3	
Volts to ground	Min. Dist.[a]	Volts to ground	Min. Dist.	Volts to ground	Min. Dist.
0 – 150 V	3 feet	0 – 150 V	3 feet	0 – 150 V	3 feet
151 – 600 V	3 feet	151 – 600 V	3 feet 6 inches	151 – 600 V	4 feet
601 – 1000 V	3 feet	601 – 1000 V	4 feet	601 – 1000 V	5 feet

a - Installations built before 1978 require a minimum clearance of only 2 feet.

Figure 1. Clearance Requirements In Front of Electrical Equipment (1000 V or less)

7.3.3 Access and Entrance to Working Space

At least one entrance of sufficient area shall be provided to give access to the working space about electrical equipment. For equipment rated 1,200 amps or more and over 6 feet wide that contains overcurrent devices, switching devices, or control devices, there shall be one entrance not less than 24-inches wide and 6 ½ feet high at each end of the working space. Where the location permits a continuous and unobstructed way of exit through, one means of access shall be permitted.

Where the working space, given in Figure 1, Clearance Requirements In Front of Electrical Equipment (1000 V or less), is doubled, only one entrance to the working space is required. It shall be located so the edge of the entrance nearest the equipment is the minimum clear distance, away from such equipment.

7.3.4 Illumination

Adequate illumination shall be provided for all working spaces about electrical equipment. The lighting outlets shall be arranged so that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment.

The points of control shall be located so that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.

7.3.5 Headroom

The minimum headroom of working spaces about service equipment, switchboards, panelboards or MCCs shall be 6 1/4 feet if made before January 1, 1994, and 6 ½ feet for installations made subsequent to January 1, 1994.

7.4 EQUIPMENT INSTALLATIONS OVER 1000 VOLTS, NOMINAL

7.4.1 General

Conductors and equipment used on circuits exceeding 1000 volts, nominal, shall comply with all applicable provisions of the preceding requirements of this section and with the following provisions, which supplement or modify the preceding requirements.

7.4.2 Working Space and Guarding

Electrical installations in a vault, room, or closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, shall be considered to be accessible to qualified persons only. A wall, screen, or fence less than 7 feet in height shall not be considered as preventing access unless it has other features (6 feet high and a one foot or more extension utilizing three or more strands of barbed wire or equivalent) that provide a degree of isolation equivalent to a 7 feet fence.

The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 1000 volts, nominal, shall be kept locked or shall be under the observation of a qualified person at all times. Entrances to rooms and other guarded locations that contain exposed live parts shall be marked with conspicuous warning sign forbidding unqualified persons to enter. An example would be “DANGER – HIGH VOLTAGE – QUALIFIED PERSONNEL ONLY.”

7.4.3 Installations Accessible to Unqualified Persons

Indoor electrical installations that are open to unqualified persons shall be made with metal-enclosed equipment or shall be enclosed in a vault or in an area, access to which is controlled by a lock. Where nonmetallic or metal-enclosed equipment is accessible to the general public and the bottom of the enclosure is less than 8 feet above the floor or grade level, the enclosure door or hinged cover shall be kept locked. A permanent and conspicuous warning sign shall be provided, reading substantially as follows:

“DANGER – HIGH VOLTAGE – KEEP OUT.”

Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. When exposed to physical damage from vehicular traffic or equipment, suitable guards shall be provided.

7.4.4 Work Space About Equipment

Sufficient space shall be provided and maintained about electrical equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear work space shall be not less than 6 ½ feet high (measured vertically from the floor or platform) and the width of the equipment or 3 feet wide (measured parallel to the equipment), whichever is greater. The depth shall be as required in Section 7.4.5. In all cases, the work space shall permit at least a 90-degree opening of doors or hinged panels. Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 6 inches beyond the front of the electrical equipment. Working space required by this section shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.

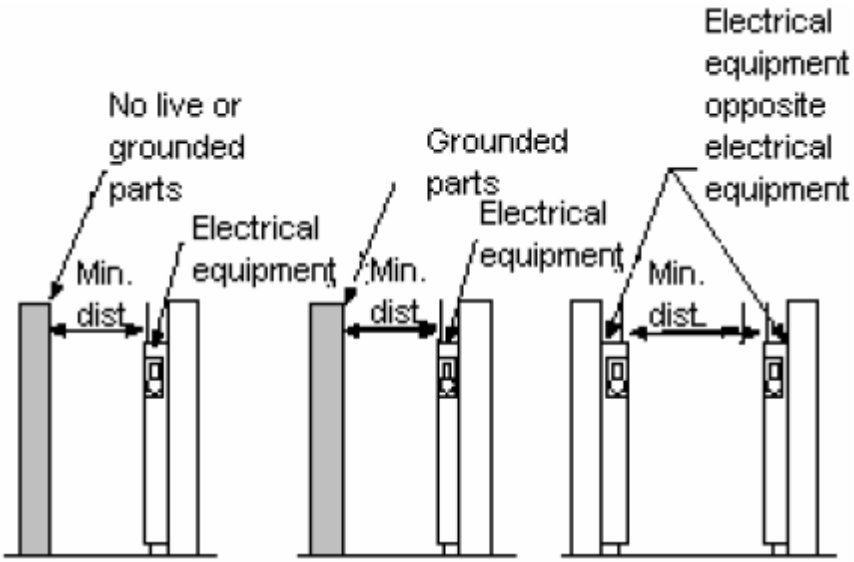
7.4.5 Work Clearances

Sufficient space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear work space shall not be less than 6 ½ feet high (measured vertically from the floor or platform), or less than 3 feet wide (measured parallel to the equipment). The work space shall be clear and extend from the grade, floor, or platform to a height of 6 ½ feet or the height of the equipment whichever is greater. The depth shall be as required in Figure 2, Clearance Requirements In Front of Electrical Equipment (over 1000 Volts). There are three conditions that apply:

Condition 1: There are exposed live parts on one side of a space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials.

Condition 2: Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls shall be considered as grounded.

Condition 3: Exposed live parts on both sides of the working space.



Condition 1		Condition 2		Condition 3	
Volts to ground	Min. Dist.	Volts to ground	Min. Dist.	Volts to ground	Min. Dist.
1001 – 2,500 V	3 feet	1001 – 2,500 V	4 feet	1001 – 2,500 V	5 feet
2,501 – 9,000 V	4 feet	2,501 – 9,000 V	5 feet	2,501 – 9,000 V	6 feet
9,001 – 25,000 V	5 feet	9,001 – 25,000 V	6 feet	9,001 – 25,000 V	9 feet
25,001 – 75,000 V	6 feet	25,001 – 75,000 V	8 feet	25,001 – 75,000 V	10 feet
Above 75,000 V	8 feet	Above 75,000 V	10 feet	Above 75,000 V	12 feet

Figure 2. Clearance Requirements In Front of Electrical Equipment (over 1000 V)

7.4.6 Illumination

Adequate illumination shall be provided for all working spaces about electrical equipment. The lighting outlets shall be arranged so that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment.

The points of control shall be located so that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.

7.4.7 Entrance and Access to Working Space

At least one entrance not less than 24-inches wide and 6 ½ feet high shall be provided to give access to the working space about electric equipment. On switchboard and control panels exceeding 6 feet in width, there shall be one entrance at each end. Where bare energized parts “at any voltage” or insulated energized parts above 1000 volts nominal are located adjacent to such entrance, they shall be suitably guarded.

Working space with one entrance provided shall be located so that the edge of the entrance nearest the switchboard and control panels is the minimum clear distance away from such equipment as given in Figure 2, Clearance Requirements in Front of Electrical Equipment (over 1000 Volts).

Permanent ladders or stairways shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, mezzanine floors, or in attic or roof rooms or spaces.

7.5 ELEVATION OF UNGUARDED LIVE PARTS

Unguarded live parts above working space shall be maintained at elevations not less than specified in NEC Table 110.34(E), Elevation of Unguarded Energized Parts above Working Space.

Table 3, Elevation of Unguarded Energized Parts above Working Space

Nominal Voltage Between Phases	Minimum Elevation
1001 – 7,500 V	9 feet
7,501 – 35,000 V	9 feet 6 inches
Over 35 kV	9 feet 6 inches + 0.37 inch per kV above 35 kV

7.6 GUARDING EXPOSED PARTS OF ELECTRICAL EQUIPMENT

Exposed parts of electrical equipment that operate at greater than 50 volts or more shall be guarded against accidental contact by approved cabinets, insulated shields, location and warning labels, and shall be accessible only to qualified personnel.

7.7 UNGROUNDED ELECTRICAL SYSTEMS

*******WARNING******

Electrical grounds occurring in ungrounded electrical equipment create a significant workplace hazard for the worker, equipment, and facility. Violent equipment damage, fires, and personnel electrocution have resulted from concurrent grounded equipment in ungrounded electrical distribution systems.

*******CAUTION*******

Ungrounded electrical systems shall be equipped with properly maintained ground detectors to avoid sustained overcurrent or over-voltage (ground fault) conditions on the system and components.

NOTE: Ungrounded electrical equipment is present in UCOR-owned buildings at the Y-12 National Security Complex, ORNL, and ETTP, primarily in process-related buildings where sustained operation of equipment was deemed necessary. Operating ungrounded equipment will continue to operate if a single phase is grounded, thus allowing time to respond to ground-fault events without impacting mission-essential activities. Modern equipment installations employ grounding features where a single phase fault will now initiate a protective action, such as tripping of power supply breakers.

7.7.1 Hazards Associated with Ungrounded Electrical Systems

Ungrounded systems operate without a grounded conductor. In other words, none of the circuit conductors of the electrical system are intentionally connected to an earth ground. The same network of equipment grounding conductors (EGCs) is provided for ungrounded systems as for grounded systems. However; EGCs are used only to locate phase-to-ground faults and provide remote indications, such as local displays or centralized alarms.

On ungrounded systems, a single sustained line-to-ground event does not result in an automatic trip of the overcurrent protection device, and is beneficial if continuance of operations is desired. When ground fault conditions are allowed to exist for extended periods, over-voltage and overcurrent conditions are present which can damage conductor insulation. During a sustained ground fault event, a significant dangerous condition exists where if a second ground fault (involving another electrical phase) were to occur, serious personnel injury or equipment damage could occur. Personnel contacting another phase to ground could experience up to 1.732 times the voltage they would experience on a neutral grounded system.

The second ground fault becomes a phase-to-phase fault at the service, feeder, or conductor. A major concern for this type of event is the first and second faults may be located at great distances apart within the ungrounded distribution system. Often these faults occur from line to conduit, metallic enclosures such as wire way, pull boxes, motor terminal housings, and motor windings. When ground fault conditions exist, a low impedance path for current flow is established between the two fault points often resulting in arc-flashes, rapid heating of components, violent energy release, and electrical equipment fires.

7.7.2 Inspection Requirements for Ungrounded Electrical Systems

Facilities Managers

Establish a process to inspect and record, at a minimum of weekly - preferable daily, ground fault status (indicated by ground fault lights, meter reading or other installed detector devices) in buildings with ungrounded electrical systems. Facilities with ungrounded and high-resistance ground electrical systems that do not have installed ground fault detector devices shall be identified and any non-conforming conditions should be reported to UCOR Electrical Engineering and the UCOR EAHJ.

7.7.3 Anticipated Response Actions to Ground Fault Events

Ground fault events are a serious workplace hazard to equipment and personnel. Prompt actions to locate and correct grounded equipment should be expedited and shall be provided adequate resources to correct the problem before any secondary fault occurs. It is important to be able to track ground fault events since many times it may be a motor or some device that only runs a short time.

When a ground fault event occurs maintenance support will be needed in order to locate the source of the event; therefore a Work Request shall be initiated, in accordance with PROC-FS-1001, *Integrated Work Control Program*. It is necessary that a preliminary field reconnaissance and a logical plan of attack for load shedding and ground fault isolation sequences is developed and executed. Facilities and work control organizations are strongly encouraged to prepare and maintain useable work control documents for ground fault location, isolation, and repair.

Physical access to affected (grounded) equipment (such as MCCs) should be controlled to only essential craft personnel working to identify and isolate the ground condition.

Load shedding involves the reduction of non-essential electrical equipment load from the affected grounded electrical distribution system. For example, lowering the overall load of an affected MCC experiencing a ground fault could theoretically lower the physical violence of a secondary ground event. Load shedding also proves useful in the identification process. If a ground fault exists immediately before a potentially grounded piece of equipment is shut down and does not exist immediately following the shutdown, there is a strong likelihood the ground had occurred on the respective feeder or equipment itself.

Load shedding may involve production-related equipment. Production-related equipment can be shut down, based on integrated process knowledge, Facility Manager’s direction, and by using system operating procedures. Reasonable effort to minimize production disruption and/or material processes can be employed to delay specific load shedding activities. Whenever possible, equipment should be shut down using normal operating procedures and controls, rather than opening feeder breakers.

Until ground-faulted equipment has been identified, reasonable effort shall be made to minimize the starting of equipment also served by the ground-faulted electrical distribution system. Precluding additional equipment starts lowers the likelihood of a second ground fault event.

Once grounded equipment has been identified, the immediate actions must be taken to control affected equipment using PROC-EH-2002, *Hazardous Energy Control (Lockout/Tagout)*, and/or PROC-ET-3013, *Power Distribution*

Work Permit, or place the equipment out-of-service and tag in accordance with PROC-FO-1066, *Administrative Tagging.*

Facility Managers

1. If a ground fault event is observed during the inspections, ensure a work request is created, prioritized, and submitted in accordance with PROC-FS-1001, *Integrated Work Control Program*, requesting a timely evaluation, identification, and isolation of the ground fault.

2. With work package and appropriate SME support (Engineering, Electrical Supervisor, and Electrician) conduct a preliminary field reconnaissance and establish a logical plan of attack for load shedding and ground fault isolation sequences. Consider mission-essential activities as part of this plan. Place signs and barricades and make appropriate notification (announcements) to warn area employees of the hazard.

3. As soon as possible considering mission-essential activities, execute troubleshooting methods such as detection devices (thumper) or load shedding and fault isolation techniques to locate and isolate the ground fault.

4. When the fault is located, direct the facility Issuing Authority or equipment owner to take immediate actions to control affected circuits or equipment using PROC-EH-2002, *Hazardous Energy Control (Lockout/Tagout)*, and/or PROC-ET-3013, *Power Distribution Work Permit*, or place the equipment out-of-service and tag in accordance with PROC-FO-1066, *Administrative Tagging*, until repairs are completed.

7.8 MULTI-WIRE BRANCH CIRCUITS (SHARED NEUTRAL CONDUCTORS)

Common and energized neutral conductors may be found in electrical systems at ORNL, ETTP, and the Y-12 National Security Complex because of previous electrical work practices that allowed such installations. Every effort should be made during the pre-work job scoping and planning walkdowns to determine if such installations exist within the intended scope of work. If the work scope has not been explicitly planned for working on multi-wire branch circuits in the hazard analysis documents or work instructions, then the work shall be suspended or stopped until the appropriate hazard controls have been developed and implemented.

All qualified electrical workers involved in electrical jobs/tasks should recognize the potential for creating a hazardous condition upon breaking the continuity of the neutral conductor. The need to break the continuity of the neutral conductor creates a special situation that requires specific hazard controls to be identified and implemented.

The policy of the UCOR is to use the Code of Record at the time of installation to determine compliance. Retrofitting of existing electrical systems as Electrical Code revisions are adopted is not required. Facility management is expected to evaluate and determine the feasibility of implementing these revised requirements into existing installations as they are identified during the course of routine work. In all cases, a JHA shall be performed to evaluate the hazards associated with working on existing, aged electrical equipment prior to retrofitting.

The Electrical Safety Program Manager, Electrical Safety SME, or EAHJ shall be consulted where there is any question relative to personnel safety with regard to hazards of multi-wire branch circuits.

The following requirements shall be followed in order to minimize the potential for personnel to be injured by current from multi-wire branch circuits:

NOTE: Suspect a multi-wire branch circuit when three or more neutral conductors are spliced together in a junction box, outlet box, or lighting fixture.

1. Maintain the continuity of the neutral by breaking only the single white wire that connects to the device being worked on. Neutral conductors of multi-wire branch circuits are wired typically with a wire-nut or crimped pigtail type connections. If the worker breaks only the single lead to the device from the wire-nut or crimp connection, the continuity of the neutral conductor is maintained back to the source and prevents the potential for exposure to voltage on the neutral lead that connects to the device. If the neutral is wired through the device and not connected using a pigtail (i.e., there is more than one white neutral wire connected to the device), then a multi-wire branch circuit should be suspected.

2. In situations where the continuity of the neutral conductor shall be interrupted, the following requirements shall be followed:

a. Assure all sources of energy in the circuit (if known) are de-energized and locked out prior to interrupting the continuity of the neutral bundle.

NOTE: Current will exist only if one or more circuits sharing the neutral have a load energized at the time of measurement.

b. **IF** the sources of energy using the neutral bundle are unknown, **THEN** test the neutral circuit with a clamp-on or non-contact type current detector (such as Extec Instruments DA30, non-contact AC current detector, UL Listed CAT III, 600V) to identify if the neutral is carrying current before lifting neutral leads or breaking a neutral connection. Treat the neutral as energized even though the circuit is locked out at the source.

NOTE: PPE should be used when disconnecting/connecting the neutral and when working around a neutral bundle that is separated.

c. Use caution and measure for absence of voltage to ground immediately after lifting leads when more than one neutral shall be lifted from a device or when a splice must be broken (e.g., lighting ballast).

d. When a common neutral hazard is discovered at a device, stop work and remove the hazardous condition or plan a new work package considering known energized conductors. The discrepancy shall be corrected by installation of pigtails or other means, to maintain continuity of the neutral wiring (See NEC 300.13(B)).

3. Label the doors of lighting and power panels where common neutrals are known to exist. This will alert personnel of potential problems.