Ames Procedural Requirements

Effective Date: __July 21, 2025___
Expiration Date: __July 21, 2028___

COMPLIANCE IS MANDATORY

Subject: Chapter 11 – Electrical Safety

Responsible Office: Code QH / Occupational Safety, Health, and Medical Service Division

CHANGE LOG

Status [Baseline /Revision /Cancelled]	Document Revision	Date of Change	Description
Revision	2	12/14/2018	Reformatted Chapter to AMS requirements added Document change log and Preface. All "Shall" requirement statements found in Appendix I, J and K have been placed within the body of the document. Statement to address requirements changes in Federal OSHA regulations, California Model Codes (primarily the California Electrical Code), and National Fire Protection Association, NFPA 70E Standard for Electrical Safety in the Workplace (2012 edition) which occur during the effectivity period of the released version.
Revision	3	12/14/2023	Heavy revisions throughout chapter and integration of multiple appendices into chapter.
Revision	4	3/3/2025	Updated requirements for energized electrical work permit. Added reference to several NASA forms.

TABLE OF CONTENTS

PREFACE

P.1 PURPOSE

a. This manual sets forth policy, procedures and instructions for the Ames Safety and Health Programs. In addition, it assigns authority, responsibility, and requirements relative to these programs. This chapter provides requirements for electrical safety standards for Ames Research Center (ARC) in addition to the requirements set forth in NASA NPR 8715.1.

P.2 APPLICABILITY

a. This directive is applicable to Ames Research Center (ARC) and associated facilities, e.g., NASA Research Park (NRP).

b. This directive applies to contractors, grant recipients, or parties to agreements as specified or referenced in their contracts, grants, or agreements; and to other organizations (i.e., commercial partners, other Federal agencies, international parties, and Ames facility tenants) as specified and described in written operating agreements.

c. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission, "should" denotes a good practice and is recommended, but not required, "will" denotes an expected outcome, and "are/is" denotes descriptive material.

d. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

P.3 AUTHORITY

a. NPR 8715.1, NASA Safety and Health Programs

b. NPR 8715.3, NASA General Safety Program Requirements

P.4 APPLICABLE DOCUMENTS AND FORMS

a. 29 CFR 1910, OSHA General Industry Regulations & Standards

b. 29 CFR 1926, OSHA Construction Industry Regulations & Standards

c. ANSI American National Standards Institute, Applicable Standards

d. APR 8500.1, Environmental Procedural Requirements

e. APR 8715.1 Chapter 4, Mishaps and Close Calls

f. APR 8715.1 Chapter 17, Lifting Devices and Equipment

g. APR 8715.1, Chapter 26 Confined Space Entry

h. APR 8715.1 Chapter 27 Construction Safety Management

i. APR 8715.1 Chapter 31 Lock Out Tag Out

j. APR 8829.1, Construction Permit Process

k. ARC909 Form, Energized Electrical Work Permit

l. Ames Local Master Specifications

m. ASTM American Society for Testing Materials, Applicable Standards

n. California Building Code (CBC)

o. California Electrical Code (CEC)

p. California Fire Code (CFC)

q. IEEE C2, National Electrical Safety Code (NESC)

r. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations

s. NF1896 Form, Electrical Worker Qualification Form

t. NF1897 Form, Electrical Job Safety Planning and Job Briefing Worksheet

u. NF1898 Form, Supervisor Electrical Safety Field Work Audit Form

v. NF1921 Form, Energized Electrical Work Permit (EEWP)

w. International Building Code (IBC)

x. NFPA 70, National Electrical Code

y. NFPA 70E, Standard for Electrical Safety in the Workplace

z. NFPA 79, Electrical Standard for Industrial Machinery

aa. NFPA 791, Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation

bb. NRRS 1441.1, NASA Record Retention Schedules

cc. QH-ELEC-EQ-SOP, Approval Process for Electrically Energized Apparatus

dd. UL Underwriter Laboratories, Applicable Standards

P.5 MEASUREMENT/VERIFICATION

a. Verification of conformance to requirements in this directive is measured through Center and Responsible Organizational management reviews, self-assessments, and subsequent analysis and reports of conformance to requirements, as well as periodic internal audits.

b. Verification is also measured through Agency triennial audit and Ames Annual Voluntary Protection Program (VPP) self-inspections.

P.6 CANCELLATION

a. APR 8715.1 Chapter 11, Electrical Safety effective December 14, 2018, and expiring December 14, 2023.

Eugene Tu
Director

DISTRIBUTION STATEMENT:

Internal and external distribution. APR 8715.1 Ames Health and Safety Manual Chapters are made available via procurement website to anyone submitting a bid for work at NASA's Ames Research Center (ARC). The exceptions are Chapter 7 – Ames Radiation Safety Guide, Chapter 10 – Pressure Systems

Safety, Chapter 12 – Explosives Safety and Chapter 23 – Control of Narcotics and Other Controlled Drugs including Alcohol, which are not made public but can be viewed onsite.

CHAPTER 11 ELECTRICAL SAFETY

11.1 Overview

11.1.1 This chapter provides requirements to address electrical hazards encountered by all who may work on and/or use electrical systems at Ames Research Center (ARC).

11.1.2 In addition to the requirements set forth in this chapter, full compliance with the latest editions of National Fire Protection Association (NFPA) 70 National Electrical Code (NEC), NFPA 70E Standard for Electrical Safety in the Workplace, IEEE C2 National Electrical Safety Code (NESC), California Electrical Code (CEC), 29 CFR 1910 General Industry, 29 CFR 1926 Construction Industry Regulations & Standards, and all equipment manufacturer's recommendations shall be required under this chapter.

11.1.3 See APR 8715.1 Chapter 31 Lock Out Tag Out for electrical Lockout/Tagout (LOTO) requirements, which are complementary to the electrical safety requirements of this chapter.

11.1.4 See APR 8715.1 Chapter 27 Construction Safety Management for electrical safety requirements for construction projects, which are complementary to the electrical safety requirements of this chapter.

11.2 Roles and Responsibilities

11.2.1 Occupational Safety, Health, and Medical Service Division (Code QH) shall:

a. Maintain the electrical safety program.

b. Ensure that electrical safety training is made available to non-electrical workers.

c. Provide safety documentation, including engineering and hazard analysis, to establish basis for safe testing of electrical articles or equipment.

d. Ensure, through a validation process, that all requirements of this chapter are followed.

11.2.2 Center Operations Directorate (Code J)

a. The Center Operations Directorate (Code J) shall designate a "High Voltage" Supervisor or Lead to oversee all high voltage electrical work performed within directorate.

11.2.2.1 The Facilities Engineering and Real Property Management Division (Code JC) shall:

a. The Chief, Facilities Engineering Branch shall serve as the Authority Having Jurisdiction for electrical safety. Role can be delegated down to the senior electrical engineer for Code JCE.

b. Be responsible for interpretations of NFPA 70, National Electrical Code, and the California Electrical Code (CEC).

c. Ensure designs of electrical equipment installations for facilities, exterior distribution, and substations are compliant with the requirements of this procedure and all references herein.

d. Provide short circuit, continuity, and grounding system analyses supporting arc flash hazard determinations to determine if an electric fault in one system can progress to other systems resulting in power system loss.

e. Provide shock hazard and arc flash hazard analysis for electrical work as requested by organizations performing electrical work, including providing labeling on electrical equipment.

f. Interpret NFPA 70 issues and approve alternate and additional measures as needed.

g. Serve as the Subject Matter Expert for interpretation of this chapter and any required information for analysis as set forth in this chapter.

h. The Facilities Engineering Branch (Code JCE) shall maintain design and construction documentation of electrical distribution systems.

11.2.3 Aeronautics Directorate (Code A)

11.2.3.1 The Aeronautics Directorate (Code A) shall designate a "High Voltage" Supervisor or Lead to oversee all high voltage electrical work performed within directorate.

11.2.4 Exploration Technology Directorate (Code T)

11.2.4.1 The Exploration Technology Directorate (Code T) shall designate a "High Voltage" Supervisor or Lead to oversee all high voltage electrical work performed within directorate.

11.2.5 Supervisors

Supervisors, by virtue of the delegation of responsibility for all aspects of occupational health and safety through their organization, shall assure compliance with all electrical safety requirements as defined in the Ames Procedural Requirements (APRs) pertaining to all programs, activities, and facilities within their respective areas of responsibility.

11.2.5.1 Supervisors have the primary responsibility for ensuring a safe working environment and shall:

a. Assess the need for establishing, implementing, and maintaining procedures and/or work practices that will ensure the safe conduct of electrical work.

b. Maintain a safe work environment and take corrective action on any potentially hazardous operations or conditions.

c. Ensure a job hazard assessment (JHA) is used to identify required personal protective equipment (PPE), and that the JHA is accurately documented and submitted.

d. Ensure all electrical workers are provided with and use the appropriate testing equipment and PPE for the assigned task.

e. Ensure personal protective equipment and clothing are approved, inspected, and used properly as defined in the JHA.

f. Ensure all electrical workers are trained and qualified in accordance with the requirements of this chapter, and only trained and qualified employees are assigned to perform electrical work.

g. Ensure those who engage in electrical work activities are all competent for the class of electrical work to be performed (e.g., low voltage, high voltage, arc flash potential).

h. Maintain records of certification criteria and certifications. See Section 11.7, Recordkeeping.

i. Ensure a pre-job briefing is conducted for those engaged in electrical work activities to understand how to safely implement the job to be performed.

j. Ensure shift routines, inspections, or surveillances that require working within the Limited and Restricted approach boundaries are conducted by personnel qualified to work within those spaces.

k. Ensure all persons who are injured, not limited to being exposed to electric shock, electrical burns, arc flash burns, or arc blast are promptly evaluated and treated under the care of an occupational physician, emergency response physician, and/or the Ames Health Unit located in building N215.

NOTE: It is highly recommended that the victim does not drive themself if possible. Damage to internal tissues may not be apparent immediately after contact with an electrical current above

50 volts. Delayed internal tissue damage including internal burns are possible. Prompt medical attention can help minimize these effects and avoid death or long-term injury.

l. Follow incident reporting requirements as defined in APR 8715.1 Chapter 4 Mishap and Close Calls.

11.2.6 Contracting Officer's Representative (COR) on any contract that specifies applicability of this chapter of APR 8715.1 shall:

a. Enforce requirements set forth in this chapter for the contractor and its employees performing work under the contract.

11.2.7 Electrical Safety Committee shall:

a. Define and review policies and procedures.

b. Support electrical safety for the protection of people at ARC.

c. Mediate disagreement on interpretation of information in this chapter.

11.3 Hazard Control

11.3.1 A safety plan shall be developed by the qualified and authorized person performing the electrical work and approved by their safety representative. The safety plan consists of:

a. Shock and arc flash / arc blast hazard analysis.

b. Appropriate safety controls.

c. Hazard Mitigations.

d. Personal protective clothing and equipment.

11.3.1.1 NF1897, *Electrical Job Safety Planning and Job Briefing Worksheet*, (https://nef.nasa.gov/) can be used as an acceptable safety plan for electrical work. Other safety plans can be provided if it meets the requirements of section 11.3.1 above.

11.3.2 Personal Protective Equipment (PPE)

11.3.2.1 Arc Flash PPE shall be based on the incident energy provided on calculated value shown on label of equipment. If a calculated label is not yet applied to the piece of equipment or directly upstream of the equipment, NFPA 70E Arc Flash PPE Categories Tables (NFPA 70E-2024 table 130.7(C)(15)(a) & (b)) may be used if the assumed short circuit and maximum fault clearance times are not exceeded. Otherwise, an incident energy value at working distance shall be calculated in accordance with NFPA 70E (NFPA 70E-2024 130.7(G)).

11.3.2.2 Storage, Maintenance, Testing, and Inspecting of PPE and Insulating Protective Equipment (IPE)

11.3.2.2.1 Each organization that is responsible for the use and maintenance of PPE and IPE shall store, maintain, test, and inspect the equipment in accordance with NFPA 70E, ASTM, and ANSI compliant processes and manufacturer's recommendations to assure that the equipment meets the requirements for periodic testing of electrical protective equipment as defined in NFPA 70E.

11.3.2.3 Leather protectors shall always be used with insulating gloves for shock protection.

11.3.3 High Current Equipment

11.3.3.1 High current equipment (i.e., equipment greater than 5 amps & e.g., microwave ovens, space heaters, coffee pots, kettles, and refrigerators) shall be plugged directly into a wall receptacle.

11.3.4 Surge Protectors

11.3.4.1 A surge protector is a special type of outlet device that is intended to protect computers and related equipment from damaging power fluctuations.

11.3.4.2 Surge power strips are allowed for use with computers and related equipment.

11.3.4.3 A UL listed power strip (UL Standard 1363) can be purchased with power surge features. These should be the device of choice for computers and related equipment.

11.3.5 Ground Fault Circuit Interrupters (GFCI) shall be installed where working within six feet of any moisture source in addition to all locations specified in NFPA 70 and NFPA 70E.

a. Within six feet of any moisture source that is not de-ionized water.

b. In other areas that could present an electrical shock hazard should the worker come in contact with the energized conductors of a tool or instrument.

11.3.6 Arc Flash Analysis

11.3.6.1 ARC may use a software system model with calculations based on the IEEE 1584 standard to create calculated arc flash labels.

11.3.6.2 Labels shall be created for all voltage classes equal to or greater 50V throughout a facility to the furthest downstream panel per IEEE 1584.

11.3.6.2.1 Calculated labels shall specify:

a. Arc Flash Boundary

b. Incident Energy at Working Distance

c. Minimum PPE

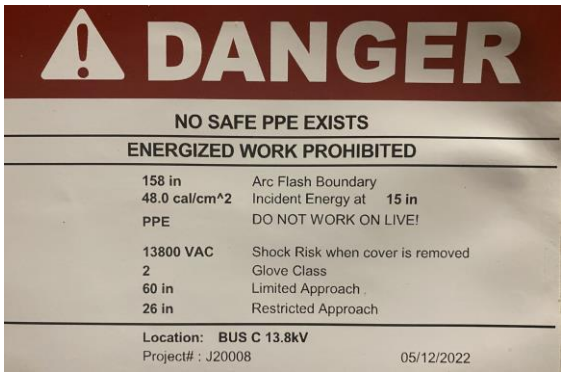
d. Nominal Voltage of Equipment

e. Glove Class (Shock)

f. Limited Approach Boundary

g. Restricted Approach Boundary

11.3.6.2.2 Arc Flash Labels are provided in two sizes and two-color configurations. Large equipment is provided with 4”x6” arc flash labels, and small equipment is provided with 3”x3” arc flash labels. Equipment with incident energy at working distance equal to or less than 40 cal/cm^2 are provided with warning arc flash labels with black letters on an orange background. Equipment with incident energy at working distance greater than 40 cal/cm^2 are provided with danger arc flash labels with white letters on a red background. Example labels are illustrated below:



11.3.6.3 As an interim control measure, generic labels shall be applied at new equipment until arc flash labels are provided. A sample generic label is illustrated below:

11.3.6.4 Disconnect switches will be provided with generic labels.

11.3.6.5 When arc flash labels are not available or interim generic labels are placed on a piece of equipment, follow the below steps for determining adequate arc flash PPE and an estimate for the incident energy for the equipment.

a. If the panel or disconnect switch is fed directly from another panel upstream and that panel has an arc flash label with incident energy provided, use that value (e.g., disconnect being powered from a motor control center). This should not be used when there is a transformer between the two panels nor when there is a second feed to the panel. PPE shall be determined based on the incident energy provided by the arc flash label.

b. If the panel is fed from a transformer, operate the circuit breaker further upstream if feed upstream has an arc flash label with incident energy. PPE shall be determined based on the incident energy provided by the arc flash label.

c. If there is no arc flash labeling upstream, use table values from NFPA 70E table 130.7(C)(15)(a) for ac systems and table 130.7(C)(15)(b) for dc systems. Maximum available fault current shall be calculated.

11.3.6.6 When a piece of electrical equipment has an incident energy of above 40 cal/cm^2, use either of the following options.

a. It shall be acceptable to operate the circuit breaker with a remote operator (e.g., Chicken Switch) or insulated line tool if personnel are safely beyond the arc flash boundary. PPE worn shall be allowed to be reduced to 8 cal/cm^2 equipment per NFPA 70E table 130.5(G).

b. Operate circuit breaker further upstream from the equipment. Incident energy upstream will need to be validated to be equal to or below 40 cal/cm^2. PPE worn shall be equal to or exceed the incident energy at location of operation.

11.3.7 Energized Electrical Work

11.3.7.1 Whenever possible, electrical work shall be performed on de-energized circuits.

11.3.7.2 When all reasonable attempts have been made to work on the equipment in a de-energized state, operations such as diagnostics and testing may be performed on or near live circuits by authorized, qualified, and trained personnel.

11.3.7.3 Safety controls shall include a safety plan or standing procedure that includes precautionary techniques and use of PPE, insulating materials, shielding materials, and rated insulated tools.

11.3.7.4 All energized work including diagnostics and testing shall follow the requirements set out in 29 CFR 1910.333 and NFPA 70E.

11.3.7.5 All metallic articles including jewelry shall be removed during all energized electrical tasks where they present an electrical contact hazard with exposed live parts.

11.3.7.6 Energized work is permitted:

a. On circuits at less than 50V to ground.

b. When all reasonable attempts have been made to work on the equipment in a de-energized state with an authorized and approved Energized Electrical Work Permit. NF1921, *Energized Electrical Work Permit (EEWP), (https://nef.nasa.gov/)* shall be used for work needing an energized electrical work permit.

c. When operations such as diagnostics and testing for voltage, current, or power can be performed on or near live circuits by electrically qualified personnel and approved by responsible supervision.

11.3.7.6.1 When any work involving equal to or greater than 50 volts when an Energized Electrical Work Permit is not required (e.g., diagnostic testing, troubleshooting, testing, etc.):

a. Safety representative or designated representative shall conduct a job safety briefing with the electrically qualified person(s) performing the work based on the safety plan for the work to be conducted.

b. The job safety briefing shall be documented and maintained for the duration of the project or job task.

11.3.7.6.2 Energized work which requires an energized electrical work permit shall meet the following criteria to be authorized:

a. Only if de-energization introduces additional or increased hazards (interruption of life support systems, shutdown of hazardous location ventilation systems, etc.). Ref. OSHA 1910.333.

b. De-energization is in-feasible due to equipment design or operational limitations, (e.g., troubleshooting; the circuits are an integral part of a continuous process that would have to be completely shut down). Ref. OSHA 1910.333.

11.3.7.6.3 When any work requires an Energized Electrical Work Permit:

a. Workers shall be familiar in the use of procedures in the safety plan and Job Briefings shall be conducted.

b. Persons shall not work alone on equipment with exposed-energized parts.

11.3.7.6.4 When an energized electrical work permit is required, coordinate with the Electrical Safety Program Manager (Code QH) for the level of signatures necessary.

11.3.7.6.5 The work procedures and mitigations to take place for the energized work shall be provided with the energized electrical work permit for review.

11.4 Qualifying and Authorizing Personnel

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

11.4.1.1 A person may be considered qualified and authorized with respect to certain equipment and methods but not authorized for others.

11.4.2 Each organization responsible for work on electrical systems shall establish policies and procedures to define qualification and authorization requirements for their workers in accordance with NFPA 70E.

11.4.2.1 Technical training shall be documented and shall meet the requirements of the worker's job description.

11.4.3 Qualification for electrical or electronics work be determined by the employee's supervisor or designated competent worker for electrical or electronic work. Designated competent worker needs

to a be person qualified and authorized to work on similar types of systems as the person that is being qualified and authorized.

11.4.3.1 Supervisors shall use the following procedure to determine whether an individual is qualified to perform specific electrical work:

a. Describe, in detail, the scope of the work task being considered.

b. Determine the employee's ability to identify all possible hazards associated with the task, and using criteria set out in section 11.4.3.1.1.

c. Qualification analysis shall always be performed. Qualifications analysis shall be based on the employee having a combination of on-the-job training and institutional training (including required periodic retraining), electrical trade training (e.g., formal apprenticeship), military, college, or work experience.

11.4.3.1.1 Guidelines to Determine Whether an Individual is Qualified to Perform Specific Electrical Work

Sample criteria for determining an employee's qualifications to perform specific electrical work are listed below:

Note: Different subsets or additions to these criteria may be selected according to the exact nature of the task.

a. The employee's experience in the selection and use of test equipment for this task.

b. The individual's ability to locate and read the appropriate engineering documents for the electrical system.

c. The employee's knowledge of how to check the equipment calibration, condition, and operation.

d. The employee's knowledge of how to shut down, isolate, and verify all sources of hazardous energy.

e. The employee's knowledge of LOTO requirements including training in LOTO being current.

f. The employee's experience and training to independently identify hazards.

g. The employee's experience and training to select the correct materials, tools, and components, and to use them in a manner consistent with their manufacture and/or listing.

h. The employee's ability to distinguish between appropriate and inappropriate equipment-grounding techniques.

i. The employee's experience, training, and ability to predict likely failure modes of a particular construction, and to properly mitigate the effects of such failures.

j. The employee's knowledge of the proper use of the precautionary techniques to address arc-flash and shock hazards including, but not limited to, insulating and shielding materials, insulated tools, test equipment, and PPE.

k. The employee's ability to distinguish exposed energized parts from other parts of electrical equipment.

l. The employee's ability to determine the nominal voltage of exposed energized parts.

m. The employee's knowledge of approach boundaries specified in NFPA 70E and the corresponding voltages to which the qualified electrical worker will be exposed.

11.4.3.2 A qualified electrical worker is a person whose qualifications are documented by their supervisor as:

a. Meeting training and certification requirements of this chapter.

b. Having sufficient understanding of a device, system, piece of equipment, or facility to complete the given task.

c. Being able to recognize and mitigate hazards for a given task, and knowing the injuries that those hazards are able to cause.

d. Having the work experience and formal training necessary to execute the work according to recognized and accepted technical standards.

e. Has taken a minimum of five hours of training on NFPA 70E within the last three years.

f. Having CPR (Cardiopulmonary Resuscitation), AED (Automatic External Defibrillator), and first aid training within the last two years.

g. Having bloodborne pathogen training within the last year.

h. Having contact release training within the last year.

11.4.3.3 Authorization to perform electrical or electronics work by a qualified employee shall be:

a. Determined by the employee's Line Management and Supervisor.

b. Based on the ability of the employee to perform a specific task safely.

11.4.3.3.1 A qualified employee shall have obtained authorization or re-authorization within the last three years.

11.4.3.3.2 NF1896, *Electrical Worker Qualification Form*, (https://nef.nasa.gov/) can be used as an acceptable way to provide validation of qualifications for authorizing personnel for electrical work. Other qualifications and authorizations forms will be acceptable if it validates that the personnel are qualified and authorized to perform the work the personnel are assigned in accordance with this section, 11.4 Qualifying and Authorizing Personnel.

11.4.3.3.3 Supervisory auditing of authorized personnel shall occur annually at a minimum to ensure the proper implementation of safety protocols. Designated competent person can be the person who provides audit, but both the supervisor and designated competent person needs to validate and sign audit form.

11.4.3.3.4 NF1898, *Supervisor Electrical Safety Field Work Audit Form*, (https://nef.nasa.gov/) can be used as an acceptable way to provide documentation of periodic auditing of personnel's electrical work regarding electrical safety. Other forms shall be acceptable if it validates that the personnel are able to conduct electrical work safely.

11.4.3.4 Electrical Two-Person Rule

11.4.3.4.1 When persons are working on or are exposed to electrical equipment that is energized at greater than 600V, or are performing electrical work that requires an energized electrical work permit, a minimum of two qualified and authorized electrical workers shall be present.

11.4.3.4.2 When the "Two-Person Rule" is required, both workers shall be present at the work site and each worker shall:

a. Be aware of the other worker's tasks.

b. Be qualified and authorized for the task.

c. Be able to de-energize equipment.

d. Know how to alert emergency rescue personnel.

e. Remain in visual and audible contact with each other.

11.4.3.5 Service or Maintenance Contracts (Equipment Subcontractors)

11.4.3.5.1 The equipment custodian of the equipment needing service, or the designated representative of the equipment custodian, shall be aware of the hazards and the nature and extent of maintenance to be

performed on the equipment when outside contractors, subcontractors, and vendors have been engaged to perform the service or maintenance.

11.4.3.5.2 The equipment custodian or designated representative may impose additional safety requirements on the work to ensure that the work can be done safely and not present a hazard to the contract worker, or other personnel in the area. This may include providing additional safeguards such as protective barriers, posting a qualified person at the work site to control access, or other safety measures as may be required to ensure safe working conditions.

11.4.3.5.3 Third-party service companies or individuals may provide installation or maintenance of commercial equipment under purchase orders, service contracts, or blanket purchase orders for service.

11.4.3.5.4 Outside contractor workers shall follow the safety requirements and procedures of their employers and NFPA 70E, which should provide a level of electrical safety consistent with this Chapter.

11.4.3.5.5 The equipment custodian or designated representative shall brief all subcontractor and vendor employees of NASA Ames electrical safety policy and requirements. A record of the briefing shall be retained by the equipment custodian or designated representative until completion of the contract.

11.5 Unqualified and Unauthorized Personnel

An unqualified and unauthorized person is one that has not met the requirements of section 11.4 Qualified and Authorized Personnel.

11.5.1 All unqualified and unauthorized personnel shall not work on/with electrical equipment (e.g., operating circuit breakers in facility distribution panels) rated nominally 50V or higher.

11.6 Training and Education

11.6.1 Minimum Training

11.6.1.1 Qualified electrical workers (see section 11.4 Qualified and Authorized Personnel) who work on or exposed to any energized electrical equipment rated nominally at 50V or higher at ARC or NRP shall complete the following training courses periodically within the specified time interval as indicated:

a. Lockout/Tag out as provided by the Ames Research Center or acceptable alternative within the last three years. Acceptable alternative shall need to be approved by the Lockout/Tagout Program Manager, Code QH.

b. Proper usage and donning of Personal Protective Equipment (PPE)

c. At least five hours of training on NFPA 70E within the last three years.

d. Certified CPR/AED (Cardiopulmonary Resuscitation/Automatic External Defibrillator) training within the last two years.

e. Certified First Aid instructor-led course within the last two years.

f. Bloodborne pathogen training within the last year.

g. Contact Release training within the last year.

11.6.1.2 On-the-Job Training

11.6.1.2.1 On-the-Job Training shall include:

a. Site-specific and equipment-specific information, including safety plans, standing procedures, and acceptable work practices and requirements.

b. Line management required authorization requirements, acceptable energized work practices, and all necessary safety controls.

11.6.1.2.2 Prior to performing work on electrical equipment, persons being qualified shall be trained in and familiar with the safety-related work practices and procedures (including applicable emergency procedures, lockout/tag out, etc.), and other safety requirements that pertain to their job assignments. Training shall cover:

a. Features of the equipment, including any specialized configuration.

b. Location of all energy sources to, and within, the equipment.

c. Location of all energy-isolating devices.

d. Arc flash boundary, limited approach boundary, and restricted approach boundaries for the equipment.

e. Techniques, tools, and personal protective equipment (PPE) including arc-flash and shock PPE used for the specific equipment.

f. Relevant documents such as wiring diagrams, schematics, service manuals, and operating, testing, and calibration procedures.

g. The system's energy control procedures, grounding and shorting procedures, and other energy-control procedures.

h. Specific operations in which energized work is anticipated (if any), and the process to obtain a valid Energized Work Permit (if required).

11.6.1.2.3 Training may be accomplished through any of the following:

a. Working under the guidance of a person who is qualified and authorized to perform the specific tasks of a job assignment

b. Study and review of written local policies

c. Study and review of standing procedures

d. Other equivalent training methods

11.6.1.2.4 On-the-job training shall be:

a. Documented to ensure that training is adequate and consistent for all employees with similar tasks.

b. Documentation shall be reviewed and approved by a person who is knowledgeable in safe electrical work practices, and familiar with the hazards involved in the apparatus.

11.6.2 Retraining

11.6.2.1 A worker shall be retrained when any of the following apply:

a. Periodic retraining comes due. See Section 11.6.1 Minimum Training.

b. Supervision or annual validation inspections indicate that the worker does not demonstrate an adequate understanding of compliance with job and safety-related work practices, procedures, or requirements.

c. New equipment, equipment controls, operational modification, or changes in procedures merit retraining.

d. New safety-related work practices are employed that are not normally used during the worker’s regular job duties.

11.6.3 Annual Review of Electrical Safety Requirements shall be performed by the worker every 12 months, and shall include:

a. Review of qualifications and authorizations for the employee’s work assignment.

b. Review of portions of this chapter as pertinent to the employee's work assignment.

c. Review of the Ames Lock-out / Tag out Program as set forth in APR 8715.1, Chapter 31.

d. For specific work requirements, a supervisor may require review of other specific portions of institutional policy and requirements as needed.

11.7 Code QH Auditing Requirements

11.7.1 Code QH shall be auditing the electrical safety program of each division that has an active Electrical Safety Program every three years with intermediate verification periodically.

11.7.2 Triennial Audits

11.7.2.1 Audits shall include, but are not limited to the following items:

a. Review of the written electrical safety program and the electrical elements of the lockout tagout program for the directorate. This written electrical safety program and lockout tagout program can be the overarching electrical safety program for the on-site contractor for the directorate, division, branch, or section only if the entire group of qualified and authorized electrical workers are qualified and authorized in accordance with the written electrical safety program.

b. Interviews of a representative sample of qualified and authorized electrical workers and supervisors of the electrical workers.

c. Review of a representative sample set of JHA.

d. Review of a representative sample set of Lockout/Tagout and/or Switching Procedures.

e. Review of the compliancy of PPE and IPE testing.

f. Review of qualification and authorization records.

11.7.3 Periodic Inspections

11.7.3.1 Periodic inspections that occur during a specific job task shall include, but not limited to the following:

a. Review of current JHA and associated Lockout/Tagout and/or Switching Procedures.

b. Verification of PPE and IPE meet requirements for the task and review of the compliancy of PPE and IPE testing.

c. Review of qualification and authorization records of the associated qualified and authorized electrical worker.

d. Witnessing of Lockout/Tagout, Switching of Equipment, and associated electrical work.

11.7.3.2 Periodic inspections that occur after a specific job task has been completed shall include, but not limited to the following:

a. Review of associated JHA and Lockout/Tagout and/or Switching Procedures.

b. Review of qualification and authorization records of the associated qualified and authorized electrical worker.

11.7.4 Code QH inspector shall provide copies of the completed inspection form to the responsible organization director, division chief, and branch chief, and include the inspection form in next triennial audit. If the work activity was performed by contractors, a copy of the inspection form will also be provided to the COR.

11.8 Recordkeeping

11.8.1 Approved Energized Electrical Work Permits shall be maintained by the supervisor of the

person(s) performing the work and the electrical safety program manager (Code QH) for no less than five years.

11.8.2 Training records shall be kept on file and archived for a duration of employment plus 5 years after separation or NRRS 1441.1 NASA Record Retention Schedules requirements, whichever is longer.

11.8.3 Qualification documents (resumes, job applications, military training records, on-the-job training records, etc.) shall be kept on file and archived for a duration of employment plus 5 years after separation or NRRS 1441.1 NASA Record Retention Schedules requirements, whichever is longer.

11.8.4 System documentation, showing the arrangement, location, and wiring of the electrical distribution and equipment shall be maintained, retained for life of equipment, and be readily available to all authorized personnel involved in the work effort for review of that portion of the system for which they are responsible.

11.9 Maintenance and Service

11.9.1 Utility Locator Requirements prior to penetration of walls, ceilings, floors, or the ground.

11.9.1.1 Sufficient clearance shall be provided to prevent the unexpected contact with any utilities (electrical, natural gas, pressured water or air, or other energies) when penetrating the ground or any permanently installed surface (walls, ceiling, or floors).

11.9.1.2 Where the ground will be penetrated or excavated more than 6 inches in depth, a subsurface utility locator site survey shall be performed prior to start on the excavation.

11.9.1.2.1 No excavation may be made for any subsurface work without first obtaining an excavation permit, ARC 874 Excavation Permit, from the Ames Facilities Engineering Branch (JCM) or Plant Engineering Branch (JCE).

11.9.1.3 Contractors performing electrical work in walls, ceilings and floors shall:

a. Perform a subsurface site survey for penetrations of greater than 2 inches.

b. Ensure enough clearance is provided to prevent the unexpected contact with any utilities when penetrating any subsurface.

c. Scan for utilities that may be affected by drilling, cutting, etc.

d. Ensure an employee is trained as per manufacturer to use the scanning equipment to conduct the survey.

e. Clearly mark surfaces with the survey findings and provide a survey report to the COR.

f. Implement appropriate controls to ensure the work is done safely when utilities are present.

11.9.1.4 Trained personnel using appropriate ground and wall scanning instruments shall conduct the survey to locate any subsurface utility (e.g., electrical, gas, high pressure, steam, water) that may be affected by the excavation.

11.9.1.5 Where utilities are present and utility location surveys are required, a JHA shall be documented.

11.9.1.5.1 Job-site personnel shall be briefed on the JHA to help ensure the work is done safely.

11.10 Grounding and Protective Practices

11.10.1 Portable Equipment Grounding

11.10.1.1 Listed double insulated hand tools without a ground are acceptable per 29 CFR 1910.304(g)(6).

11.10.1.2 The case or frame must be connected to ground if all other electrical equipment is supplied with 50V or greater, except as follows:

a. Devices that are double insulated by engineering controls or have cases and all exposed parts protected by two layers of insulating material.

b. Devices operated solely from self-contained batteries.

11.10.2 Medium and High Voltage (Above 1000 Volts)

11.10.2.1 Protective Grounding - General

a. The circuit or equipment must be de-energized, isolated, tagged and locked before protective grounds are attached.

b. All protective-grounding cables must first be attached to a common port on the metal structures or be connected together with a jumper not smaller than 2/0 AWG copper. The grounding cables must be applied to both the ground and all the conductors of the circuit.

c. Protective grounds must be placed on all sides of the work where there is a possible source of power (including wire crossings and parallel lines) and as close to the point of the work as possible.

d. Additional grounds must be placed where necessary to reduce static charges or induced voltage from adjacent lines.

e. Use only grounding devices approved by ANSI.

f. All grounding devices must be removed prior to energizing equipment or circuits.

g. Protective grounding equipment shall be tested periodically (per ANSI standards).

11.10.2.2 Protective Grounding – Transformers

Before work on transformers, the following shall be performed:

a. Isolate the transformer primary disconnecting means.

b. Remove the secondary fuses or open the secondary breaker.

c. Check the system to verify that the voltage is zero and that all stored energy is released.

d. Install protective grounds.

11.10.2.3 Protective Grounding of Current Transformers

a. In current transformers both the case and secondary must be grounded.

b. Where multiple current transformers are connected, a common ground point must be selected that provides grounding for the entire network.

c. The current transformer secondaries must never be opened while the transformer is energized.

d. The current transformers must be connected through a load to ground when energized or shorted at all times when the system is de-energized.

11.10.2.4 Protective Grounding of Power Capacitors

a. All individual power capacitor banks must be grounded except the capacitors installed in tanks on specially insulated mounting racks. In the case of a capacitor bank mounted on a specifically insulated rack, the rack also must be grounded before working on the bank.

b. In order to work on any capacitor unit or bank, the capacitor(s) must be removed from service and grounded per manufacturer's requirements.

11.10.2.5 Protective Grounding of Coupling Capacitors

a. The pedestal base of all coupling capacitors must be permanently grounded.

b. Before any work is performed on the external part of a coupling capacitor, it must be de-energized, each section discharged to ground, and then grounded at the line side of the top section. The conducting terminals shall then be shorted to maintain a safe state. In discharging the sections, first attach the ground clamp to the station ground and then use a ground stick to touch the ground conductor to the bottom of each section.

11.10.2.6 Protective Grounding – Underground Cables

a. Protective grounding of conductors in underground cables cannot always be performed at the point of work. Protective grounds shall be attached at the nearest location where the conductors can be reached.

b. Conductive sheathing or shielding tape shall have a protective ground applied on both sides of the work point.

11.10.3 Working in Underground Utilities

11.10.3.1 General Requirements

Ames Confined Space Entry Permit requirements must be met for work performed in all underground utilities. Refer to APR 8715.1, Chapter 26 Confined Space Entry.

11.10.3.2 Underground Cables

a. Electrical power system cables shall not be spliced when energized.

b. When cables are to be de-energized to permit work on them the following are required:

(1) Identify cables by use of impulse identification system tester along with cable tags, duct reference, and/or records.

(2) Identify and tag cables.

(3) Test for voltage with a remote-operated piercing tool.

a. All cables in manholes must be considered a source of potential shock.

c. Tests must be made to ensure there is no voltage between their outer sheaths and ground.

d. Movement of energized cables shall be authorized and minimized.

e. Workers shall wear appropriate PPE as per NFPA 70E.

f. When new cables are being pulled into manholes or a splice is occurring in a manhole, a physical shield such as a rated high voltage blanket must be provided to prevent contact between existing energized cables and the new cables or spliced cables, cable pulling equipment, and personnel.

g. High voltage cables shall be grounded to prevent shocks when doing Hi-Pot DC testing or allow adequate time for discharge of potential.

h. Even though cables are shown to have no potential between their outer sheath and ground, contact shall be avoided.

Note 1: If contact is necessary to complete some specific item of work, a JHA shall be conducted consisting of hazard identification and mitigation.

Note 2: Appropriate PPE per NFPA 70E shall be worn unless the cable has been proven de-energized.

i. The conductive sheathing or shielding tape of all energized cables adjacent to the underground work area shall be verified as grounded prior to commencing work.

j. If ground verification is not feasible, then barriers shall be installed to prevent workers from making contact with energized cables or equipment.

k. If neither barrier erection nor ground verification is feasible, all cables adjacent to the work area shall be de-energized.

11.10.4 Cutting and Splicing Power Cables

a. Splicing or tapping of energized power cables shall not be permitted.

b. Before cutting into de-energized high-voltage cables (above 1,000 volts), workers shall also comply with these procedural requirements covering:

(1) Clearing

(2) Tagging

(3) Testing

(4) Grounding

(5) Short-circuiting

c. Isolation switching, grounding and cutting procedures of medium voltage power cables shall be performed by resident onsite authorized and qualified workers.

d. Workers shall also comply with the following requirements:

(1) Check impulse identification testing, cable tags, and ducts associated with cables against one-line diagrams before spiking or cutting.

(2) Perform impulse testing identification checks upstream and downstream of the location where the work is to be performed.

e. After the cable has been identified, the following shall be followed to ensure that the cable is de-energized:

(1) Spike the cable by using a remotely operated grounded, spiking device.

(2) Install the spiking device on the cable using appropriate NFPA 70E PPE and shall be actuated remotely by an insulated stick or by a hydraulically actuated or other mechanically actuating device outside the greater of the Limited Approach or Arc Flash Protection Boundaries. A spiking device that cuts through the cable is permitted, provided that the cutting head is grounded.

(3) Ensure workers are outside of the manhole during remote spiking located in a manhole.

(4) After spiking, if no voltage is detected, the cable may be cut.

11.10.5 Racking Medium Voltage (1,001V – 35,000V) Circuit Breakers

a. Racking in or out of circuit breakers shall follow the requirements set forth by the manufacturer.

b. The organizations responsible for racking circuit breakers shall:

(1) Have defined policies and procedures for these operations.

(2) Have certified operators and procedures for these operations.

(3) Have only personnel that are authorized and qualified perform racking.

(4) Ensure appropriate PPE is selected and used during racking operations.

c. DO NOT rack the breaker into operation position with the closing springs charged or fully compressed.

d. Ensure the breaker is in the open position before racking in or out.

e. Clear all personnel from the immediate and adjacent areas where blast effect might be present and barricade the area.

11.10.6Medium and High Voltage (above 1,000V) Switching

11.10.6.1 All electrical switching shall be performed by authorized and qualified electrical workers for the specific equipment in accordance with section 11.4.

11.10.6.2 NFPA 70E-compliant PPE shall be used when operating disconnecting means.

11.11 Facility Infrastructure Requirements

11.11.1 Removal of Obsolete Equipment

11.11.1.1 When work is to be done to remove old or obsolete equipment, the electrical wiring, conduit, and control boxes shall be removed all the way to the source of feed.

11.11.1.2 After the equipment has been removed, the electrical wiring diagrams, schematics, etc., shall be updated to show the changes.

11.11.1.3 Demolition and safety plans shall utilize approved techniques such as LOTO or air gaps to ensure the safety of workers removing equipment and/or apparatus.

11.11.2 Electrical Shutdown Requests

11.11.2.1 Work that requires an interruption of electrical service to a facility or infrastructure shall include a clause that requires the contractor to notify the responsible Ames Contracting Officer prior to commencement of the work.

11.11.2.2 A 30-day notice shall be provided to occupants of any buildings or facilities affected by an interruption of electrical services in accordance with APR 8829.1 Construction Permit Process.

11.11.2.3 The shutdown request shall:

a. State the date, time, duration, location, and service involved for the outage.

b. Be accompanied by the Lockout Tagout (LOTO) Submittal. Refer to APR 8715.1, Chapter 31 for LOTO requirements.

c. Be submitted for signature approval to the NASA Ames personnel designated for approving shutdown requests for the specified electrical work.

d. Be approved before the circuit(s) is/are de-energized.

11.11.3 Standby and Emergency Electrical Power

Standby and emergency electrical power shall be installed, used, and maintained in accordance with the California Fire Code (CFC), California Building Code (CBC), California Electrical Code (CEC) and pertinent NFPA standards. Diesel generators and battery storage devices shall meet the requirements of

APR 8500.1 Environmental Procedural Requirements specified in Chapter 2 - Air Pollution Control, Chapter 6 - Hazardous Materials Management, and Chapter13 - Spill Prevention, Control, and Countermeasures (SPCC).

11.11.4 Color Coding – Wiring

The color coding of electrical wiring at ARC shall follow the National Electrical Code (NEC).

11.11.5 Working Clearances and Accessibility

11.11.5.1 All fixed electrical equipment must be accessible for maintenance, repair, and de-energization per the NFPA 70-2023 Article 110.26(A) and Table 110.34(A). Sufficient access and working space shall be provided and maintained about all electric equipment in place to allow ready and safe operation and maintenance.

11.11.6 Approach Distance to Exposed Energized Parts

11.11.6.1 Qualified workers shall not approach or take any conductive object, within the "approach distance" to an exposed energized part. Refer to NFPA 70E for approach boundaries.

11.11.7 Cranes and Lifting Equipment (Work Adjacent to Electrical Line)

11.11.7.1 Any overhead wires and cables shall be considered to be energized lines unless it has been verified de-energized by an authorized and qualified electrical worker and is visibly grounded or air gapped.

11.11.7.2 A person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.

11.11.7.3 When electrical distribution and transmission lines have been energized at point of work, the equipment or machines shall be operated proximate to energized power lines per the below minimum clearances.

a. For lines rated 50 kV or below: Minimum clearance from closest contact point of crane, load, or other projection and energized lines is 10 ft.

b. For lines rated over 50 kV: Minimum clearance from closest contact point of crane, load, or other projection and energized lines shall be 10 ft plus 0.4 in. for every 1 kV.

11.11.7.4 Crane with No Load and Boom Lowered:

a. Lines 50 kV or less shall have a minimum clearance of 4ft.

b. Lines over 50 kV shall have a minimum clearance of 4ft plus 0.333ft for every 10 kV over 50 kV.

11.11.7.5 Refer to APR 8715.1 Chapter 17, Lifting Devices and Equipment, for full requirements for cranes and lifting equipment.

11.12 Research Apparatus

11.12.1 Nationally Recognized Testing Laboratory (NRTL), such as UL (Underwriters Laboratory), APPROVED electrical devices shall be used to the greatest extent possible in research applications, in lieu of custom-built research apparatus.

11.12.2 Only authorized and qualified persons as stipulated by paragraph 11.4 may fabricate, modify, install, or repair electronic or electrical equipment used at NRP and ARC.

11.12.3 All unqualified and unauthorized personnel shall not work on/with electrical equipment (e.g., operating circuit breakers in facility distribution panels) rated nominally 50V or higher. Refer to paragraph 11.5 for more information.

11.12.4 Equipment with any voltage equal to or greater than 50V that is modified or designed and built for and/or at ARC shall meet one of the following:

a. Be submitted to a nationally recognized testing laboratory (NRTL) for approval. Equivalencies for international NRTLs may be allowable on a case-by-case basis. Submittal will need to be approved by the Ames Electrical Safety Program Manager (Code QH).

b. When product is being provided by outside of Ames Research Center personnel, be submitted with a report to show that the system meets the minimum documentation and safety requirements of 29 CFR 1910.303, NFPA 70E, NFPA 70, NFPA 79, and NFPA 791. Submittal will need to be approved by the Ames Electrical Safety Program Manager.

c. Be approved by the Ames Electrical Safety Program Manager in accordance with documented procedures for safety analysis of the design, testing of grounding and overcurrent protection, and testing of any other interlock or safeguard designed to protect the user.

11.12.4.1 Equipment that has been approved for use by the Ames Electrical Safety Program Manager shall be per QH-ELEC-EQ-SOP, Approval Process for Electrically Energized Apparatus and thus labeled with the Ames approval sticker. Contact Code QH to initiate the equipment approval process. Process will include fee for service of design review, inspection, and documentation.

11.12.4.2 The organization responsible for assembling the equipment shall supply and apply a durable identification label, per NEC 110.21 that includes:

a. Name of builder.

b. Responsible organization.

c. Voltage.

d. Amperage or power.

e. Environment use restrictions.

11.12.4.3 Design and test documents shall be retained by the responsible directorate for as long as the equipment exists and made available for OSHA and safety inspector, if requested. If equipment leaves the center, the design and testing documents accompanies the equipment.

11.12.5 Removal of Research Apparatus and Associated Wiring

11.12.5.1 It is the responsibility of the research organization to work with Permit Review Board per APR 8829.1 Construction Permit Process for removal of research apparatus and associated wiring where the equipment is hardwired.

11.12.5.2 Removal of all equipment shall meet the same requirements of section 11.11.1 Removal of Obsolete Equipment.

11.12.6 Electrical Shutdown Requests

11.12.6.1 It is the responsibility of the research organization to provide shutdown requests when needed for their equipment.

11.12.6.2 Electrical shutdown requests shall meet the same requirements of section 11.11.2 Electrical Shutdown Requests.

11.13 Temporary Wiring

11.12.1.1 Temporary wiring is allowed in the following instances:

a. During the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, and similar activities.

b. During emergencies and for tests, experiments, and developmental work.

c. Temporary wiring shall be removed immediately upon completion of construction or purpose for which the wire was installed.

d. For holiday decorative lighting and similar purposes temporary wiring may not exceed 90 days and must be removed and stored properly.

11.12.1.2 All temporary wiring must conform to NFPA 70 (NEC) and the California Fire Code (CFC) Section 605 - Building Services.

11.12.1.3 Extension Cords

11.12.1.3.1 Extension cords shall have adequate current-carrying capability to handle the maximum current draw of the electrical device serviced.

11.12.1.3.2 Verify the ampere rating of the electrical devices is less than the rating of the extension power cord.

11.12.1.3.3 Extension cords must be of the three-pronged grounded variety and suitable for the conditions of use and location.

11.12.1.3.4 Extension Cord Used in Outdoor or Wet Locations: All cords used in outdoor or wet locations shall utilize integral or separate Ground Fault Circuit Interrupters (GFCI) for shock protection.

11.12.1.3.5 Extension cords shall only be used for temporary use. Temporary use is allowable for up to 90 days.

11.12.1.3.6 Where extension cords and/or power strips are utilized, they **shall not** be:

a. Used as a substitute for the fixed wiring of a structure.

b. Routed through holes in walls, ceilings, or floors.

c. Run through doorways, windows, or similar openings.

d. Attached to buildings or surfaces.

e. Concealed behind building walls, ceilings, or floors.

f. Linking two or more extension cords and/or power strips together. This is “Daisy chaining” and is prohibited.

APPENDIX A. DEFINITIONS

Accessible (as applied to equipment)	Admitting close approach; not guarded by locked doors, elevation, or other effective means.
Approved	Acceptable to the authority having jurisdiction (AHJ)
Arc Flash Protection Boundary	A calculated burn protection boundary for an arc blast event around a potentially energized system which, when crossed, requires the use of flame-resistant clothing and personal protective equipment (PPE) and work practices by the qualified or escorted person crossing the boundary. These controls are prescribed in NFPA 70E.
Arc Flash Hazard	A dangerous condition associated with the release of energy caused by an electric arc.
Arc Flash Hazard Analysis	A study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of personal protective equipment (PPE).
Contact Release Training	Employees exposed to electric shock hazards and those responsible for the safe release of victims from contact with energized electrical conductors or circuit parts shall be trained in methods of safe release.
De-energized	Achieving the zero-energy state by opening every electrical connection to an electrical source of potential difference and from electrical charge, not having a potential different from that of the earth.
Electrical Hazard	A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or blast injury.
Enclosed	Surrounded by a case, housing, fence, or wall that prevents persons from accidentally contacting energized parts.
Electrically Safe Work Condition	The goal is the verified zero energy state. Energized at less than 50 Volts and low amperage or verified de-energized, locked and tagged, tested to ensure the absence of voltage, and grounded (if deemed necessary).
Electrical Safety	Recognizing hazards associated with the use of electrical energy and taking precautions so those hazards do not cause injury or death.
Energized	Intentionally or unintentionally connected to a source of electrical power.
Energized Electrical Work Permit	A management-approved, written permit required by NFPA 70E to work on energized equipment that cannot be placed in an electrically safe work condition for the task to be attempted (diagnostics and testing).
Exposed (as applied to energized parts)	On or near capable of being inadvertently touched or approached nearer than a safe distance by a person, including conducting material in contact with that person. This also applies to equipment and apparatus that is not suitably guarded, isolated, or insulated.

Grounded	Connected to earth or to some conducting body that serves in place of the earth.
Guarded	Covered, shielded, fenced, ENCLOSED, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to protect against the likelihood of approach or contact by persons or objects to a point of danger.
Insulated	Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of electric current.
Insulated Protective Equipment (IPE)	Like PPE (for example, insulating gloves and sleeves), IPE is used to provide workers protection from contacting energized conductors, but unlike PPE it is not worn on the body. Insulating Protective Equipment (IPE) includes items such as: • Insulating (rubber) line hose, blankets, and hoods. • Insulating barriers made of fiberglass or phenolic resin. • Live-line tools such as hot sticks, switch sticks, and shotgun sticks. • Plastic or fiberglass hardcover items that can be installed with live-line tools.
Job Hazard Analysis (JHA)	A required document prepared to help workers and management review the hazards and safety precautions required for each job.
Limited Approach Boundary	An approach limit at a distance from an exposed live part within which a shock hazard exists. Qualified electrical personnel as a part of the authorized work effort may cross this boundary in appropriate PPE, using prescribed safety and work practices from NFPA 70E. Unqualified personnel in appropriate PPE may cross this boundary if escorted by qualified and authorized electrical worker. If the qualified electrical workers are unable or unwilling to provide escort for unqualified workers, the unqualified worker may not enter the limited approach boundary.
Line Management	Supervisory chain including direct supervisor and management above the person's direct supervisor.
Listed	Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction 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 the equipment, material or services either meets appropriate designated standards or has been tested and found suitable for a specific purpose.
Live	See "Energized."
Nationally Recognized Testing Laboratory (NRTL)	Certain private sector organizations recognized by OSHA as an NRTL. That recognition signifies that the organization has met the necessary qualifications specified in the OSHA NRTL program. The NRTL determines that specific equipment and materials (products) meet consensus-based standards of safety to provide assurance that these products are safe for use in the U.S. workplace.

Lockout/Tagout (LOTO)	Reference APR 8715.1 chapter 31 and OSHA 29 CFR 1910.147. The control of hazardous energy by engineered isolation from the feed source. A complete step by step procedure that when completed provides a verified isolation from all potentially harmful energy to human personnel. This action involves identification of all hazardous energies, verified mitigation and isolation from harmful sources, and the application of locks and tags to ensure that the system remains safe.
Personal Protective Equipment (PPE)	Apparel and tools deemed to comprise a sufficient protection system for a given set of hazards. PPE can include, but is not limited to, rubber gloves and other hand protection, foot protection such as boots, eye protection, hearing protection, hardhats, face shields, protective arc-flash clothing, hoods, flame resistant clothing, etc., used to protect a person from electrical shock and arc flash hazards.
Power Strip	A device used to provide electricity to multiple, low power electrical appliances. The California Fire Code and California Electrical Code requires that these devices be certified by a Nationally Recognized Testing Laboratory to UL Standard 1363. Federal OSHA identifies these as Outlet Devices and requires that their use must be restricted such that no more than 12 amps of load can be plugged into a 15 amp-rated power strip. Power strips are not considered as temporary wiring. There are other use restrictions for these devices that are not listed here.
Premises Wiring (System)	The interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with their associated hardware, fittings, and wiring devices, both permanently and temporarily installed, that extends from the utility service point (i.e. source of power) to the outlet(s). Such wiring does not include wiring internal to appliances, luminaries (fixture), motor, controller, motor control center and similar equipment.
Qualified Electrical Person	One who has skills and knowledge related to the construction, installation, maintenance and operation of the electrical equipment and installations and has received safety training on the hazards involved.
Qualified Industrial Person	A person trained in basic industrial safety including but not limited to: a. Lockout/Tag out b. Electrical Safety c. Confined Space d. Fall Protection e. Job Safety Analysis f. Personal Protection g. Equipment as applicable to the specific task.
Restricted Approach Boundary	An approach limit at a distance from an exposed live part within which there is an increased risk of shock and burn, due to electrical arc combined with inadvertent movement, for personnel working in close proximity to the live part. Only qualified and authorized electrical workers shall be allowed within the restricted approach boundary.

Shock Hazard	A dangerous condition associated with the possible release of energy caused by contact or approach to live parts.
Temporary Wiring	Wiring that is providing electricity to applications or uses that are temporary and/short term in nature. Examples: wiring on a construction site or providing electricity to holiday decorations.
Verified De-energized	See Electrically Safe Work Condition.
Voltage	The potential difference between any two or more conducting points or conductors. a. Low Voltage: Voltage class designation for electric power systems and equipment operating at 1,000 volts or less. b. Medium Voltage: Voltage class designation for electric power systems and equipment operating above 1,000 volts to 35,000 volts. c. High Voltage: Voltage class designation for electric power systems and equipment operating above 35,000 volts.

APPENDIX B. ACRONYMS

AC	Alternating Current
ARC	Ames Research Center
AED	Automatic External Defibrillator
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
APR	Ames Procedural Requirement
CBC	California Building Code
CEC	California Electrical Code
CFC	California Fire Code
CPR	Cardiopulmonary Resuscitation
DC	Direct Current
IBC	International Building Code
IEEE	Institute of Electrical and Electronics Engineers
IPE	Insulated Protective Equipment
JHA	Job Hazard Analysis
LOTO	Lockout/Tagout
NASA	National Aeronautics and Space Administration
NFPA	National Fire Protection Association
NPR	NASA Procedural Requirement
NRP	NASA Research Park
NRTL	Nationally Recognized Testing Laboratory
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
UL	Underwriter Laboratories