ISSUED

Effective Date: 03/08/16

WP 12-IS.03
Revision 13

Electrical Safety Program Manual

Cognizant Department: Environmental, Safety and Health

Approved By: Tom Ferguson

Nuclear Waste Partnership LLC

An AECOM-led partnership with B&W and AREVA

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

CHANGE HISTORY SUMMARY

REVISION NUMBER	DATE ISSUED	DESCRIPTION OF CHANGES
9	07/16/14	• Changed heading in Table 8-1 from “100% cotton clothing” to “non-melting clothing.” • Added statement in section 8.6 regarding the need for a specific hazard analysis when PPE is required for work performed in conjunction with electrical work.
10	09/15/14	• Added new subsection 8.6.1 regarding arc flash and anti-contamination clothing. • Added in Table 8-1 the words, “or equivalent eye protection” to safety glasses requirement.
11	01/08/15	• Added in subsection 4.1.4 vending machines and refrigerators to list of stationary equipment examples, and added “when repairs are made” to list of reasons for inspections, in response to WIPP Form WF 14-324. • Clarified language in subsection 4.1.5.
12	05/20/15	• Added in subsection 8.5.3.1 A, subcontractors and others to requirements for qualified electrical workers. • Added in subsections 8.5.3.1 B, and 10.2.1, language to allow management to designate a competent person to perform inspections when a certified electrical inspector is unavailable.
13	03/08/16	• Removed “to be followed by action plans in response to findings as part of the annual ISM assessment” from 6th bullet under Section 2.0, *Performance Objectives*.

ACRONYMS AND ABBREVIATIONS

AED	automated external defibrillator
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CMR	Central Monitoring Room
CPR	cardiopulmonary resuscitation
DOE	U.S. Department of Energy
EEWP	energized electrical work permits
ESC	Electrical Safety Committee
ES&H	Environmental, Safety and Health
GFCI	ground fault circuit interrupter
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
LO/TO	lockout/tagout
MSHA	Mine Safety and Health Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	nationally recognized testing laboratory
NWP	Nuclear Waste Partnership LLC
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
PVC	polyvinyl chloride
SDD	system design description
UL	Underwriters' Laboratory
V	volt(s)
WCD	Work Control Document
WIPP	Waste Isolation Pilot Plant

1.0 INTRODUCTION

1.1 Summary

The requirements in this manual incorporate applicable electrical safety requirements to ensure an electrically safe workplace at the Waste Isolation Pilot Plant (WIPP), free from unauthorized exposure to electrical hazards for employees and subcontractors. The contents of this manual define the minimum set of requirements for employee roles and responsibilities, hazard analysis and control, electrical work qualifications, safety-related work practices, hazard classification, unlisted electrical equipment examination and approval, and assessments. This manual establishes the electrical safety program; a structure to provide and update electrical safety requirements and guidance for the implementing departments; the role of the Electrical Safety Committee (ESC) serving as the Nuclear Waste Partnership LLC (NWP) authority having jurisdiction (AHJ), and an electrical safety improvement process.

1.2 Purpose

The purpose of this electrical safety program is to:

- Promote an electrically safe workplace free from unauthorized exposure to electrical hazards for all employees and contractors.

- Provide direction to implement electrical safety requirements of U.S. Department of Energy (DOE) orders, criteria, and guides in accordance with the Integrated Safety Management System.

- Provide requirements for NWP departments and subcontractors, including qualification of workers, electrical hazard assessment, mitigation methods, approval of unlisted electrical equipment, and developing and implementing work controls and energized electrical work permits (EEWP) meeting the National Fire Prevention Association (NFPA) 70E, *Standard for Electrical Safety in the Workplace*, requirements.

- Establish requirements and controls for implementation;

- Achieve compliance with Occupational Safety and Health Administration (OSHA) regulations in accordance with DOE Orders.

- Establish the hierarchy of authorities for interpreting electrical safety requirements, approving equipment, assemblies, and materials, and determining the acceptability of electrical installations.

- Achieve compliance with the applicable Mine Safety and Health Administration (MSHA) regulations in accordance with the Land Withdrawal Act.

- Achieve compliance with Title 10 *Code of Federal Regulations* (CFR) Part 851, "Worker Safety and Health Program Description."

An electrically safe workplace will be achieved by mandating and implementing the Integrated Safety Management System, specifically the electrical subparts of 29 CFR: 29 CFR Part 1910, Subpart S; §1910.269; and 29 CFR Part 1926, Subpart K, as directed by the DOE and OSHA; and applying the Standard for Electrical Safety in the Workplace (NFPA 70E), the National Electrical Code (NFPA 70), Institute of Electrical and Electronics Engineers (IEEE) C2 National Electrical Safety Code, 30 CFR Parts 56 and 57, applicable portions of 30 CFR Part 75, and any exceptions by applicable state requirements to the design, construction, and maintenance operation of facilities at the WIPP, and other Carlsbad, New Mexico, facilities covered per 10 CFR Part 851. WP 15-GM.02, *Worker Safety and Health Program Description*, is the NWP program document implementing 10 CFR Part 851. WP 15-GM.03, *Integrated Safety Management System Description* (ISM), provides a general roadmap to the overall implementation of ISM.

1.3 Scope

The electrical safety program shall apply to all WIPP organizations and subcontractors and any individual performing electrical work or using unlisted or unapproved electrical equipment. This includes individuals involved in the design, construction, maintenance, or operation of electrical and electronic systems. This manual establishes expectations that will be implemented by the WIPP workforce, including managers, supervisors, staff, technicians, contract personnel/workers, and off-site NWP employees not covered by a host plan.

1.4 Ownership

NWP Environmental, Safety and Health (ES&H) is the owner of the electrical safety program. The electrical safety program governs the electrical safety implementing procedures owned by each department. The departments will develop and implement safe operating procedures specifically applicable to their role in implementation of the program plan and address any special electrical hazards in their workplaces as reviewed and approved by NWP ES&H.

2.0 PERFORMANCE OBJECTIVES

The electrical safety program has the following objectives.

Establish an effective electrical safety program by:

- Establishing the AHJ for interpreting OSHA, NFPA 70, NFPA 70E, and other requirements for electrical work.

- Establishing requirements and controls for implementing the program.

- Providing guidance to all departments, which includes developing and implementing safe operating procedures with electrical requirements.

- Developing an electrical safety program self-assessment process.

- Establishing measurement criteria and documentation for self-assessment of the electrical safety program.

- Evaluating the electrical safety program on an annual basis.

- Ensure a safe workplace with the lowest reasonable risks from electrical hazards by:

  — Establishing training programs for qualified and unqualified worker requirements and safe work practices for all personnel engaged in electrical work in accordance with 29 CFR §1910.331-335.

  — Complying with applicable electrical requirements of 29 CFR Part 1910 and 29 CFR Part 1926; 30 CFR Part 57, the NFPA; DOE Orders; and state, county, and local revisions of the preceding requirements.

  — Requiring the development and maintenance of an electrical safety program; and allocation of resources for implementing this program.

3.0 ROLES AND RESPONSIBILITIES

Management is responsible to provide a workplace that is free from recognized hazards that might cause injury, illness, or death and to comply with the specific safety and health standards issued by federal, state, and local authorities. Managers expect their employees to comply with these regulations as well as the DOE requirements formulated for the health and safety of employees. Prevention of injury and illness requires the efforts of all.

3.1 ES&H Department Manager

- Ensures that the electrical safety program is integrated into an overall ES&H program.

- Advises management of the need to fund and support these requirements.

- Approves the committee's charter.

- Develops and maintains the electrical safety program.

- Provides oversight and customer liaison for electrical safety for the departments.

- Provides safety professionals trained in the application of the National Electric Code (NEC), OSHA, etc.

- Identifies the need for and establishes new electrical safety initiatives and programs.

- Reviews and approves electrical safety training programs.

- Reviews occurrence reports involving electrical issues and ensures that a member of the ES&H Department participates in electrical incident root cause analysis.

- Regularly communicates status and issues associated with the electrical safety program to the General Manager's Office, the senior management team, and as appropriate, with others involved in electrical safety.

3.2 Industrial Safety/Industrial Hygiene Section

- Assists in the development, maintenance, and review of up-to-date safe work procedures.

- Reviews and approves procedures, work packages, and permits involving electrical work in accordance with the work control process.

- Assists in identifying Nationally Recognized Testing Laboratories-listed electrical equipment for purchase, if available.

- Reviews and approves unlisted electrical equipment.

- Assists management in providing an electrically safe workplace by ensuring that electrical reviews are conducted before proceeding with work or experimentation on newly designed or modified equipment and apparatus.

- Provides assurance to management for electrical safety by conducting periodic random walk-throughs of electrical work areas to ensure application of safety-related work practices and report findings.

- Participates in investigations of electrical incidents.

- Inspects facility electrical installations as covered by the NEC.

- Works to resolve issues identified regarding installation code or safe work practices issues during performance including subcontractor performance, ensuring protection of workers, and compliance with electrical safety requirements.

- Keeps records of all inspections, including the date of such inspections and a summary of any violations found to exist, and submits violations as WIPP Forms, even if corrected on the spot, to allow appropriate trending of electrical safety issues.

3.3 Electrical Safety Committee

The ESC is expected to provide NWP with a competent technical resource for identifying, recommending resolution of, and communicating electrical safety issues. The ESC is expected to enhance electrical safety. The ESC acts as the NWP AHJ for interpreting electrical codes and regulations. The WIPP ESC is chartered per MC 6.3.3, *Electrical Safety Committee*.

The ESC:

- Provides recommendations to management on the requirements and training needed to implement the program and update in accordance with standards and requirements.

- Presents management with the requirements and training needed to implement the program, including updates to standards and requirements.

- Provides recommendation in the implementation of the electrical safety program; including addressing electrical safety issues and promoting electrical safety program improvement.

- Provides representation for electrical workers on workplace electrical safety issues.

- Works with Performance Assurance in reviewing occurrence reports involving electrical issues, participating in root-cause analysis on electrical incidents, and assists in the assessment and evaluation of the electrical safety program's performance.

- Assists the departments by interpreting the electrical requirements of DOE Orders, criteria, and guides and other codes, standards, and practices; and evaluating the impact of these requirements and interpretations on the WIPP.

- Maintains a copy of each interpretation given.

- Evaluates and recommends the contractual adoption of new or revised standards, codes and requirements for electrical work when an exemption or variance is determined to be applicable, develops the documentation and presents the request to the Carlsbad Field Office AHJ accordingly, and to the Safety Programs Manager for submittal for 10 CFR Part 851 variance.

3.4 Maintenance Managers

- Maintain an electrical preventative maintenance program.
- Provide qualified electrical workers (QEWs).
- Implement lockout/tagout (LO/TO) requirements and procedures.
- Ensure that managers, first line supervisors, and a staff of crafts workers and their assistants complete all applicable courses of electrical safety training.
- Ensure that all facilities are maintained in compliance with NEC (NFPA 70), where applicable.

3.5 Operations Managers

- Implement the electrical safety program by providing safe work procedures and permits for high- and low-voltage work as required.
- Provide and implementing other critical procedures such as LO/TO, testing, and safety related work practices as required by 29 CFR §1910.331 335.
- Ensure that craft workers of all disciplines and their immediate supervisors working with, or in proximity to, electrical equipment receive electrical safety awareness training; general and job-specific training in safe electrical work practices as required in 29 CFR Part 1910, Subpart S; and training in NFPA and ANSI codes and standards.
- Discuss job-related electrical issues at safety meetings.
- Ensure that unlisted electrical equipment is not used without prior ESC approval.

3.6 Engineering Managers

- Ensure that applicable requirements of electrical safety codes, standards, and regulations are implemented into electrical designs in accordance with WP 09, *Conduct of Engineering*.
- Ensure that projects have adequate design reviews for compliance with the NEC and other applicable electrical codes and standards, as required.
- Ensure that the electrical engineers and designers attend electrical safety awareness training, general and job-specific training in safe electrical work practices as required in 29 CFR Part 1910, Subpart S; and training in NFPA, IEEE, and ANSI codes and standards.

- Ensure that all workplace modification designs are in compliance with 29 CFR Part 1910, Subpart S, and NFPA 70E; in accordance with WP 09 and the system design descriptions (SDDs).

- Provide and maintaining up-to-date electrical drawings to adequately describe the various building systems and modifications.

3.7 Managers, Supervisors, Work Planners, and Personnel Who Approve Work Procedures, Work Packages, and Permits

- Receive appropriate electrical training to ensure that they understand the hazards of the work they are approving.

- Review and approve electrical work procedures.

- Ensure that workers comply with safety roles and responsibilities.

- Engage worker in work planning in accordance with the work control process. Disseminate relevant electrical safety information and lessons learned to electrical workers.

- Encourage positive safety behaviors through feedback to workers.

3.8 Qualified Electrical Workers

QEWs will be responsible for performing authorized electrical work safely by assessing and controlling the hazards associated with performing that work, by adhering to safety-related work practices. Responsibilities include:

- Maintaining qualification.

- Participate in the pre- and post-job briefings as required, and ensuring an understanding of the hazards and controls.

- Participating in defining the scope of work, the hazards, and hazard mitigation controls, and in the generation, review, and verification of job specific safety documents when requested for new work.

- Participating in completing and signing EEWPs. (Note: it is mandatory that the EEWP be signed by the qualified persons doing the work.)

- Being aware and warning others about electrical hazards in the workplace.

- Implementing safe work procedures when performing any task or activity that exposes the worker to an electrical hazard.

- Performing no unauthorized electrical work.
- Using required personal protective equipment (PPE) in accordance with procedures, work package, and permits.
- Stopping work immediately when necessary.
- Informing the immediate supervisory of any electrical task or deficiency that exceeds the worker's resources, competence, or level of authority.
- Maintaining copies of required work documents at the work site.
- Immediately reporting unanticipated incidents (e.g., shock, electrical flash, arcing, and fire) to the Central Monitoring Room (CMR).
- Ensuring all electrical equipment is listed or approved for use prior to the use of such equipment.

3.9 Employees, and On-Site Workers

Employees and on-site workers have electrical safety-related responsibilities such as Stop Work, using listed or approved equipment, following safe work practices, and event reporting. In addition, workers are responsible for:

- Having an awareness of the electrical hazards in their workplaces.
- Reporting electrical occurrences, shocks, and discovered hazards.
- Reporting all electrical shocks as injuries to Health Services.
- Reading, understanding, and following applicable safe operating procedures having electrical requirements.
- Adopting and implementing safe electrical work practices.
- Attending appropriate electrical safety awareness training and other equivalent job-specific training as required by 29 CFR §1910.332 and NFPA 70E.
- Using appropriate personnel protective equipment.
- Developing interfaces with their representatives on the ESC.

3.10 Purchasing Managers

Purchasing managers are responsible for specifying in subcontracts that:

- Purchases of electrical equipment and appliances are listed by a nationally recognized testing laboratory (NRTL) such as Underwriters' Laboratories, Inc. (UL).

- This manual is to be included in all subcontracts involving electrical work in accordance with WP 15-PC3609, *Preparation of Purchase Requisitions*.

4.0 MANAGING ELECTRICAL HAZARDS

This section of the manual provides the concepts and tools for managing electrical hazards. The fundamental concepts of how a worker may be exposed to an electrical hazard are introduced, as well as how engineering and administrative controls are used to prevent such exposure. Integrated safety management and the work control process are discussed with respect to the management of electrical hazards.

There are two basic ways in which a worker interfaces with electrical energy: (1) using electrical equipment, and (2) working on or near electrical equipment. When using electrical equipment, a worker is protected primarily by engineered controls (i.e., design features) that prevent the worker from being exposed to a hazard. When working on or near electrical equipment, when some or all of the engineered controls may be absent or removed, the worker is largely protected by administrative controls. The understanding of engineering and administrative controls is critical to working safely.

The methods used to protect workers from electrical hazards are a function of the way in which the worker is interfacing with the equipment. For instance, a user or operator of a piece of listed electrical equipment is protected by engineered controls and should not need special training, work control, or PPE to operate the equipment. The processes that have occurred, or continue to occur, to protect that worker include design review and approval, failure analysis, configuration management, and maintenance. At the other extreme, a worker performing energized electrical work is protected by administrative controls, including a work control process (work control documents [WCD]), training and qualification, PPE, and diligence in their work.

All workers regardless of training are responsible for using safe equipment and reporting damage, degradation, or modification that might affect the engineered controls. Management and supervisors are responsible for ensuring that equipment in their area of responsibility is safe for use, with adequate engineered controls in place, by either being listed or approved.

4.1 Using Electrical Equipment- Engineered Controls

Normally, operators and users of electrical equipment are protected by engineered controls, which prevent the user from being injured by the electrical energy within the equipment. Such engineered controls include enclosures and other barriers, electrical insulation, overcurrent protection and ground fault circuit interrupters (GFCI), equipment grounds, and interlocks.

Components are generally listed by a NRTL and installed according to the manufacturer's installation instructions and the NEC. Most appliances, electric tools, and commonly available utilization equipment are NRTL-listed.

If engineered controls are acceptable and documented, they may be taken into account in the risk assessment, and administrative work controls (work package) may not be required to use the equipment (example: office employee turning on a space heater). In some cases, engineered controls can also be used to reduce the risk when working on or near equipment and may be taken into account accordingly.

Engineered controls are ensured to be acceptable by being NRTL-listed, or installation according to the manufacturer's installation instructions and the code (e.g., NEC) with inspection, or qualified ES&H approval for unlisted equipment.

4.1.1 Codes and Standards for Design

This section of the Manual presents the principal codes and standards for engineered controls for the protection of the facility and personnel. The intent is not meant to be comprehensive, but to present the key references; specifics are contained in the site SDDs. SDDs are developed in accordance with WP 09-CN3007, *Engineering and Design Document Preparation*.

A. Select Codes and Standards

Electric Supply - Electric power is delivered to facilities through the utility transmission and distribution system, including substations and relevant equipment. The principle rules for the safeguarding of persons during the installations, operation, or maintenance of electric supply associated equipment are OSHA 1910 and 1926, and MSHA.

Buildings and other structures - Electric power is distributed within facilities using wiring methods, overcurrent protection, grounding, etc., that are covered by the NEC (NFPA 70).

Components and equipment - Many individual components (e.g., wires, breakers, terminal strips) and equipment (e.g., computers, lamps, extension cords, appliances, and electric tools) are built to standards. Standards organizations include UL, Canadian Standards Association, National Electrical Manufacturers Association (NEMA), IEEE, Instrument Society of America (ISA), NFPA (e.g., 70E).

Custom Equipment - This can include equipment such as Waste Handling Equipment, Mining Equipment, but each is designed as per the SDDs, meeting NFPA 70, OSHA, MSHA, and applicable related industry Codes and Standards, such as ANSI, ASTM, and IEEE specifications.

B. NRTL Listing

All electrical equipment used in the workplace must be acceptable for safe use, per OSHA regulations. An NRTL is recognized by OSHA as an organization that tests for safety and lists, labels, or accepts equipment or materials that meet specific criteria detailed in OSHA 1910.7. Visit OSHA website for current approved NRTLs.

All electrical equipment that contains an electrical hazard should be listed by an NRTL. Otherwise, the equipment is unlisted and must be approved by the ESC before use. See other sections of this manual for determining which equipment needs NRTL listing or approval, and for the process of approving unlisted electrical equipment.

All employees are responsible for using electrical equipment that is either listed or has been inspected and approved. This includes electrical equipment that contains an electrical hazard, as defined by the electrical hazard classification. The most common NRTL symbols are shown in Figure 4-1. Note that Conformity Assessment is not an NRTL.

Figure 4-1 - Most Common NRTL Symbols

The symbol below signifies Conformity Assessment and is not a NRTL.

CE NOT A NATIONALLY RECOGNIZED TESTING LABORATORY

4.1.2 Purchase or Construction of New Electrical Equipment

New equipment that is purchased or built for use at WIPP must be NRTL listed or approved by the ESC before use, if the equipment contains electrical hazards. Purchase of listed equipment that is used for its intended purpose does not require additional approval. NRTL-listed equipment must be purchased and used, if available.

For efficient acquisition of new equipment, Engineering should be consulted prior to its purchase. They can help determine if a listed version is available. If not, they may help determine electrical safety design specifications that can be a part of the purchase process. The design review process is controlled by the NWP engineering procedures.

For subcontractor equipment, electrical design or vendor proposals for unlisted equipment should be approved by the ESC prior to contract award or issuance of a purchase request.

4.1.3 Unlisted Electrical Equipment Approval

All electrical equipment, components, and conductors shall be approved for their intended uses. If any electrical system component is of a kind that any NRTL accepts, certifies, lists, or labels, then only NRTL accepted, certified, listed, or labeled components can be used. A non-listed, non-labeled, noncertified component may be used if it is of a kind that no NRTL covers. WIPP considers unlisted electrical equipment containing electrical hazards to include electrical equipment that is not NRTL-listed, and NRTL-listed equipment that has been modified or is used outside of its intended use (as stated in the listing). All unlisted or modified NRTL-listed electrical equipment that contains an electrical hazard must be examined and approved before use. This requirement applies to any individual, including employees, subcontractors, or organizations that use electrical equipment at WIPP. Such equipment must be approved prior to use. Unlisted equipment must be examined and approved by the ESC per procedure meeting the OSHA requirements for accepting electrical equipment and wiring methods that are not approved by an NRTL.

4.1.4 Appliances for Personal Use

- Portable electrical equipment and tools and installed electrical equipment used at WIPP must be tested/listed by a NRTL, when available. In applications where tested/listed tools and equipment are not available, other tools and equipment may be approved for WIPP use via the process outlined in the ES&H procedure for equipment approval.

- Installed electrical equipment must be inspected and approved prior to initial use in accordance with requirements.

- Portable electrical equipment, electric tools and electrical cords must be visually inspected before each use for damage and/or external defects (e.g., loose, missing, broken or deformed parts; pinched or crushed outer coverings or insulation; insulation pulled away from plugs or tool/equipment housings; signs of overheating, sparks or smoke). Damaged or deformed equipment, tools and electrical cords must be removed from service and tagged.

- Stationary electrical equipment (e.g., vending machines, refrigerators, computers, monitors, copiers, printers, multi-outlet strips and surge suppressors, fans, coffee makers, microwave ovens, and toasters), electrical tools, and electrical cords must be visually inspected when initially placed in service, when repairs are made, and any time they are moved to another location.

- Coffee makers, toasters, microwave ovens and other similar appliances designed to heat or cook food shall not be used in an office or cubicle. Appliances shall be maintained clear of combustible materials. A common break room or other designated combustible-free area may be used instead of an office or cubicle.

- Power strips shall not be overloaded. The combined wattage of all equipment plugged into a single power strip shall not exceed the rated design wattage of the power strip.

- No power strip shall be plugged into another power strip.

- Power strips shall not be supported by the cord and plug only.

- When electrical equipment or tools are operated in wet/damp locations, GFCI protection must be used. Permanently installed GFCI receptacles or circuit breakers may be used as well as portable GFCI units.

- When working in environments with hazardous atmospheres or combustible materials where sparks or heat generated by the tools or equipment could cause fire or explosion, portable electrical tools and equipment designed and approved for use in such areas must be used.

- Should electrical equipment, tools or cords begin to smoke/spark/flame during use, they should be turned off and/or unplugged (if this can be done safely) and should be removed from service by attaching a tag until they are replaced or repaired. If it is not safe to unplug the equipment/tool/cord, the area should be controlled to prevent others from entering and the CMR should be notified.

4.1.5 Portable Electric Tools, Appliances, Equipment and Extension Cords

The following general requirements apply to the use of portable electric tools, portable electrical equipment and extension cords used to supply power to portable equipment.

- These items shall be GFCI protected, with the exception of portable air monitoring equipment and other equipment where nuisance tripping can create a hazard. Industrial Safety/Industrial Hygiene (IS/IH) will assist in performing an assessment to determine exceptions for critical equipment.

- The combined length of cord(s) with conductors 12 AWG (American wire gauge) shall not exceed 150 feet. WIPP Electrical Engineering should be contacted for specific guidance for other applications.

- Placements that will expose power supply cords or receptacles to sources of damage such as pinch points or crushing (as in doors and windows); mechanical loading; foot or vehicular traffic; moisture, solvents or chemicals, shall be avoided.

- Cord placements that will create hazards to nearby workers, such as tripping hazards, shall be avoided.

- No tool shall be lifted, carried, or suspended by its cord.

- All extension cords, plugs and receptacles, or other equipment connected by cord and plug, will be visually inspected, by the user, before each day's use.

- Insulation or jacket must be present and in good condition. Covers, insulation, guards, and other shields covering conductive parts, must not be removable without the use of tools. If this is not the case, the item is not effectively insulated.

- Splices are not allowed on extension cords.

- Ground connections are present and secure.

- Cords and connectors must be approved and marked for the conditions of use. Questions regarding the appropriate conditions of use for a specific item should be directed to management.

Any device that is found to be defective during the pre-use inspection will be removed from service, tagged to indicate the defect, and sent for repair or removed to the tool crib so it is not accessible to general employees. Before being placed back in use, maintenance and repair of these devices will include inspections per NFPA 70E to ensure that:

- Polarity is correct
- There are no breaks, damage, or cracks exposing energized conductors and circuit parts
- There are no missing cover plates
- Terminations have no stray strands or loose terminals
- There are no missing, loose, altered, or damaged blades, pins, or contacts

4.1.6 Electric Space Heaters

This section provides safety requirements for portable electric space heaters to be used at the WIPP site and in off-site office buildings. Usage of portable electric space heaters at all WIPP facilities shall be limited due to the potential fire hazard and for energy conservation purposes. Anyone needing additional heating in their work area should first contact the appropriate facility representative to determine if adjustments can be made to the building's heating system. If additional heating is necessary, employees should first (before purchasing high-energy use heaters) consider the use of energy efficient panel heaters or foot warmers that are already available. Any unauthorized or improperly used space heaters will be removed.

The features listed below must be on all portable electric space heaters:

- Listed and labeled by an NRTL such as UL
- Tip-over shut-off switch
- Visible power-on indication (indicating light is preferable)
- Thermostat control
- Grounded or polarized cord (UL-listed or three-prong plug)

Compliance with the following safety guidelines is mandatory:

- Clearance of the front of space heaters to any combustible surface shall be in accordance with manufacturers' recommendations. In no case shall the distance be less than 18 inches.

- Electric space heaters shall not be used in areas where there is a potential to ignite flammable liquid vapors, or there are operations which could cause an explosive atmosphere.

- Flexible cords shall not have worn, frayed, or damaged areas which present an electrical hazard to employees.

- Employees shall contact the appropriate facility representative to investigate tripping of breakers caused by usage of electric space heaters. Such appliances shall not be used until the problem is corrected.

- Electric space heaters in use shall be placed where they can be readily observed.

Electric space heaters shall not be left on when unattended.

Extension cords or power strips shall not be used to supply power to electric space heaters. These appliances must be plugged directly into the building or cubicle receptacle.

4.2 Electrical Preventive Maintenance

An electrical preventive maintenance (EPM) program has been established at WIPP to ensure safe and reliable operation of electrical wiring, protection devices, and operating equipment such as switches, circuit breakers, and utilization equipment. The term electrical preventive maintenance refers to a program of regular inspection and service of equipment to detect potential problems and to take proper corrective measures through the approved work process controls.

4.2.1 Development and Implementation Requirements

The WIPP EPM program is based on the requirements of:

- DOE O 433.1B, Maintenance Management Program for DOE Nuclear Facilities
- NFPA 70B, Recommended Practice for Electrical Equipment Maintenance
- NFPA 70E, Standard for Standard for Electrical Safety in the Workplace
- NFPA 72, National Fire Alarm Code
- National Electrical Testing Association

4.2.2 Definition

An EPM program is defined as the system that manages the conducting of routine inspections and tests and the servicing of electrical equipment so that impending troubles can be detected and reduced or eliminated. Where designers, installers, or constructors specify, install, and construct equipment with optional auxiliary equipment, that optional equipment should be part of the EPM program. Records of all inspections, tests, and servicing should be documented and reviewed. All electrical equipment that is appropriate for EPM should be inspected, tested, and serviced in accordance with the EPM program.

Inspections, tests, and servicing shall be performed by personnel who are qualified for the work to be performed.

4.2.3 Maintenance

Electrical equipment should be maintained in accordance with the manufacturer's recommendations and instructions for the local operating environment as determined by the cognizant engineer and maintenance.

4.2.4 Inspection

The inspection frequency is determined by the cognizant engineer and maintenance and may be based on manufacturer recommendations, NFPA good practices, actual equipment history, or other pertinent factors.

5.0 GROUNDING

Grounding shall be designed as per SDD ED00 and NFPA 70.

6.0 BACKGROUND FOR DEFINING THE SCOPE OF WORK (ISM CORE FUNCTION 1)

Electrical instructions may include, but not be limited to, the following:

- De-energizing circuits, if possible, and providing a means to prevent re-energization (LO/TO)
- Grounding conductors and all possible conducting parts
- Controlling associated generating equipment
- Testing of equipment to ensure safe conditions
- Provision of rubber-insulated protective equipment rated for the highest voltage present

- Qualified personnel
- PPE and protective clothing (e.g., hardhats, safety shoes, eye and face protection, insulated live-line tools, hot sticks, cotton or fire-resistant clothing, and arc protection)
- Working on experimental equipment

6.1 Scope of Electrical Work

Any electrical, electronic equipment or system work must be clearly defined or scoped to include the location of work, general summary of work to be performed, and equipment to be worked on before starting work. Changes to the scope of work while work is in progress, or arrival on location and not exactly as written will require a new definition or scope and a new hazard assessment before commencing.

The scope of work must be broken down into specific enough tasks to identify all hazards with each step. Those tasks that expose the worker to hazard(s) must be detailed in the work control process, including WCDs, hazard analysis (JHA/HIS) and LO/TO procedures.

Examples of specific tasks potentially exposing the worker to electrical hazards include:

- Using a meter for verification or testing
- Operating a breaker or disconnect switch
- Placing a lock and tag
- Removing stored energy in a capacitor
- Using insulated tools on energized circuits
- Tuning or adjusting controls with protective covers removed
- The effects of other workers who are working on or near the same equipment or system

6.2 Working Space Around Electrical Hazards

Working space around electrical enclosures or equipment shall be adequate for conducting all anticipated maintenance and operations safely, including sufficient space to ensure safety of personnel working during emergency conditions and workers rescuing injured personnel. Spacing shall provide the dimensional clearance for personnel access to equipment likely to require examination, adjustment, servicing, or maintenance while energized. Such equipment includes panel boards, switches, circuit breakers, switchgear, controllers, and controls on heating and air conditioning equipment.

These clearances shall be in accordance with the NEC. These working clearances are not required if the equipment is not likely to require examination, adjustment, servicing, or maintenance while energized. However, sufficient access and working space is still required.

6.3 Identification of Disconnection Means

Switches in service panels, subpanels, or elsewhere shall be marked to show what loads or equipment are supplied.

6.3.1 Disconnecting Means

In accordance with the NEC, all disconnecting means (disconnect switches or circuit breakers) shall be located for easy access and shall be clearly and permanently marked to show the purposes of the disconnects, unless located and arranged so that the purpose is evident. Labeling should match and be traceable to appropriate drawings. This applies to all existing electrical systems and all new, modernized, expanded, or altered electrical systems. Disconnecting means shall be capable of being locked out where required.

6.3.2 Panel Board Circuit Directories

Panel board circuit directories shall be provided and fully and clearly filled out.

6.3.3 Enclosure Labeling

Printed labeling or embossed identification plates affixed to enclosures shall comply with the requirements that disconnects be legibly marked and that the marking shall be of sufficient durability for the environment involved.

6.3.4 Load Labeling

As with the disconnecting device, the load should be labeled. For example, the motor, the controller, and the disconnecting device could have the same identification number.

6.3.5 Source Labeling

The source supplying power to the disconnecting means and load should be labeled as well. This requirement allows the electrical worker to know the identification of the elements from the source of power through the entire circuit.

6.3.6 Equipment and Piping Labeling

Equipment and piping labeling is implemented per WP 04-CO.01-18, *Conduct of Operations Program-Equipment and Piping Labeling*.

6.4 Ground Fault Circuit Interrupters

The use of GFCIs substitutes for an Assured Equipment Grounding Program.

GFCI protection will be provided for circuits supplying power as follows:

- Personnel using hand-held electrical devices and portable electrical equipment that operate on a 15- or 20-ampere, 120 volt (V)-rated, single-phase circuit will be protected from ground fault risk by use of a GFCI.

- All GFCI devices in use will be trip tested each day before use. If the GFCI device fails the trip test, the employee must stop work and return the GFCI to the tool crib or otherwise remove it from service.

- Functional testing of the GFCI will include:

  — Portable GFCI Device:

    - Connecting the GFCI cord into the wall receptacle and plugging the electrical tool, extension cord, or electrical equipment into the GFCI.

    - Retesting the GFCI trip function by depressing the trip button after connecting the electrical tool or equipment to the GFCI, but before performing work.

    - Attempting to operate the electrical tool or equipment (the tool should not operate at this time).

    - Pressing the reset button to reestablish electrical power (the tool or equipment should now be energized).

- Permanent Installed GFCI Receptacle:
  - Press GFCI "TEST" button.
    - If the Reset button does NOT extend, consider the GFCI as inoperable, and notify Facility Operations.
    - If the Reset button is extended following the test, reset the GFCI by depressing the reset button until a "click" is heard and the Reset button does not extend back.
    - If the reset button will not reset (stay depressed), notify Facility Operations.
- Circuit Breaker GFCIs:
  - Tested by Facility Operations or Underground Facilities

GFCI testing is conducted in accordance with WP 04-ED1022, *Ground Fault Circuit Interrupter Testing*.

These steps will confirm that the GFCI is functioning and that the GFCI will interrupt any harmful electrical currents before they can become a hazard to the employee.

- When portable electric devices are used under wet conditions, the tool and the worker will be kept as dry as practicable. The hands will be insulated from the device with electrical gloves tested and rated for the voltage expected.

- GFCI devices that control monitoring equipment in continuous service can be tested at the end of the duty cycle.

In accordance with the NEC, ground-fault protection shall not apply to outlets used to supply equipment that would create a greater hazard if power was interrupted or having a design that is not compatible with GFCI protection (i.e., emergency and life essential equipment).

There are two classes of GFCIs, each with a distinct function. A Class A GFCI trips when the current to ground has a value in the range of 4 through 6 milliamperes and is used for personnel protection. A Class A GFCI is suitable for use in branch circuits. A Class B GFCI (commonly used as ground fault protection for equipment) trips when the current to ground exceeds 20 milliamperes. A Class B GFCI is not suitable for employee protection. Ground-fault circuit protection can be used in any location, circuit, or occupancy to provide additional protection from line-to-ground shock hazards because of the use of electric hand tools. There are four types of GFCIs used in the industry:

1. Circuit breaker type
2. Receptacle type
3. Portable type
4. Permanently mounted type

The condition of use determines the type of GFCI selected. For example, if an electrician or maintenance person plugs an extension cord into a nonprotected GFCI receptacle, the easiest way to provide GFCI protection is to use a portable-type GFCI.

6.4.1 How a GFCI Works

GFCIs are devices that sense when current-even a small amount-passes to ground through any path other than the proper conductor such as current passing through a person to ground. When this condition exists, the GFCI quickly opens the circuit, stopping all current flow to the circuit and to a person receiving the ground-fault shock.

A GFCI will not protect the user from line-to-line or line-to-neutral contact hazards. For example, if an employee using a double-insulated drill with a metal chuck and drill bit protected by a GFCI device drills into an energized conductor and contacts the metal chuck or drill bit, the GFCI device will not trip (unless it is the circuit the GFCI device is connected to) as it will not detect a current imbalance.

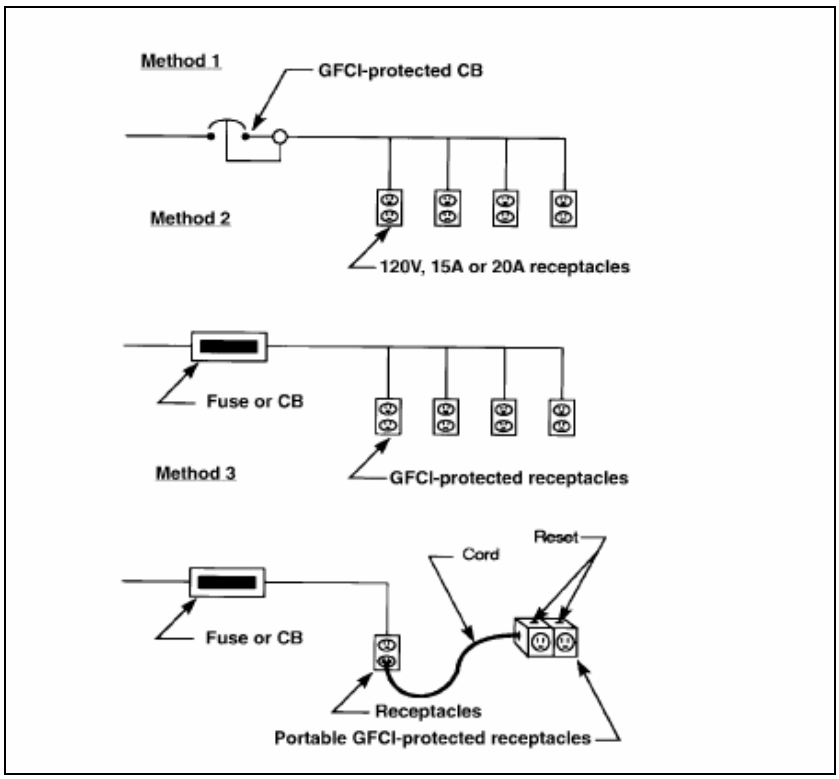

Figure 6-1 - Three Methods of Providing GFCI Protection for Construction Sites

GFCI-protected circuits are one way of providing protection of personnel using electric hand tools on construction sites or other locations.

6.4.2 Uses

The use of GFCIs for temporary modifications is covered by engineering procedures, and in WP 04-AD3012, *Temporary Plant Modification Control*.

GFCI protection will be provided for circuit powers supplying power as defined in WP 12-IS.01-7, *Industrial Safety Program - General Electrical Safety*. Portable electric tools, appliances, equipment, and extension cords will also be GFCI protected with specific requirements contained in WP 12-IS.01-7. Specific rules, inspection requirements, and other GFCI specifics are also contained in that procedure.

6.5 Personnel Protective Grounds

Personnel working on or close to de-energized lines or conductors in electrical equipment should be protected against shock hazard and flash burns that could occur if the circuit were inadvertently reenergized. Properly installed protective grounds can aid in lessening such hazards by providing additional protection to personnel while they service, repair, and work on such systems.

6.5.1 Purpose of Personnel Protective Grounds

Personnel protective grounds are applied to de-energized circuits to provide a low-impedance path to ground should the circuits become reenergized while personnel are working on or close to the circuit. In addition, the personnel protective grounds provide a means of draining off static and induced voltage from other sources while work is being performed on a circuit.

Personnel protective grounds are used to protect electrical workers while they service, repair, or are close to circuits that can be accidentally reenergized.

6.5.2 Personnel Protective Grounds

6.5.2.1 Protective Ground Clusters

Protective ground clusters will meet the following requirements; Ground clusters will be large enough to carry the anticipated fault current, and will be a minimum of 2/0 conductor.

- Ground clamps must be manufactured specifically for the intended use, and rated to handle the maximum available fault current of the system.
- Ground clusters shall be stored in a clean and dry area.
- Ground clusters shall be properly inspected and tested before use.
- Grounding clusters will be connected between phases to the ground system.
- The grounding cluster connection to the system ground will, if possible, be made outside the cabinet, preferably where the system ground attaches to the cabinet.
- The grounding cluster shall be connected first, and pulled last.
- Resistance from phase connection ends to the grounding point is less than or equal to 0.01 ohms, excluding test leads, verified using a 10-amp digital low-resistance ohm meter.

6.5.2.2 Safety Check of Discharge Stick

Verification of safe operation of the discharge stick will be performed by:

- Visually checking the discharge stick for wear and for loose or bad connections.
- Performing an appropriate resistance test from the capacitive discharge hook to the ground connection using a megger at 1,000V.

The resistance value should be within 5 percent of the equivalent bleed-off resistance. If the resistance reading is not within 5 percent of the equivalent bleed-off resistance, remove the discharge stick from service and return it to the tool crib.

For the 70kV Biddle discharge stick, the megohm reading must be within 85.5 to 94.5 megohms.

6.6 Protective Apparel and Equipment

Protective apparel shall be worn when applying or removing grounds. An insulating tool (hot stick) shall be used to install and remove grounding cables. PPE should include at least the following:

- Safety glasses and, if necessary, a face shield appropriate for existing fault currents
- Appropriately rated Hardhat
- Appropriate electrical gloves and protectors
- Appropriate clothing

6.7 Special Occupancies

Special occupancies address the specific requirements and information for installing electrical equipment and wiring in explosive and hazardous locations and underground facilities. Classifications of areas or locations with respect to hazardous conditions are discussed. Information is provided on the correct methods and techniques needed for system grounding, lightning protection, and controlling of static electricity. This section references DOE, NFPA, and MSHA standards. These standards and manuals should be referenced to ensure safe and reliable installations of electrical equipment and wiring methods in explosive and hazardous locations. The explosives section of the DOE-HDBK-1092-2004 and the related DOE and NFPA requirements do not apply to WIPP. Though many of the related requirements apply to the armory at WIPP, the electrical requirements focus on locations where operations use electrostatic-sensitive bulk explosives or electro-explosive devices, and are, therefore, not applicable at WIPP.

6.8 Underground Facilities

Underground facilities consist of electrical equipment and wiring installed in the WIPP mine. Working conditions underground can present to electrical workers hazards different from those presented above ground. Electrical work in support of construction of mines, shafts, and underground utilities shall be performed by qualified workers who must meet the requirements in 30 CFR Part 57. Grounding is addressed in section 5.0. Grounding specific to the underground is per SDD ED00, 30 CFR Part 57, and 30 CFR Part 75.

7.0 ANALYZE THE HAZARDS (ISM CORE FUNCTION 2)

The objective of hazards analysis is to develop an understanding of the potential for the hazard to affect the health and safety of the worker. Hazard controls are then established based on this understanding and other factors related to the work. There are numerous possible injury mechanisms from exposure of a worker to electrical energy. Therefore an electrical hazard assessment includes multiple analysis approaches including shock analysis, arc-flash analysis, boundary analysis, failure analysis, basic job hazard analysis, and others as applicable. As the second core function or step in the ISM process, the thoroughness in completing this step is key to successfully identifying the controls to put in place to ensure protection of the worker in performing work. An assessment of the electrical hazards that includes involvement by a QEW will be performed for all work that requires workers to work on or near exposed electrical conductors or circuit parts that are or could become energized in order to determine the required safety-related work practices. The electrical hazard assessment will include an identification of electrical hazards associated with each task or activity, along with specific mitigation, controls or work rules for each hazard. The electrical hazard assessment will include multiple analysis approaches including failure analysis, shock analysis, arc-flash analysis, boundary analysis, basic job hazard analysis, and others as applicable.

7.1 Hazardous Locations

Hazardous areas and locations are classified by group, class, and division. These classifications are determined by the atmospheric mixtures of various gases, vapors, dust, and other materials present. The intensity of the explosion that can occur depends on concentrations, temperature, and many other factors that are listed in NFPA codes. Hazardous locations must be well understood by anyone designing, installing, working on, or inspecting electrical equipment and wiring in such areas. Such locations carry a threat of flammable or combustible gases, vapors, or dusts being present some or all of the time.

This section covers the requirement for electrical equipment and wiring in locations that are classified according to the properties of the flammable vapors, liquids, or gases or combustible dusts that may be present and the likelihood that a flammable or combustible concentration is present. The following hazardous (classified) location designations are applicable at WIPP.

- Class 1 Division 1
- Class 1 Division 2

Hazmat Storage Area 474 is designated Class 1 Division 1.

The gas pumps are designated Class 1 Division 1 and Class 1 Division 2 as follows:

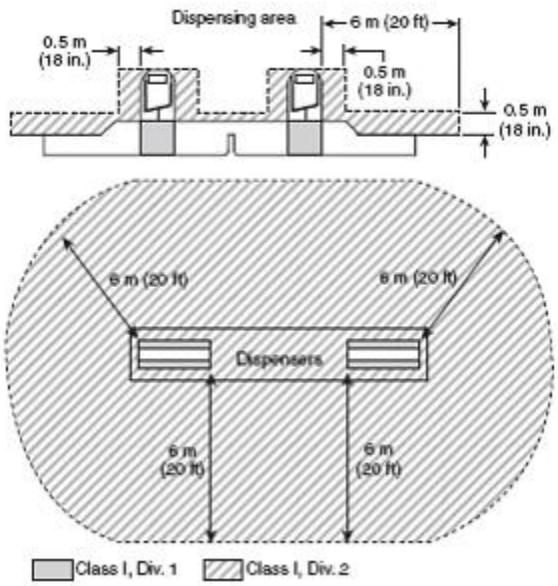

Figure 7-1 - Gas Pump Area

7.1.1 Class 1

Class 1 locations are identified in the NEC as those in which flammable gases or vapors are or may be present in the air in amounts sufficient to create explosive or ignitable mixtures. Gases or vapors may be continuously or intermittently present. However, if a gas or vapor is present, there is a potential that a flammable mixture will be present. From an engineering standpoint, greater precautions are needed if a particular set of conditions is likely to occur (e.g., the presence of a flammable mixture within the explosive range) than if it is unlikely. This is the reason for dividing hazardous locations into two divisions.

7.1.1.1 Division 1

NEC defines Class 1 Division 1 hazardous locations as those in which:

- Ignitable concentrations of flammable gases, liquids, or vapors can exist under normal operating conditions;
- Ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or
- Breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases, liquids, or vapors and might also cause simultaneous failure of electrical equipment.

7.1.1.2 Division 2

NEC defines Class 1 Division 2 locations as those:

- In which flammable liquids or gases are handled, processed, or used, but where such materials are normally confined in closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems or in case of abnormal equipment operation.

- In which gases or vapors are normally prevented, by positive mechanical ventilation, from forming ignitable concentrations and which might become hazardous through failure or abnormal operation of the ventilating equipment

- That are adjacent to a Class 1 Division 1 location and to which ignitable concentrations of gases or vapors might occasionally be transmitted unless such transmittal is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

7.1.1.3 Maintenance

In accordance with NFPA 70E, equipment and installations in these locations shall be maintained such that the following apply:

- No energized parts are exposed (exception- intrinsically safe and non-incendive circuits).

- There are no breaks in conduit systems, fittings, or enclosures from damage, corrosion, or other causes.

- All bonding jumpers are securely fastened and intact.

- All fittings, boxes, and enclosures with bolted covers have all bolts installed and bolted tight.

- All threaded conduit shall be wrench tight and enclosure covers shall be tightened in accordance with the manufacturer's instructions.

- There are no open entries into fittings, boxes, or enclosures that would compromise the protection characteristics.
- All close-up plugs, breathers, seals, and drains are securely in place.

- Marking of luminaries (lighting fixtures) for maximum lamp wattage and temperature rating is legible and not exceeded.

- Required markings are secure and legible.

7.2 Potential Hazards

7.2.1 Electric Shock

Electricity is one of the most commonly encountered hazards in any facility. Under normal conditions, safety features (engineered controls) built into electrical equipment protects workers from shock. Shock is the flow of electrical current through any portion of the worker's body, from an external source. Accidents can occur in which contact with electricity results in serious injury or death.

Most electrical systems establish a voltage reference point by connecting a portion of the system to an earth ground. Because these systems use conductors that have electrical potential (voltage) with respect to ground, a shock hazard exists for workers who are in contact with the earth and exposed to the conductors. If a person comes in contact with a "live" (ungrounded) conductor while also in contact with a grounded object, they become part of the circuit, and current passes through their body.

The effects of electric current on the human body depend on many variables, including the following:

- Amount of current
- Waveform of the current (e.g., direct current [dc], 60 HZ, rf, impulse)
- Current pathway through the body (determined by contact location and internal body chemistry)
- Duration of shock
- Energy deposited into the body

The amount of current passing through the body depends on:

- Voltage driving the current through the body.
- Circuit characteristics (impedance, stored electrical energy).
- Frequency of the current.
- Contact resistance and internal resistance of the body.
- Environmental conditions affecting the body's contact resistance.

The heart and brain are the parts of the body most vulnerable to electric shock. Fatal ventricular fibrillation (cessation of the heart's rhythmic pumping action) can be initiated by a current flow of as little as several tenths of milliamperes. Without immediate emergency resuscitation, electrical shock can cause nearly instantaneous fatality from direct paralysis of the respiratory system, failure of rhythmic pumping action, or immediate heart stoppage. Severe injuries, such as deep internal burns, can occur even if the current does not pass through vital organs or the nerve center. Specific values for hazardous voltages and for hazardous current flow through the body are not completely reliable because of the physiological differences between people.

There are four principal electrical waveforms of interest that cause various responses to electrical shock: power frequencies (50/60 Hz), dc, rf, and impulse shock (such as a capacitor shock). Perhaps the most dangerous are power frequencies (50 or 60 Hz). Exposure to current at these frequencies causes ventricular fibrillation at the lowest thresholds and causes clamping of the muscles with a possible no-let-go response.

Exposure to dc electric currents can also cause a muscle response at first contact and when releasing, as well as heart fatigue and failure at high enough current levels. Radio frequencies (3kHz to 100 MHz) have decreasing neurological effects with increasing frequency, but energy deposited results in tissue burning. Capacitor shock above the skin breakdown threshold (400 to 500 V) results in immediate deposition of the high-voltage capacitor energy into the body. Once above this skin breakdown threshold, the voltage and current of the shock are not the determining factors in the body's response. The electrical energy deposited will determine the severity of the reflex action, the effect on the heart, and the neurological and other tissue injury.

Reflex action occurs when electric current causes a violent contraction of the muscles. Such contraction can result in violent recoil, resulting in falling, recoiling into a nearby hazard, or self-injury resulting in broken bones, torn ligaments, or dislocated joints. Reflex action is enhanced by high-voltage shock as the energy can be delivered more quickly from higher instantaneous currents.

A no-let-go response occurs when continuous alternating current (ac) shock current keeps the muscles violently contracting such that the victim is clutching the conductor without any ability to release.

Because of the effects of waveform on the body's response, the thresholds for acceptable shock vary depending on the form of the electricity. Acceptable means that below these thresholds there is no injury, and above these thresholds there could be injury. The thresholds are listed in Table 7-1.

Table 7-1 – Thresholds for Defining Shock Hazards

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
Batteries	All	> 100 V
RF	3kHz to 100 MHz	A function of frequency

NOTE 1: It is possible for a worker to be exposed to more than one shock hazard at any given location.
NOTE 2: There may be other electrical hazards below the above shock thresholds (e.g., a thermal burn hazard).
NOTE 3: Injuries may result from startle reactions due to contact with energized components, even though there is no shock hazard, especially high-voltage, low-energy.
NOTE 4: Shock and burn hazards from induced and contact RF currents become negligible above 100 MHz.

7.2.2 Electrical Burn

Burns suffered in electrical accidents are of three basic types: electrical burns, arc burns, and thermal contact burns. The cause of each type of burn is different, and prevention requires different controls.

7.2.2.1 Electrical Burns

In electrical burns, tissue damage (whether skin-deep or deeper) occurs because the body is unable to dissipate the heat from the current flow. Typically, electrical burns are slow to heal. Such electrical burns result from shock currents, and thus adhering to the shock current thresholds will prevent electrical burns.

7.2.2.2 Arc Flash Burns

Arc flash burns, or just arc burns, are caused by electric arcs and are similar to heat burns from high-temperature sources. Temperatures generated by electric arcs can melt nearby material, vaporize metal in close vicinity, and burn flesh and ignite clothing at distances of several meters, depending on the energy deposited into the arc. The arc can be a stable low-voltage arc, such as in an arc welder, or a short-circuit arc at higher voltage, resulting in an arc explosion such as expanding arc can ignite clothing and/or cause severe burns at a distance from centimeters (cm) to meters (m). The flash protection boundary is defined to characterize the distance at which this injury mechanism is severe.

7.2.2.3 Thermal Contact Burns

Thermal contact burns are those that occur when skin comes into contact with the hot surfaces of overheated electric conductors, including conductive tools and jewelry. This injury requires close proximity to a high-current source with a conductive object. Thermal burns can occur from low-voltage/high-current systems that do not present shock or arc-flash hazards. Otherwise, the controls to prevent injury from shock and arc flash will also protect against thermal contact burn. Low-voltage/high-current hazard classes with thermal burn hazards are given in Table 7-2.

Table 7-2 – Thermal Burn Hazards non Included in Shock and Arc-Flash Hazards

Source	Includes	Thresholds
AC, R&D	1 – 3 kHz	< 50 V and > 1000 W
DC	all	< 100 V and > 1000 W
Capacitors	all	< 100 V and > 100 J
Batteries	all	< 100 V and > 1000 W
RF	NA	NA

7.2.3 Delayed Effects

Damage to the internal tissues may not be apparent immediately after contact with electric current. Delayed swelling and irritation of internal tissues are possible. In addition, imperceptible heart arrhythmia can progress to total fibrillation. In some cases, workers have died two to four hours after what appeared to be a mild electrical shock. Immediate medical attention following an electric shock may prevent death or minimize permanent injury - this is the primary reason for reporting electrical shock immediately.

7.2.4 Battery Hazards

During maintenance or other work on batteries and battery banks, there are electrical and physical hazards that must be considered. In addition, when working near or on flooded lead-acid storage batteries, additional chemical and explosion hazards must be considered. The hazards associated with various types of batteries and battery banks include the following:

- Electric shock
- Burns and shrapnel-related injuries from a short circuit
- Chemical burns from electrolyte spills or from battery surface contamination
- Fire or explosion due to hydrogen
- Physical injury from lifting or handling the cells
- Fire from overheated electrical components

7.2.5 Stored Energy

Stored electrical energy that might endanger personnel shall be placed in a safe state. Capacitors shall be discharged and high-capacitance elements shall be short-circuited and grounded if the stored electrical energy could endanger personnel.

Stored nonelectrical energy in devices shall be blocked or relieved. Examples include wound springs and pneumatic-driven devices.

7.2.6 Arc Explosion Hazards

A rapid delivery of electrical energy delivered into an arc can cause additional hazards not covered by arc-flash hazards. The acoustical shock wave, or arc blast pressure wave, can burst eardrums at lower levels and can cause cardiac arrest at high enough levels. In addition, high currents (> 100 kA) can cause strong magnetic forces on current carrying conductors, which can lead to equipment destruction, or the whipping of conductors. Such arc explosion hazards are of particular concern in high-energy facility power circuits.

7.2.7 Handling Energized Power Cables

When conditions warrant handling, touching, or moving of power cables over 150V phase to ground, one of the following shall be used:

- The appropriate class of insulated electrical gloves
- Sleds or slings, insulated from the machinery, when moving mining cables with machinery
- Non-conductive ropes, hooks, or slings when moving mining cables by hand
- Appropriate PPE as listed in Table 8-1

7.2.8 Other Hazards

Voltage sources that do not have dangerous current capabilities may not pose serious shock or burn hazards themselves and, therefore, are often treated in a casual manner. However, low voltage circuits are frequently used adjacent to lethal circuits, and even a minor shock can cause a worker to rebound into a lethal circuit. Such an involuntary reaction may also result in bruises, bone fractures, and even death from collisions or falls. The hazard is due to the secondary effects of the reflex action. Thus, when working "near," or within the limited approach boundary, of a conductor, adequate work controls must be in place, although the work is not on that hazardous conductor.

Electricity also poses other hazards. An arc can form when a short circuit occurs between two conductors of differing potential, or when two conductors carrying current are separated, attempting to interrupt the current. If the current involved is strong enough, the arc can cause injury or start a fire. Injury to personnel can result from the arc flash, or arc blast, resulting in severe burns to exposed skin, or ignition of clothing. Overheated equipment or conductors that carry too much current can also start fires. Extremely high-energy arcs can cause an explosion that sends fragmented metal flying in all directions. Even low-energy arcs can cause violent explosions in explosive or combustible atmospheres.

Because research and development (R&D) equipment is often unique, the hazards it presents are sometimes peculiar. An uncommon or one-of-a-kind design scheme complicates analyzing and identifying such hazards. For this reason, special efforts are often necessary to identify all of the potential hazards that may be present in an R&D equipment design. In addition to shock, determining electrical hazards should include identifying potential arcs, blasts, and thermal burns. Once these hazards have been identified, a risk mitigation plan should be developed. Personnel working on unique R&D equipment must meet the WIPP qualification requirements. Additional training may be required dependent on the unique safety problems inherent in the equipment.

7.3 Boundary Analysis

The risk to a worker from an exposed electrical source of energy is determined by the proximity of the worker to the hazard. The risk of electrical shock is a function of voltage, as air breakdown distances increase with higher voltages. Arc flash injury is determined by the distance that the arc-flash energy, including ionized gas and metal, can injure the worker. Burn injury from contact with hot conductors has no boundary, as contact or near contact is required for injury.

There are three shock boundaries, (a) the limited approach boundary, (b) the restricted approach boundary, and (c) the prohibited approach boundary. These three boundaries are encountered as a worker approaches an exposed electrical conductor.

The arc-flash boundary is the distance from an exposed, energized conductor that would result in a second-degree burn to the face or chest of the worker, should an arc occur at that conductor.

At WIPP the working boundary to be used encompasses all worst case boundaries in order to provide defense in depth and simplify site work. The analysis is conducted based on NFPA 70E requirements.

If software is used to conduct the analysis it must be approved by Quality Assurance (QA) per WP 13-1, *Nuclear Waste Partnership LLC Quality Assurance Program Description*, for significance in employee protection.

8.0 DEVELOP AND IMPLEMENT HAZARD CONTROLS (ISM CORE FUNCTION 3)

8.1 Engineered controls

Engineered controls are actually discussed throughout this manual as they can be as simple as a cover over a terminal post or a door on a breaker panel, or the use of NRTL equipment, or the use of GFCIs. While the following sections are not specific to any single engineering control, these sections are included to ensure that the appropriate engineered controls are selected in the initial planning and design phases.

8.1.1 Codes and Standards

Implementing the appropriate codes and standards is vital to ensuring the engineered controls not only meet the provisions considered necessary to protect the workers, but are expected to provide electrical systems that are free from hazard and are efficient, convenient, and adequate for good service, maintainable, standardized, and adequate for future expansion of electrical use as needed. The following codes and standards are expected to be observed:

- Standards published by the National Fire Protection Association
- National Electrical Safety Code, ANSI C2
- State of New Mexico Electrical Code
- Title 10 CFR Part 851, which requires specific compliance with certain safety and health standards including NFPA 70 and NFPA 70E
- Institute of Electrical and Electronics Engineers (IEEE)
- National Electrical Manufacturers Association
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- National Fire Protection Association (NFPA)
- UL
- Factory Mutual Engineering Corporation (FMEC)
- Other NRTLs recognized by OSHA on a limited basis

Where no clear applicable code or standard provides adequate guidance or when questions regarding workmanship, judgment, or conflicting criteria arise, personnel safety protection shall be the primary consideration. Therefore, where there are conflicts between the mandatory requirements of the above codes, standards, and regulations, the requirements that address the particular hazard and provide the greater safety shall govern. OSHA and MSHA requirements are expected to be met without waiver or equivalencies per 10 CFR Part 851.

In addition to new electrical installations, these codes and standards apply to all renovation, replacement, modification, maintenance, or rehabilitation projects at the WIPP. Where the NEC uses terms similar to "by special permission" obtain written permission from the ESC which serves as NWP AHJ.

8.1.2 Design Documentation in Planning

All design documentation in planning will be developed in accordance with the appropriate engineering procedure and SDD, and in accordance with the NEC and the appropriate IEEE Standard for Safety Systems.

8.1.2.1 Drawings

Provide a complete drawing package as required to meet the WIPP specific drawing requirements.

8.1.2.2 Personnel Safety

Design systems and select equipment to reduce the risk of electrocution, arc flash, and arc blast hazards to maintenance and operations personnel.

Equipment and design practices are available to minimize energy levels and the number of at-risk procedures that require an employee to be exposed to energy sources. These designs are expected to be used at WIPP whenever feasible to provide additional engineered controls. Proven designs to reduce the hazards of electrical systems include:

- Arc-resistant switchgear, motor control centers, etc.
- Remote racking (insertion or removal) of circuit breakers.
- Remote opening and closing of switching devices.
- Current limitation obtained with higher impedance transformers or current-limiting reactors.
- Insulated or isolated bus in switchboards and switchgear assembles.

8.1.2.3 Additional Requirements for Safety-Related Electrical Systems (Programmatic and Facility)

Comply with requirements in DOE O 420.1B, Facility Safety, in the design of nuclear safety related electrical structures, systems, and components (SSCs) for Hazard Category 2.

Some of these requirements are implemented through WP 09-CN3021, *Component Indices*.

Use the additional guidance provided in DOE G 420.1-1, *Implementation Guide*, for Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria, for basic approach to preclude single point failure.

Design electrical SSCs to perform all safety functions with reliability required by the DSA.

Use environmental qualification to ensure electrical SSCs can perform all safety functions, as determined by the DSA.

Meet the quality assurance requirements of 10 CFR Part 830, Subpart A, for safety-related electrical SSCs for nuclear facilities, meeting Nuclear Quality Assurance (NQA-1) requirements specified.

Emergency communications systems for areas that must respond to emergency events to control acute exposures to radiation in excess of the annual exposure limits or to hazardous materials in excess of Permissible Exposure Limits, must meet NFPA 72, Chapter 24 requirements for materials, installation, an performance. At WIPP, per this manual it is expected that the recommendations in NFPA 72 will be incorporated as appropriate.

8.1.3 Failure Analysis

On complex or high-hazard systems, some level of failure analysis should be performed that considers how failure of engineered controls could endanger the use/operator. Equipment failure that is reasonably possible must be taken into account both in the design of the engineered controls and in the selection of the administrative controls. This analysis is also expected to include an HPI focus, to include the potential for human error, and ensure the appropriate barriers are included to prevent that potential error from becoming a major event. For instance, if no administrative controls (procedure, WCD, or PPE) are required to operate electrical equipment containing high hazards, a thorough failure analysis of the engineered controls must be performed. This can range from operating breakers in a custom-built enclosure to operating a capacitor bank. If an engineering control failure could seriously endanger a worker, multiple levels of engineered controls should be implemented. An example is the failure of a single interlock allowing access to high-voltage hazards.

Examples of issues to consider when performing failure analysis include:

- Interlock failure (a sticking switch)
- Control system failure (a failed relay)
- Facility power failure (to what state does the system default)
- Water or air pressure failure
- Insulation failure (equipment grounds must be present; or double insulation)
- Arc inside of the enclosure
- Single capacitor or battery failure in a capacitor or battery bank
- Failure of an overcurrent protection device to interrupt fault current
- Failures caused by any or several of the above failures

Failure analysis should be documented as part of the equipment approval package or work package as appropriate.

8.1.4 Operational Configuration Management

One aspect of operational configuration management is the control of changes to engineered controls to prevent hazards from being introduced from unauthorized, unapproved and/or undocumented changes. Hazards introduced by a weakness in configuration management can be as simple as a worker changing the plug on a power cord without inspection and re-approval, to adding an interlock switch to significant access controls. If the state of piece of equipment (not being worked on) could endanger workers, its configuration must be controlled. If a lock is used to protect workers in the vicinity, it must be placed and under the control of the equipment, machinery, or systems owner/operators. If a worker is placing a lock for their own protection while working on a piece of equipment, they must use a lock in accordance with the NWP LO/TO process.

Section 4.1 discussed the requirement for approval or re-approval of any changes to NRTL listed or ES&H-approved equipment that affect the electrical safety engineered controls. Such changes might include replacing a power cord or cord cap, any changes to equipment grounds, any changes to the protective enclosure, replacing a fuse or breaker with a different size, and reconfiguring extension cords, multi-outlet taps, or UPS. Each worker and user of electrical equipment is responsible for realizing that changes they may make to electrical equipment may compromise the protective engineered controls and must seek the advice and approval of ES&H before and after making such changes.

8.1.5 Maintenance

Maintenance and/or periodic inspection ensure that engineered controls will work appropriately to protect the user/operator. We want to ensure that maintenance of safety engineered controls and safety significant systems are adequate. If a failure mode based on time, aging, or abuse could lead to the failure of a critical engineering control, there must be a program to periodically inspect the component or system. For WIPP, these types of systems are captured in the Maintenance Implementation Plan. Other specific electrical maintenance requirements are adopted as required by NFPA 70E, Chapter 2.

8.2 Working on or near Electrical Equipment - Administrative Controls

Administrative controls are required when engineered controls are not sufficient to protect the worker. Work control procedures for electrical work implement (1) OSHA 1910.269 for electric supply; (2) OSHA 1910 Subpart S, and (3) NFPA 70E. Administrative controls used at WIPP to mitigate electrical hazards can be divided into seven basic categories:

- Controls for Electrical Work
- Work control (including WCDs)
- LO/TO
- Working alone, two-person rule, or safety watch rule
- Warning signs, labels, and tags
- Qualification and training
- PPE

The controls for mitigating the electrical hazards during the work must be listed in the hazard analysis (JHA/HIS), including specific disposition for each control. Depending on the specific work scope and hazard analysis, disposition of the control(s) may range from LO/TO training, qualification, and procedures to specific verbiage embedded in the WCD.

8.3 Lockout/Tagout

WIPP LO/TOs are controlled by WIPP procedures WP 04-AD3011, *Equipment Lockout/Tagout*; WP 10-AD3005, *Control and Use of Maintenance Looks*; WP 04-AD3005, *Administrative Control of System Lineups*; and WP 04-CO.01-9, *Conduct of Operations Program- Lockout/Tagouts*. Administrative controls are required when engineered controls are not sufficient to protect the worker.

8.3.1 Work Control

8.3.1.1 WCD Instructions

WCD instructions involving electrical work must include, but not be limited to, the following:

- If LO/TO is part of the instructions, using the current LO/TO procedure during performance of the WCD
- Grounding conductors and all possible conducting parts, if applicable
- Controlling associated generating equipment
- Testing of equipment to ensure safe conditions
- Providing rubber-insulated protective equipment rated for the highest voltage present
- Adhering to Qualified Personnel requirements
- Using PPE and protection clothing
- Implementing scope details
- Working alone, two-person, or safety watch rule

A qualified worker shall perform general housekeeping by conducting tests or visual inspections to verify that all personnel are in the clear and that all tools, electrical jumps, shorts, grounds, and other such devices have been removed so that the circuits and equipment can be safely energized.

8.3.1.2 EEWP

Justification and additional work control process review/approvals (e.g., Hazard Review Team, Senior Management Review Board, etc.) are required for hazardous energized work to be conducted. Justification must be submitted with the request for an energized work permit. The energized work permit requirements and process are in WP 12-IS0302, *Energized Electrical Work Permit*. An EEWP is required for any intentionally energized electrical work above 50 volts. (This does not apply to troubleshooting, testing, or absence of voltage verification, in accordance with NFPA 70E.) Troubleshooting, testing, or absence of voltage verification on circuits with an incident energy level of 40 cal./sq. cm or greater requires an EEWP.

WIPP LO/TO is controlled by WP 04-AD3011, WP 10-AD3005, and WP 04-AD3005. The LO/TO procedure will be used to safeguard employees from injury while they are working on or near de-energized electric circuits and equipment. The LO/TO procedure must be maintained to meet the requirements of NFPA 70E 120.2, 29 CFR §§1910.147(c) to (f), 1910.269(d) and (m), 1910.333, and 1926.417.

8.3.1.3 Temporary Modifications

Temporary modifications at WIPP are controlled by WP 09-CN3007.

8.3.1.4 General Guidance

In planning for a work package that will involve LO/TO, the following considerations are to be included:

- Applicable operational/surveillance requirements and limitations on stand-by equipment are addressed in the package.

- Appropriate groups are identified in the work package for notification before their equipment is de-energized.

- Appropriate sequence steps and selected LO/TO points safely isolate the component.

- Push buttons, control switches, relays, solenoids, and check valves (unless specifically designed to have both an isolation and check feature) are restricted from use as a primary LO/TO point.

- The use of energy isolation devices on equipment that is only accessible by remote means (e.g., RH cell) and where a LO/TO device cannot be used is avoided. If a remotely accessible energy isolation device must be used in this special situation to prevent employee hazard exposure, then a special LO/TO plan must be developed and approved by the ESC as the NWP AHJ prior to use.

- A walkdown verification shall be performed by the preparer in the development of all new lockouts. For repetitive work (e.g., weekly, or monthly), the lockout boundaries will be re-verified by a walkdown, or review of the controlled documents before installation of the lockout. If the lockout package is approved, but not yet installed, and greater than 45 days old, the lockout boundaries will be re-verified by a walkdown before installation.

- Equipment interlocks are not to be relied upon as a means to provide energy isolation. However, when testing for positive isolation of energy and/or prevention of equipment start-up, the interlock function must be taken into account.

- Installation of physical blocking or restraint devices is directed to prevent wind-milling, and/or other component movement that could be hazardous to personnel. The device must be installed after the equipment is de-energized and before work has begun.

- Component identification information of LO/TO points are determined by methods including review of controlled documents, drawings, field walkdown, etc. to uniquely identify the component lockout point.

8.3.1.5 Lockout of Electrical and Electrically Driven Equipment

The work control process integrates hazard analysis (JHA/HIS) and LO/TO processes during development of the WCD to ensure:

- Circuits have been de-energized by having qualified electrical personnel perform and document inspection of switch blade positioning, removal of fuses and/or, test for less than 50V present at work area.

- Switchgear is racked out to disengage the main contacts from the bus when possible.

- Power to motors and controls with multiple feeds have all control and auxiliary circuits de-energized.

- Locks are applied externally on enclosures where possible. Locks should be visible and accessible without exposing personnel to energized parts.

- Automatic transfer switches are not a source of energy when working upstream of the transfer switch. An automatic transfer switch cannot be used as an isolation device if the work is to be performed downstream of the transfer switch. Therefore, automatic transfer switches will not be a part of the lockout.

- Components are not locked in the energized state.

- Batteries are isolated by lifting battery leads and/or, opening the associated disconnect.

- When walkdowns are required, the following apply:

  — All LO/TO points except those located in High-Radiation Areas, Airborne/Contamination Areas, or inaccessible areas (e.g., confined spaces, areas requiring scaffolding) shall be walked down. Use of LO/TO points in these areas without a walkdown requires the approval of Maintenance Management and a Cognizant Operations Manager.

- LO/TO revisions will require a walkdown of the revised LO/TO points unless the LO/TO points meet the above exceptions.

- During the walkdown the LO/TO preparer shall verify component accessibility and confirm that equipment location and labeling are per controlled documents.

- If a discrepancy exists between the controlled document and the field, the discrepancy must be resolved before the walkdown is considered completed.

- If labeling deficiencies (e.g., no label, label does not match) are found during the walkdown, then ensure resolution of the deficiency prior to finalizing the LO/TO order. Resolution may include correction of the field label (a permanent tag or a lead label in the case of lifted leads) or a correction of the affected drawing(s).

8.3.1.6 Working Alone, Two-Person Rule

If the risk of injury from working on or near with an electrical conductor is minimal, a person may work alone.

If working on or near an exposed electrical conductor could result in fibrillation, serious burn, a no-let-go effect, or other injury, the two-person rule will be followed. The second person must be a qualified, electrical worker who understands the activities of the worker and the hazards present and knows what to do in case of an electrical accident involving the worker. Such emergency response tasks could include de-energizing the circuit, performing cardiopulmonary resuscitation (CPR) or using an automated external defibrillator (AED), and other emergency response procedures. Both persons may be working but must stay in visible and audible contact with each other.

8.4 Warning Signs, Labels, and Tags

Warning signs, labels, and tags will be installed as per the NEC, OSHA, MSHA, and WIPP procedures.

8.5 Qualification and Training

The training requirements in NFPA 70E apply to employees who face a risk of electrical hazard that is not reduced to a safe level by the applicable electrical installation requirements. Such employees shall be trained to understand the specific hazards associated with electrical energy. They shall be trained in safety-related work practices and procedural requirements as necessary to provide protection from the electrical hazards associated with their respective job or task assignments. Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury. The NFPA 70E training shall be classroom or on-the-job training, or a combination. It cannot be self-paced training. Specific training requirements for Qualified Persons and Unqualified Persons are adopted directly from NFPA 70E. Components in NFPA 70E regarding "awareness" is to be addressed in training to reinforce "awareness." Electrical training for each group will also include the applicable responsibilities of that group. The training program is implemented in accordance with WP 14-TR.01, *WIPP Training Program*.

8.5.1 Qualified Personnel

All persons performing electrical work will be qualified in accordance with the requirements of 29 CFR §1910.331 through 335. Electrical work will be performed by qualified personnel as follows.

The premise for electrical worker qualification is that the employer can decrease the frequency of electrical incidents and the consequences of electrical accidents by employing an electrically qualified work force. Analysis by National Institute for Occupational Safety and Health of electrical accidents has shown that employers can prevent electrical accidents by having knowledgeable workers perform prescribed tasks in a safe manner that results in a professional product. Electrical worker qualification is the process by which employee conformance to the management expectations is ensured. There are five elements to qualification to allow the employer to efficiently and continually evolve workplace safety. The elements incorporate principles of ISM at the employer level as follows:

- Know the work.
- Know the employee.
- Prepare the employee for the work by training in hazard recognition, codes, and workplace standards.
- Ensure worker compliance.
- Retrain workers at regular intervals and as new hazards arise in the workplace.

8.5.2 General qualifications

Only QEWs (i.e., qualified persons per NFPA 70E) who have completed their WIPP qualification card, or meet the WIPP subcontractor electrical qualification requirements will be permitted to perform work on or near electrical equipment with exposed electrical hazards.

QEWs must be knowledgeable about the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools and test equipment, as needed for the work.

The electrical worker's manager must review and document the education, training, and work-experience credentials of QEWs on the worker's qualification form. Re-evaluation will be required for changes in job assignment, changes in requirements, or if deficiencies in performance are identified.

Detailed requirements for training and qualifications of workers, supervisors, and ES&H are specified below. Subcontractors training is expected to meet the requirements in WP 12 IS.01-6, *Industrial Safety Program - Visitor, Vendor, and Subcontractor Safety Controls*.

8.5.3 Specific Qualifications and Training Requirements

8.5.3.1 Electrically Qualified Worker

Electrical qualification card program demonstrates the ability to work safely with or around electrical hazards to the satisfaction of their electrically knowledgeable and/or qualified supervisor with guidance from the ESC. The worker will also have the training described below.

An electrically knowledgeable and/or qualified supervisor/manager must be aware of the hazards involved in the electrical work and responsible for ensuring the appropriate controls have been put in place per this manual.

A. Training Requirements for QEWs

Training for electrically qualified workers, including subcontractors, vendors and tenants, must include, but not be limited to, the following:

- Recognition and classification of the hazards involved in electrical work
- The development of skills and techniques necessary to determine the nominal voltages, currents, power, energy, and waveform of exposed energized parts
- The methods that will enable the worker to determine the shock and flash protection boundaries

- The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment
- The required procedures on how to perform jobs safely and properly
- Appropriate control of hazardous electrical energy, including the appropriate LO/TO training
- The use, care, and limitations of the PPE necessary to perform jobs safely and properly
- Current CPR/AED training for employees working on or near electrical conductors or circuit parts, where shock is a hazard
- Methods of release of victims from contact with exposed energized electrical conductors or circuit parts

B. Electrical Inspector Qualifications

Electrical inspectors will have comprehensive knowledge of the NEC and NFPA 70E, extensive knowledge of OSHA 29 CFR Part 1910 and 29 CFR Part 1926, knowledge of the applicable sections of the WIPP engineering SDDs and procedures, and demonstrated knowledge of the standard materials and methods used in the installation of electrical equipment. Inspectors will be well versed in the approved methods of construction for safety to persons and property. In addition electrical inspectors will receive site specific training in electrical safety and formal training in NEC and Certified Industrial Electrical Inspector training, in accordance with the NWP ES&H Electrical Inspector Authorization Card. In lieu of the availability of a certified Industrial Electrical Inspector, ES&H management may designate a competent person to inspect electrical installations.

C. Supervisors Who Authorize Electrical Work

First Line Supervisors must be familiar with the hazards to which their workers are being subjected. They must know that the work they assign can be done safely. For this reason, they must take basic electrical safety training, ELC 103. In addition, since LO/TO is usually needed to do electrical work in the facility sector, facility work supervisors must have LO/TO training.

D. Experimental Scientists

Scientists are expected to take the same level training as required for others exposed to the same level of hazards based on their agreed upon level of electrical work tasks.

8.5.3.2 Training Courses

A. Required Training

The Basic Electrical Safety Course is to include the basics of this manual, electrical injury mechanisms, electrical hazard classification, qualification, responsibilities, requirements, and safe work practices. The course presents methods to manage electrical hazards through ISM and use of work control processes as well as numerous resources for the electrical worker. The course also provides the worker with practical guidance on recognizing and managing common electrical hazards in the office and WIPP facilities.

Basic Refresher - Reviews the program described above and any recent changes in electrical safety requirements as well as recent lessons learned, obtained per WP 15-PA.01, *Operating Experience/Lessons Learned Program*.

Electrical Worker Safety Training - Addresses the hazards involved in working on or near energized electrical equipment or systems. The course covers electrical safety guidelines and safe work practices; explains procedures that govern energized electrical work including diagnosis, testing, repair, and maintenance; and discusses when documentation is required, when an EEWP is required, when LO/TO can be used, and when the presence of two workers is necessary. The course is required for electricians, equipment operators, and other crafts workers who work on or near electrical equipment or systems that are or may be electrically energized above 50 V. Employees shall also be trained to select an appropriate voltage detector and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall including information that enables the employee to understand all limitations of each specific voltage detector that may be used.

Lockout/Tagout - Specific course for those that use LO/TO as their energy control method. Designed to meet OSHA training requirements for LO/TO.

Retraining - An employee shall receive additional training (or retraining) under any of the following conditions:

- If the supervision or annual inspections indicate that the employee 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 employee would normally use.

- If employee must use safety-related work practices that are not normally used during their regular job duties.

B. Additional Course Recommendations that are Good Practices, but are not Required:

Computer Safety - Covers hazard identification and safe work practices for computer work, servers, including shock, electrostatic discharge and UPS suggested for those developing, building, and working on data acquisition and control systems.

Designing Safe Electrical Equipment - Covers guidelines for designing and fabricating electrical equipment that meets the NEC, OSHA, and NRTL safety standards. Covers over current protection, enclosure grounding, and protection of the operator. Designed for engineers and others who specify, design, build, or approve electrical equipment.

Electrical Theory - Covers the basics of electrical theory, including electrical parameters, electromagnetic fields, Ohms Law, impedance, induction, energy storage, resistive heating conductors, and dielectrics, and dielectric breakdown. Designed for electrical workers that do not have a heavy technical background or significant education in the electrical theory and applications, as well as work planners to assist in the assessment and implementation of electrical hazard mitigation techniques.

8.6 Personal Protective Equipment and Protective Clothing

Managers shall ensure that appropriate PPE is provided and ensure that employees using PPE are trained in its proper use. Furthermore, managers shall ensure that employees use the appropriate PPE for their assigned task. When PPE is required for other than electrical work, and that work is being performed in conjunction with electrical work, a specific hazard analysis shall be performed. Proper PPE for the task and how it shall be worn shall be documented in the work control document. In addition, heat stress shall be evaluated due to the possible extra layers of protective clothing to determine work period.

Employees shall visually inspect rubber-insulated PPE at the beginning of each workday prior to use and after any work performed that could damage the equipment. Such inspections shall include a field air test of the gloves used. Visual inspection shall be performed on hot sticks, grounds, aerial lift equipment and booms, rope, ladders, insulated tools, etc. Equipment that does not successfully pass visual inspection shall not be used and shall be returned for repair and testing or disposal. See ladder requirements in WP 10-AD3016, *Ladder Control*.

Employees shall wear appropriate PPE and protective clothing to protect them from electrical hazards. Employees authorized or required to work on electrical systems shall be completely familiar with the PPE and protective clothing they need for adequate protection while working on such systems. Shock protection PPE, as determined by a shock hazard analysis, is required whenever any portion of the worker's body passes inside the shock protection boundary. Arc flash PPE is required whenever any portion of the worker's body passes inside the arc flash boundary. PPE will meet NFPA 70E. Work packages will specifically list the Incident Energy.

Electrical/arc flash related clothing is outlined in Table 8-1.

Incident energy calculations are found in engineering controlled drawing 25-J-020-W1.

PPE will meet the requirements in WP 12-IS.01-7HV.

Storage and cleaning of PPE is expected to meet the requirements of NFPA 70E, factoring in manufacturer's recommendations. The ESC will address any related ambiguities.

8.6.1 Personal Protective Equipment and Protective Clothing in Radiological Contaminated Areas Where Electrical Work is Performed

- PPE required by a Radiological Work Permit (RWP) shall not be worn next to the skin unless it is also meets, as a minimum, the requirements in table 8-1.

- Outer garments shall be rated for the hazard as shown in table 8-1 for the specific activity being performed. Anti-C/FR clothing is an acceptable replacement for both Anti-C and Arc rated clothing.

- Anti-C/FR garments are acceptable to be worn next to the skin and act as an equivalent for the outer garment requirement.

- Melting garments/material such as Orex or ice packs for thermal stress may be worn in between non-melting clothing next to the skin and outer garments rated for the hazard exposure as shown in table 8-1.

Table 8-1 – General Guidelines to Electrical Safety Requirements

50 to 150V AC Line to Ground					
Work Description **Where work is being performed within the flash protection boundary of exposed energized systems.** • Flash Protection Boundary based on Incident Energy • Calculated Fault Current and its corresponding Incident Energy Exposure Level in Calories per Square Centimeter and arc flash boundary are shown on Drawing 25-J-020-W1, Table 20-1A. • Calories per Square Centimeter = cal/ sq cm • Arc Thermal Performance Exposure Value = ATPV	**Protective Clothing and Equipment** • Safety glasses or equivalent eye protection required on all operations.				
	Non-melting clothing (ASTM F 1506-08) or untreated natural fiber. Long sleeve shirt and long pants or coveralls	Voltage-rated gloves with leather protectors (Note 1)	Voltage Rated Tools/ Instruments	Leather Footwear ASTM F2413 EH, ANSI Z41 EH or SD	Hard Hat
Removing panel covers. **< 1.2 cal/sq cm**	**X**			**X**	
Energized Work/Verification of Absence of Power **< 1.2 cal/sq cm**	**X**	**X**	**X**	**X**	
CB or Fused Switch Operation. Doors/Covers "CLOSED"	**X**				

Note 1: EXCEPTION: Leather outers are not required when using Class 0 or Class 00 gloves for activities requiring manipulation of small equipment and parts if Management and the qualified worker both agree that the work to be performed poses no risk of damage to the rubber gloves and when the AC voltage does not exceed 250V.

Garments worn as under layers that neither ignite nor melt and drip in the course of an exposure to the electric arc and related thermal hazard may provide additional thermal protection. Materials which melt, such as hard hat liners and hair nets, shall not be permitted to be worn.

Table 8-1 Cont'd

> 151 Volts AC to 600 Volts AC									
Work Description **Where work is being performed within the flash protection boundary of exposed energized systems.** • Flash Protection Boundary based on Incident Energy • Calculated Fault Current and its corresponding Incident Energy Exposure Level in Calories per Square Centimeter and arc flash boundary are shown on Drawing 25-J-020-W1, Table 20-1A. • Calories per Square Centimeter = cal/ sq cm • Arc Thermal Performance Exposure Value = ATPV		**Protective Clothing and Equipment** • Safety glasses or equivalent eye protection required on all operations. • Hard hat required on all operations except for closed cover switching. • Hearing protection required for all Incident Energy above 1.2 cal/sq cm. • Incident Energy greater than 40 cal/sq cm requires an approved energized electrical work permit (EEWP).							
		Non-melting clothing (ASTM F 1506-08) or untreated natural fiber. Long sleeve shirt and long pants or coveralls	Clothing for full body protection including arms and legs Arc-rated for Incident Energy encountered or greater	Full Head, Face, Neck protection Arc-rated for Incident Energy encountered or greater (Note 3)	Arc-rated arc flash suit hood for Incident Energy encountered or greater	Arc-rated Gloves for Incident Energy encountered or greater	V-Rated Gloves with leather protectors (Note 1)	Leather Footwear ASTM F2413 EH, ANSI Z41 EH or SD	Volt-Rated Tools/ Instr
CB or Fused Switch Operation. Doors/Covers "CLOSED"		X							
Racking breaker to connect and disconnect position. **≥ 1.2 cal/sq cm ≤ 12 cal/sq cm**		X	X	X		X		X	
Racking breaker to connect and disconnect position. **> 12 cal/sq cm ≤ 40 cal/sq cm**		X	X		X	X		X	
CB or Fused Switch Operation. Doors/Covers "OPEN" **≥ 1.2 cal/sq cm ≤ 12 cal/sq cm**		X	X	X		X		X	
CB or Fused Switch Operation. Doors/Covers "OPEN" **> 12 cal/sq cm ≤ 40 cal/sq cm**		X	X		X	X		X	
Insertion or removal of low-voltage motor starter "buckets" **≥ 1.2 cal/sq cm ≤ 12 cal/sq cm**		X	X	X			X	X	
Insertion or removal of low-voltage motor starter "buckets" **> 12 cal/sq cm ≤ 40 cal/sq cm**		X	X		X		X	X	
Insertion or removal of power circuit breakers **≤ 12 cal/sq cm**		X	X	X		X		X	
Insertion or removal of power circuit breakers **> 12 cal/sq cm**		X	X		X	X		X	
Removal of bolted covers from switchgear	**< 1.2 cal/sq cm**	X				X		X	
	≥ 1.2 cal/sq cm ≤ 12 cal/sq cm	X	X	X		X		X	
	> 12 cal/sq cm ≤ 40 cal/sq cm	X	X		X	X		X	
Verification of absence of power	**< 1.2 cal/sq cm**	X					X	X	X
	≥ 1.2 cal/sq cm ≤ 12 cal/sq cm	X	X	X			X	X	X
	> 12 cal/sq cm ≤ 40 cal/sq cm	X	X		X		X	X	X
Work on Energized Parts (Note 2)	**< 1.2 cal/sq cm**	X					X	X	X
	≥ 1.2 cal/sq cm ≤ 12 cal/sq cm	X	X	X		X	X	X	X
	> 12 cal/sq cm ≤ 40 cal/sq cm	X	X		X	X	X	X	X
Phasing		X	X		X		X	X	X
Moving Insulated Energized Mining Cable >151 to 600 volts * (Refer to Industrial Safety Program WP 12-IS.01-7 for handling energized cables)								X	

Note 1: EXCEPTION: Leather protectors are not required when using Class 0 or Class 00 gloves for activities requiring manipulation of small equipment and parts if Management and the qualified worker both agree that the work to be performed poses no risk of damage to the rubber gloves and when the AC voltage does not exceed 250V.

Note 2: When working on <151 volts circuits and energized parts >151/≤600 volts are present in the cabinet, the work can be worked as a <151 volt category when all other >151 /≤600 volt parts are covered by appropriate insulating sheeting.

Note 3: Balaclava worn under Head gear and face shield or a full head gear meets requirements for full head, face, and neck protection. **Garments worn as under layers that neither ignite nor melt and drip in the course of an exposure to the electric arc and related thermal hazard may provide additional thermal protection.** Materials which melt, such as hard hat liners and hair nets, shall not be permitted to be worn.

Table 8-1 Cont'd

>600 Volts AC to 15,000 Volts AC										
Work Description **Where work is being performed within the flash protection boundary of exposed energized systems.** • Safety Flash Protection Boundary based on Incident Energy • Calculated Fault Current and its corresponding Incident Energy Exposure Level in Calories per Square Centimeters and arc flash boundary are shown on Drawing 25-J-020-W1, Table 20-1A. • Calories per Square Centimeter = cal/ sq cm • Arc Thermal Performance Exposure Value = ATPV • Two-person rule		**Protective Clothing and Equipment** • Safety glasses or equivalent eye protection required on all operations. • Hard hat required on all operations except for closed cover switching. • Hearing protection required for all Incident Energy above 1.2 cal/sq cm. • Incident Energy greater than 40 cal/sq cm requires an approved energized electrical work permit (EWP).								
		Non-melting clothing (ASTM F 1506-08) or untreated natural fiber. Long sleeve shirt and long pants or coveralls	Clothing for full body protection including arms and legs Arc-rated for Incident Energy encountered or greater	Full Head, Face, Neck protection Arc-rated for Incident Energy encountered or greater (Note 2)	Arc-rated arc flash suit hood for Incident Energy encountered or greater	Grd Stick 3 ft. Min.	Arc-rated Gloves for Incident Energy encountered or greater	V-Rated Gloves with leather protectors	Leather Footwear ASTM F2413 EH, ANSI Z41 EH or SD	V-Rated Tools/ Instr.
CB, Fused Switch or LIS Switch Operation, Doors /Covers "CLOSED."		X								
CB, Fused Switch or LIS Switch Operation, Doors/Covers "OPEN." This includes racking breaker to connect and disconnect position. **≥ 1.2 cal/sq cm ≤ 12 cal/sq cm**		X	X	X			X		X	
CB, Fused Switch or LIS Switch Operation, Doors/Covers "OPEN." This includes racking breaker to connect and disconnect position. **> 12 cal/sq cm ≤ 40 cal/sq cm**		X	X		X		X		X	
Removal of bolted covers from switchgear	**< 1.2 cal/sq cm**	X					X		X	
	≥ 1.2 cal/sq cm ≤ 12 cal/sq cm	X	X	X			X		X	
	> 12 cal/sq cm ≤ 40 cal/sq cm	X	X		X		X		X	
Verification of absence of power & Installation of Ground Clusters. Test cluster prior to use, acceptance using 10-amp DLRO is less than or equal to .01 Ohms, excluding test leads.	**< 1.2 cal/sq cm**	X				X		X	X	X
	≥ 1.2 cal/sq cm ≤ 12 cal/sq cm	X	X	X		X		X	X	
	> 12 cal/sq cm ≤ 40 cal/sq cm	X	X		X	X		X	X	X
Work on Energized Parts (Note 1)	**< 1.2 cal/sq cm**	X						X	X	X
	≥ 1.2 cal/sq cm ≤ 12 cal/sq cm	X	X	X				X	X	X
	> 12 cal/sq cm ≤ 40 cal/sq cm	v	X		X			X	X	X
Insertion or removal of CBs from cubicles		X	X		X		X		X	
Troubleshooting Continuous Miner, 74-U-605 (Note 1)		X	X					X	X	X
Phasing		X	X		X			X	X	X
Moving Insulated Energized Mining Cable > 600 to < 1000 volts *(Refer to Industrial Safety Program WP 12-IS.01-7 for handling energized cables)									X	

Note 1: When working on <151 volts circuits and energized parts >151 /1000 volts are present in the cabinet, the work can be worked as a <151 volt category when all other >151 /1000 volt parts are covered by class "O" insulating sheeting.

Note 2: Balaclava worn under Head gear and face shield or a full gear meets requirements for full head, face, and neck protection. **Garments worn as under layers that neither ignite nor melt and drip in the course of an exposure to the electric arc and related thermal hazard may provide thermal protection**. Materials which melt, such as hard hat liners and hair nets, shall not be permitted to be worn.

Table 8-1 Cont'd

Battery Work					
Work Description Lead Acid Batteries = X Gel Sealed Batteries = S See Note 1	**Safety Equipment and Protective Clothing*** * Safety glasses or equivalent eye protection required on all operations				
	Tools Insulated Hand Tools/ Approved instrumentation	Face Shield	Apron	Nitrile Gloves	Eye Wash Station Within 25 Feet
Voltage Reading	**XS**				
Changing Batteries	**XS**	**X**	**X**	**X**	**X**
Torque Bolts	**XS**			**X**	**X**
Add Water	**X**	**X**	**X**	**X**	**X**
Testing Specific Gravity	**X**	**X**	**X**	**X**	**X**
Removal/Installation of Battery Lead	**XS**	**X**		**X**	**X**
Cleaning Terminals	**XS**	**X**	**X**	**X**	**X**

Note 1: Lead Acid Gel Sealed Batteries fall under the Gel Sealed Battery designation (S)

Table 8-1 Cont'd

Direct Current (DC) System and DC Test				
Work Description Where work is being performed within the restricted shock protection boundary of 1 foot.	**Protective Clothing and Equipment** • Safety glasses or equivalent eye protection required on all operations.			
	Non-melting clothing (ASTM F 1506-08) or untreated natural fiber. Long sleeve shirt and long pants or coveralls)	Leather Footwear ASTM F2413 EH, ANSI Z41 EH or SD	V-Rated Gloves with Leather protectors	V-Rated Tools/Instr.
Verification of absence of voltage and voltage testing. ≥ 100V DC	X	X	X	X
Removing panel covers. ≥ 100V DC ≤ 500V DC	X	X		
DC Tests Megger/Hipot/Vidar ≥ 500V DC ≤ 45KV DC	X	X		X

8.6.2 Look-Alike Equipment

Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, the following actions shall be employed to prevent the employee from entering look-alike equipment.

- Create a typical sign (large, distinguishable from existing signs compliant with ANSIZ5 35, which will be temporarily placed on the look-alike equipment during work, within a work area.

- Use a plastic sign, with the words "WARNING ENERGIZED LOOK-ALIKE EQUIPMENT." The word "WARNING" shall have the triangle symbol (with exclamation mark within), adjacent to it, on the left side. The message "energized look-alike equipment" shall be black letters on a white back ground or white letters on a black background. The "LOOK-ALIKE" signs shall be used on the look-alike equipment when the look-alike equipment is within the limited approach boundary of the work being performed. These signs should be placed and removed by the personnel performing the work. The use of the look-alike signs should be a step in the work package. When look-alike equipment is located outside the limited approach boundary, look-alike signs can be used as conditions warrant, on a case-by-case basis.

8.6.3 Maximum Use Voltage

Maximum use voltage phase-to-phase or phase-to-ground for insulating blankets, mats, covers, line hose, sleeves, and gloves shall be as follows:

Class	Voltage	Label Color
00	500	Beige
0	1,000	Red
1	7,500	White
2	17,500	Yellow
3	26,500	Green
4	36,000	Orange

8.6.4 Rubber Hoods, Covers (Sheeting), Sleeves, Mats and Blankets

Rubber insulating sleeves are worn to provide protection from electric shock and burn to the arm and shoulder areas. They are available in several different thicknesses, lengths, and designs, depending on the maximum voltage they are designed to protect against. Rubber insulating blankets are molded sheets of insulating rubber or synthetic elastomer, usually square or rectangular in shape, designed to cover energized electrical equipment to prevent direct accidental contact by electrical workers. Insulated items will be approved and rated for use at the expected voltage(s).

8.6.4.1 Rubber-Insulated Gloves

When rubber-insulated protective gloves are required, at less than or equal to 250 volts, for Arc Flash Protection only, no leather gloves are required. The requirements for wearing leather gloves for reasons other than Arc Flash still apply.

8.6.4.2 Insulating Sheeting

There are two types of electrical insulating sheeting available on site: the Class 00 (clear) polyvinyl chloride (PVC) sheeting and the Class 0 rubber insulating sheeting.

- Class 00 PVC sheeting is a clear, flexible product that can be cut to the desired size. The sheeting is designed to be hung over un-insulated energized components. The "use" voltage range for this class sheeting is 500V. This sheeting cannot be stored or left in the underground. When used underground, the sheeting must be checked out at the surface tool crib and brought back to the surface at the end of the shift.

- Class 0 rubber insulating sheeting is a yellow rubber product that is more flexible and lighter than the PVC but is not transparent. This product can be cut into any shape. The sheeting is also designed to be hung over uninsulated energized components. The "use" voltage range for this electrical sheeting is 1,000V.

Inspection and Storage - The user must inspect the sheeting before each use, and exchange it when wear or damage is detected. The PVC sheeting can be reused indefinitely as long as it is inspected before each use. Rubber sheeting must be discarded or retested after one year. When not in use, the sheeting shall be stored flat, undistorted, and protected from sharp objects or stored in a protective cylinder two inches in diameter or larger.

Application - Appropriate class of either sheeting shall be used to cover un-insulated energized components within an enclosure or work area when working within the protective boundary or when inadvertent contact is possible. The sheeting can be secured over the uninsulated energized areas with large insulated clothespin-type clamps. Appropriate class of insulated gloves shall be worn during the installation of the sheeting. The sheeting and the attachment clamps are available from the Tool Crib.

8.6.4.3 Insulated Tools

A careful periodic inspection shall be made of equipment used for handling or testing energized lines or equipment. Such tools shall be examined before each use to make certain they are in good condition.

Particular attention shall be given to preserving the surfaces of wooden and fiberglass tools used around electrical equipment, including ladders, and insulated hand tools.

Insulated tools shall be stored in a dry location.

8.6.5 Storeroom Storage

Since heat, light, oil, and distortion are natural enemies of rubber, rubber protective equipment should be guarded from these as much as possible. Rubber equipment shall not be stored near boiler rooms, steam pipes, or radiators and should be protected from exposure to direct sunlight. Gloves should be stored in their natural shape in the leather protector. Blankets should be stored flat, hung on pegs by the eyelet or rolled up.

9.0 SAFE CONDUCT OF ELECTRICAL WORK- PERFORM WORK WITHIN CONTROLS (ISM CORE FUNCTION 4)

Once the controls are in place, work shall be performed safely according to the work control process (work package, etc.). The employee must be prepared to pause or stop work at any indication that the work is unsafe or occurring outside the boundaries of the work scope set by the work control process (the work package, the EEWP). An electrically safe work condition must be achieved and verified by the following process:

- Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

- After properly interrupting the load current, open the disconnecting device(s) for each source.

- Whenever possible, visually verify that all blades of the disconnecting devices are fully open or that draw out-type circuit breakers are withdrawn to the fully disconnected position.

- Apply LO/TO devices in accordance with a documented and established policy.

- Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

- 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 ground connecting devices rated for the available fault duty.

9.1 Basic Rules

Following are the basic rules for all electrical work performed on site:

- All electrical circuit conductors, bare or insulated, are assumed to be energized until placed in a safe energy state.

- Prior to working on or near electrical circuit conductors of 50V or more, the conductors are to be de-energized and placed in a safe energy state, except as allowed for trouble shooting and testing per NFPA 70E.

When all accessible electrical circuit conductors have been placed in a safe energy state and absence of voltage is proven, work may be performed without shock and arc flash PPE.

Electrical conductors and circuit parts that have been disconnected, but are not locked out/tagged out, tested, and grounded (where appropriate) shall not be considered to be in an electrically safe work condition, and safe work practices appropriate for the circuit voltage and energy level shall be used. Lockout/tagout requirements shall apply to fixed, permanently installed equipment, to temporarily installed equipment, and to industrial portable equipment.

Low-voltage circuits are those operating from 50V to 600V; high-voltage circuits are those operating at more than 600V.

Energized electrical circuits operating at or above 50V to ground shall be de-energized and isolated under the WIPP LO/TO program before any employee works on or near the circuit. If it can be shown that de-energizing introduces increased hazards, or is infeasible due to equipment design or operational limitations, work on energized equipment will proceed under the requirements for energized work in this section.

When electrical equipment is being serviced, supplemental illumination will be provided as required.

Nonconductive fish tapes will be used when fishing blind, or where energized circuits might be contacted.

All measuring instrumentation will be tested before and after each use and after equipment has been subject to an event that may damage it or affect its ability to function effectively.

Prior to drilling into electrical devices, all associated circuits in the device will be de-energized in accordance with the WIPP LO/TO program.

Prior to drilling into or through walls or floor surfaces, all known circuits that could be in the area of penetration will be identified, de-energized, and locked and tagged out. Provisions of WP 12-IS.01-14, *Industrial Safety Program – Blind Penetrations*, shall be followed.

Workers should keep in mind that a current path through the body can pass from hand-to-hand, foot-to-foot, or hand-to-foot contact with source and ground.

9.1.1 De-Energized Electrical Work

The following requirements apply to work on both low- and high-voltage de-energized circuits.

Where work is performed on equipment that is de-energized and placed in an electrically safe condition, but exists in a work area with other energized equipment that is similar in size, shape and construction, an alerting technique, as required by NFPA 70E shall be applied to prevent the employee from entering look-alike equipment.

The alerting technique shall consist of a warning sign applied to each energized equipment within the limited approach boundary and adjacent to the de-energized equipment to be worked on.

The warning sign shall be constructed in accordance with the ANSI Z535 series of standards, and shall state, "WARNING: ENERGIZED LOOK-ALIKE EQUIPMENT."

When performing work on de-energized circuits where inadvertent contact with energized circuits is possible, insulation from contact shall be provided by installing insulating material or wearing proper PPE. Approval by Industrial Safety is required before this type of work is performed.

Systems will be treated as energized until:

- All energy sources have been de-energized and locked out.
- Verification of absence of energy has been performed.
- All residual power has been discharged.

Verification of absence of energy shall include one of the following:

- For working on electrical devices or circuits, a qualified person will use appropriate testing methods and equipment to verify that circuit elements and electrical parts of equipment have been de-energized prior to beginning work.
- For performing work on mechanical devices where the electrical circuit component protective guards have not been removed, a qualified person shall operate the equipment operating controls or otherwise verify that the equipment cannot be restarted.

Testing and verification of de-energization will include verification that stored electrical energy has been dissipated or otherwise isolated from de-energized systems. For example, capacitors will be discharged and high-capacitance elements will be grounded.

9.1.2 Reenergizing Equipment

The following requirements shall be met before circuits or equipment are reenergized, even temporarily:

- Tests and Visual Inspections by a qualified person to verify that all tools, electrical jumpers, grounds, and other devices have been removed and the equipment is in safe condition for restart.

- Employees exposed to the hazards associated with reenergizing the circuit or equipment shall be warned to stay clear of circuits and equipment.

9.1.3 Energized Electrical Work - General Requirements

This section contains the requirements that apply to energized electrical work or work on energized systems. The requirements apply to work on both low- and high-voltage energized circuits.

Energized work or work on energized equipment means coming in contact with energized electric conductors or circuit parts with hands, feet, or other body parts, with tools, probes or with test equipment, regardless of the personal protective equipment a person is wearing.

Work such as testing, troubleshooting and voltage measuring shall be permitted without an energized electrical work permit provided safe work practices and personal protective equipment are used, except when the incident energy is great than 40 cal./sq. cm.

When energized parts are exposed, workspace clearances shall be required as specified by 29 CFR §1910.303 and NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces. Where such workspace clearance does not exist, the equipment will be de-energized prior to access.

Additional requirements for subcontract work are located in WP 12-IS.01-6 and WP 12-IS.01-7.

Work will be performed on energized circuits only under the following conditions:

- When it is infeasible to isolate or de-energize the circuit or equipment, as in testing and calibration of circuits, or when de-energized troubleshooting techniques have been exhausted.

- When de-energizing will introduce or increase the hazard(s) to employees, as in deactivation of an alarm system, shutdown of critical ventilation systems, or removal of lighting from an area.

- When de-energizing is infeasible due to equipment design or operational limitations.

All work on energized circuits or equipment will be performed by qualified individuals in accordance with approved work procedures. Procedures and work package steps involving work on energized equipment will be clearly identified as "energized work."

Barriers will be placed around energized work to prevent unauthorized entry. The barriers will be posted to warn of the hazard(s) in the area.

Insulated tools and equipment will be used when working inside the flash protection boundary, as specified in the MOIM, of live parts where tools or equipment might make accidental contact.

Portable ladders shall have nonconductive side rails if they are used where the employee or ladder could contact live parts.

Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, cloth with conductive thread, metal headgear, or unrestrained metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts. Long hair will be secured to prevent contact with energized equipment or moving parts.

Only properly rated, approved, and tested rubber insulated gloves, mats, blankets, and tools will be used to protect the worker from energized components.

A minimum of two levels of insulated protection will be used when working on energized equipment (e.g., gloves and insulated mats, or gloves and insulated tools).

Measuring devices will be appropriate to the job and set on the correct range. Range selection shall not be performed while connected to an energized circuit.

Work on energized circuits requires the review and concurrence of the following:

- Immediate manager of personnel performing the work
- Environmental, Safety and Health (ES&H)
- Cognizant Operations manager, when released for work
- QEWs who will perform the work
- Hazard Review Team
- Senior Management Review Board

9.1.4 High-Voltage Work

All high-voltage (>600V) work will be performed on de-energized systems, except for phase verification of parallel circuits, verification of power, and troubleshooting activities on the underground mining machines. The requirements contained in this section apply to these three exceptions, in addition to the requirements listed above for energized work.

High-voltage systems will be considered energized until:

- All incoming power feeders have been verified as de-energized.
- All feeder conductors have been discharged of residual energy and ground cables have been installed; ground cables must remain in place except during testing and when no work is being performed.
- Ground clusters will not be required on the underground mining machines or portable power center when the trailing cables are unplugged from the power source.

Work procedures may include a mock-up of the planned job as part of the pre-job briefing. The mock-up will involve the actual personnel who will be conducting the work, and will also involve the same tools, protective gear, and equipment as far as practicable.

A qualified person will be present at the job site until high-voltage work is completed.

9.1.5 Power Electronic Equipment

The requirements of NFPA 70E, Article 340 for power electronic equipment applies.

Power electronic equipment includes:

- Electric arc welding equipment (this also applies to those in the underground)
- High-power radio, television transmitting towers, antennas (this also applies to the mobile paging, truck radio systems, radio terminals, radio towers, antennas)
- Process equipment that includes rectifiers and inverters such as the following;
    - Motor drives
    - Uninterruptible power supply systems
    - Lighting controllers

Welding requirements are implemented through WP 10-5, *WIPP Welding Guide*.

9.1.5.1 Specific Measures for Personnel Safety

Managers, Supervisors, and employees shall be trained on the specific hazardous effects of electricity on the human body associated with power electronic equipment in accordance with NFPA 70E 340.5, and 340.6 and the related responsibilities in accordance with NFPA 70E 340.7.

9.1.6 Excavations

Prior to underground excavation, any utilities shall be identified/located and appropriately marked to the best extent possible, and all appropriate excavation permits shall be obtained. JHAs shall be developed in accordance with WP 12-IS3002, *Job Hazard Analysis Performance and Development*. Site excavations are per WP 12-IS.01-6, EA09DCO1-5-0, and EA09DC01-6-0, *Buried Utility Identification*. EA09DC01-5-0, *Excavation and Backfill Permit*, must also be completed.

9.1.7 Buried Cables

In general, work should not be performed on energized buried cables. However, strictly external work not requiring an appreciable change in location of the cable may be performed under direct supervision. Energized cables that are to be moved shall be inspected for defects in accordance with 29 CFR §1910.269. EA09DC01-6-0 must be completed before start of work.

9.1.8 Additional Notes related to Basic Rules

Work may require supplemental lighting to safely perform the task; therefore, job site lighting shall be assessed and supplemented, if necessary, prior to beginning this work.

Work on or near energized electrical circuit conductors may only be performed by qualified personnel who have been authorized to do the work. Personnel who are not QEWs may be qualified to conduct work activities near unguarded electrical conductors or circuit parts provided they are trained to recognize and avoid the specific electrical hazard to which they may be exposed (e.g., working behind control room panel boards, taking readings, adjusting radiological chart recorders). These personnel are considered specific task workers (STWs) and must meet the applicable training requirements and must wear the proper PPE. Completion of training as an STW associated with a specific work area or equipment does not qualify a person to work in other areas or on other equipment with electrical hazards they have not been trained to recognize and avoid.

Observation by personnel not performing "hands-on" work may be initiated without arc flash PPE if all of the following conditions are met:

- The equipment cover or door is opened by personnel observing all the requirements of this procedure.

- The observer remains outside the arc flash boundary, if the equipment has not been placed in an electrically safe work condition, for the entire observation period.

- Opening the hinged outer door to a power or lighting panel, switchgear or other equipment that only provides access to switch handles, instrumentation or dead front components and does not expose the worker to live parts does not require any arc flash PPE.

All applicable site and area safety rules must be followed. If there is doubt about what rules exist or their interpretation, or if more information is needed, the employee must call a time-out and contact the Facility Shift Manager before proceeding with the job.

When working on one conductor, make sure that other nearby conductors have also been tested to determine if they are energized. All terminals, conductors and other unguarded live parts of the electrical circuitry which could be contacted (purposely or accidentally) by body parts, tools or equipment while doing the planned work must be tested using an approved voltage tester before the job begins.

When electrical equipment appears to be defective, it shall be removed from service as soon as reasonably possible. The power to the equipment shall be de-energized and locked out before making any attempt to operate or repair it. All repairs to electrical devices or equipment shall be performed by a QEW. If energized troubleshooting is determined to be necessary, go back for a work package that specifically addresses troubleshooting.

Non-conductive safety glasses are always required when doing any electrical work at all voltages.

When hoods or face shields are used, safety glasses shall always be worn under them.

Watchbands, bracelets, rings, key chains, necklaces, cloth with conductive thread, or metal frame glasses shall not be worn where they present an electrical contact hazard with unguarded live parts. In cases where there are small, conductive components on apparel that is otherwise non-conductive, the supervisor and employee evaluate such conditions before beginning any work.

QEWs and operations personnel shall be aware of the final established boundary distance and ensure that unprotected persons near the work area are not allowed to cross the boundary. The established boundary shall be sufficient to ensure that the qualified worker(s) are not distracted from their work assignment(s) to maintain the integrity of this boundary. A physical boundary is preferred; however an attendant may be assigned to maintain the boundary integrity if that is not feasible.

9.2 Pre-Job Briefing

A pre-job briefing is required and important for all electrical work. Before starting each electrical job, a pre-job briefing must be conducted with all employees who will be conducting tasks in the work package. The electrical pre-job briefing will include:

- Electrical hazards included with the work task
- Other hazards associated with the work task
- Procedures that must be followed
- Work rules (two person rule, safety watch)
- Special tools or test equipment to be used
- Any special precautions that are required by the working conditions
- Where and how to remove the source(s) or electrical energy
- Verification requirements
- Location of the nearest AED
- Required PPE and protective clothing
- Any other work that will be going on in the immediate physical area
- Other work associated with the same electrical circuits or equipment
- Discussion of boundaries, and any other controls in place for the work tasks
- Review of the JHA

The above requirements for electrical are in addition to the pre-job briefing requirements that apply to all pre-job briefing. Those are located in WP 04-AD3030, *Pre-Job and Post Reviews*.

9.3 Use of equipment

All test equipment and portable electrical equipment must be either NRTL listed or approved per the process in this Manual for the application and environment before being used.

Refer to NFPA 70E 110.9 for general safety-related work practices for test instruments and portable electric equipment. This includes the requirements for rating, design, and visual inspection before use. The visual inspection and operation verification steps must be included in the work package. For operation verification, when test instruments are used for the testing for the absence of voltage on conductors or circuit parts operating at 50V or more, the operation of the test instrument shall be verified before and after an absence of voltage test is performed.

9.4 Continual Confirmation of Safety

Throughout the electrical work, all workers are responsible for assuring that work is proceeding safely. Changes in the state of the work might include:

- New hazards are found that are not under work control.
- The state of the system.

- Workers change (a new shift).
- New workers appear on the job.
- Work changes in a way that might introduce new hazards.
- Potential for Unexpected Discovery of Electrical Hazards.

When an unknown electrical hazard may exist (e.g., during penetrations into walls, ceilings, floors, or excavations into masonry surfaces, slabs, ground surfaces, or other structures) the work package must contain any as-built drawings and signature that a walk-down of the job site was conducted (e.g., planning walkdown, JHA/HIS, etc.). Provisions of WP 12-IS.01-14 shall be followed. If the work package is authorized and released, work begins, and there is discovery of an unplanned electrical hazard, employee must stop work, and call the CMR. The protective barrier must be maintained around the location until the Facility Shift Manager provides further direction.

10.0 PROVIDE FEEDBACK AND CONTINUOUS IMPROVEMENT

The WIPP electrical safety program will be assessed, measured, and monitored in accordance with the following program controls.

10.1 Quality Assurance

WP 13-1 contains the NQA-1 requirements implemented at the WIPP to assist in ensuring the quality of supplied equipment, components, and supplies to protect workers conducting electrical work. The requirements for inspectors are also contained in WP 13-1, as well as expectations for meetings the requirements of DOE Orders, standards, and codes.

10.2 Inspections

Electrical Inspectors are expected to be qualified per the requirements in:

- National Electrical Code (NFPA 70).
- Standard for Electrical Safety in the Workplace (NFPA 70E).
- National Electrical Safety Code (ANSI C2).
- 29 CFR Part 1910, Subpart S.
- 29 CFR Part 1926, Subparts K and V.

Inspections are to be conducted in accordance with 29 CFR Part 1910, Subpart S, and the requirements referenced in other sections of this manual. Inspection records will be maintained in the inspector's department files.

10.2.1 Requirements for Electrical Inspection

The inspection of electrical equipment and installations includes (but is not limited to):

- Facility inspection by an authorized electrical inspector or management-designated competent person during or after construction, and modification by maintenance involving electrical systems and/or electrical equipment.
- External inspections, as required, of any electrical equipment for listing, damage, or modification by any worker.
- External and/or internal inspection of unlisted electrical equipment for approval review as requested by ESC.
- Pre-job inspection as determined by the initial ES&H package review as part of the work package review for modification work package, to ensure that adequate engineered controls are in place and have been approved by ES&H. Pre-job inspection will be conducted by the electrical inspector for all EEWPs.
- The annual ISM review includes selected post job inspections to ensure that the engineered controls were adequate and that the controls as applied to future work were not damaged or modified.
- Grounding equipment, cables, clusters, and sticks, are inspected annually and prior to each use.

10.3 Annual Assessments

10.3.1 Lockout/Tagout Assessment

The annual LO/TO assessment will be conducted by Operations annually to meet the requirements in OSHA, and copies will be sent to ES&H and Performance Assurance for trending.

10.3.2 Electrical Safety Program Assessment

The ES&H senior manager is responsible for the electrical safety program annual assessment. The EFCOG/DOE Electrical Safety Assessment Document contains guidance and criteria review and approach documents that cover seven different areas in the electrical safety program requirements and expectations. It is anticipated that a portion of these documents will be selected each year (ensuring that the complete program is covered within a three-year timeframe), as part of the annual assessment of the electrical safety program. The annual assessment is also to include the electrical safety program components applicable to NWP employees and subcontractors per 10 CFR Part 851. Results of the annual electrical safety program Assessment will be included in the annual ISM, 10 CFR Part 851, and Voluntary Protection Program assessments and reports as applicable.

To meet various requirements, the following specific assessment actions will be taken annually in conjunction with the appropriate assessments scheduled that year.

- Every hazardous electrical conductor or circuit part that could potentially harm a worker is considered energized until proven otherwise. Surveys will be conducted asking the workers how this is ensured.

- Reenergizing an electrical conductor or circuit part and making it safe to work on is in itself a potentially hazardous task. Workers will be asked how they safely de-energize and verify the electrically safe condition and how they safely reenergize. Workers will be asked to confirm their knowledge and use of appropriately required PPE.

- The employer develops programs, including training, with input from workers and SMEs, and employees apply them. Training records will be reviewed for electrical workers and verified as up to date.

- Managers and supervisors identify the hazards and develop plans to eliminate/control the hazards, with input from workers and SMEs. Sample work packages will be reviewed for adequacy and completeness.

Any additional direction or guidance on electrical safety program assessments received during the year from DOE EM; DOE Health, Safety, and Security; or the Carlsbad Field Office is to be incorporated in the annual assessment plan.

10.4 Deficiencies and Corrective Actions

Deficiencies identified will be entered into the WIPP Form (Issues Management) process with corrective actions assigned according to that process.

10.5 Performance Indicators

10.5.1 Amount of Energized Electrical Work

The following electrical safety performance metrics are to be monitored:

- Data on the number of EEWPs and the quality of information contained. This performance metric is expected to track the amount of energized electrical work.

- Number and severity of occurrence reporting and processing system (ORPS) electrical incidents. The number and severity of ORPS electrical events will be reviewed for trends and individual event significance. Although any recurring causes will be identified.

Additional Performance Indicators will be established on fiscal year annual basis to be used for trending to ensure performance is continuing to improve. These are expected to be leading indicators, and will be established by the ESC.

10.6 Electrical Occurrence Reports

Electrical occurrences, including electrical shocks, shall be reported in accordance with DOE Order 232.2 Occurrence Reporting and Processing of Operations Information, with follow-up actions taken accordingly.

11.0 REFERENCES

The following section includes technical references for further information to assist in interpretation and implementation of this manual as well as specific documents referred to in this manual.

Because all reference materials are periodically revised, the attached references may include dated editions. Refer to the most current edition of each document when using the reference.

REFERENCES	
DOCUMENT NUMBER AND TITLE	KEY STEP
American National Standards Institute	
ANSI C50.13-1989, *Rotating Electrical Machinery*	
ANSI Z87.1-1979, *Practice for Protection Occupational and Educational Eye and Face Protection*	
ANSI Z89.1-1986, *Protective Headwear for Industrial Workers-Requirements*	
American Society for Testing and Materials	
ANSI/ASTM 0120-1987, *Specifications for Rubber Insulating Gloves*	
ASTM 0178-1988, *Specifications for Rubber Insulating Matting*	
ASTM 01048-99, *Standard Specification for Rubber Insulating Blankets*	
ASTM 01049-98, *Standard Specification for Rubber Insulating Covers*	
ASTM 01050-99, *Standard Specification for Rubber Insulating Line Hoses*	
ASTM 01051-02, *Standard Specification for Rubber Insulating Sleeves*	
ASTM F478-02, *Standard Specification for In-Service Care of Insulating Line Hose and Covers*	
ASTM F496-02a, *Standard Specification for the In-Service Care of Insulating Gloves and Sleeves*	
ASTM F696-02, *Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens*	
ASTM F711-02, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*	
ASTM F855-03, *Standard Specification for Temporary Protective Grounds to be Used on De-Energized Electric Power Lines and Equipment*	
ASTM F887-04, *Standard Specification for Personal Climbing Equipment*	
ASTM F1116-03, *Standard Test Method for Determining Dielectric Strength of Overshoe Footwear*	
ASTM F1117-03, *Standard Specification for Dielectric Overshoe Footwear*	
ASTM F1505-01, *Standard Specification for Insulated and Insulating Hand Tools*	
ASTM F1506-02ae1, *Standard Performance Specification for Flame Retardant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards*	

REFERENCES	
DOCUMENT NUMBER AND TITLE	KEY STEP
ASTM F1742-03, *Standard Specification for PVC Insulating Sheeting*	
ASTM F2413, *Standard Specification for Performance Requirements for Foot Protection*	
ASTM PS-57, *Test Method for Determining the Ignitibility of Clothing by the Electrical Arc Exposure Method Using a Mannequin*	
ASTM PS-58, *Test Method for Determining the Arc Thermal Performance (Value) of Textile Materials for Clothing by Electric Arc Exposure Method Using Instrumented Sensor Panels*	
Department of Energy Orders, Manuals, and Guides	
Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities, 2001*	
Manual 440.1-1A, *DOE Explosives Safety Manual*	
Department of Labor-OSHA	
29 CFR Part 1910, "Occupational Safety and Health Standards"	
29 CFR Part 1926, "Safety and Health Regulations for Construction"	
30 CFR Part 57, "Safety and Health Standards-Underground Metal and Nonmetal Mines"	
Institute of Electrical and Electronic Engineers	
IEEE 80-2000, *Guide for Safety in AC Substation Grounding*	
IEEE 141-1993, *IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)*	
IEEE 978-1984, *IEEE Guides for In-Service Maintenance and Electrical Testing of Live-Line Tools*	
IEEE 1100 - *IEEE Recommended Practice for Powering and Grounding Electronic Equipment*	
IEEE/ANSI C-2, *National Electrical Safety Code*	
IEEE C62.11-2008, *IEEE Standard for Metal-Oxide Surge Arrestors for AC Power Circuits*	
Instrument Society of America	
ANSI/ISA-S82.01, *Safety Standard for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment -General Requirements*	
ANSI/ISA-S82.02, *Safety Standard for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment: Electrical and Electronic Test and Measuring Equipment (Partial Revision and Redesignation of ANSI C39.5-1974)*	
National Electrical Manufacturers Association	
NEMA 250-1997, *Enclosures for Electrical Equipment (1000 Volt Maximum)*	
NEMA 280, *Application Guide for Ground Fault Circuit Interrupters, NEMA MG1, Motors and Generators*	
NEMA PB2.2, *Application Guide for Ground Fault Protection Devices for Equipment*	

REFERENCES	
DOCUMENT NUMBER AND TITLE	KEY STEP
National Fire Protection Association	
NFPA 70, *National Electrical Code*	
NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*	
NFPA 70E, *Standard for Electrical Safety in the Workplace*	
NFPA 72, *National Fire Alarm Code*	
NFPA 101, *Life Safety Code*	
NFPA 325, *Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids*	
NFPA 780, *Standard for the Installation of Lighting Protection Systems*	
New Mexico Electrical Code	
Underwriters' Laboratory	
UL 508, *Safety for Industrial Control Equipment*	
UL 745-1, *Safety for Portable Electric Tools*	
UL 1244, *Electrical and Electronic Measuring and Testing Equipment*	
Other Reference Materials	
Cooper Crouse Hinds (CCH Digests)	
EIAITIA-607-1994, *Commercial Building Grounding/Bonding Requirements*	
IEC (6)1010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, International Association of Electrical Inspectors, Soares Book on Grounding*	
Society of Fire Protection Engineers, *Handbook of Fire Protection Engineering*, Third Edition	
Uniform Building Code Chapter 51, 1997	
Referenced Documents	
10 CFR Part 830, "Nuclear Safety Management"	
10 CFR Part 851, "Worker Safety and Health Program"	
29 CFR, *Labor*	
DOE Order 232.2, *Occurrence Reporting and Processing of Operations Information.*	
EA09DC01-5-0, *Excavation and Backfill Permit*	
EA09-DC01-6-0, *Buried Utility Identification*	
MC 6.3.3 *Electrical Safety Committee*	
SDD ED00, *Electrical System (ED00)*	
MW100004 *Portable High Voltage cables (ED10)*	
MW100008, *Grounding of Equipment (Underground)*	
PM000057, *Safety Maintenance Procedures*	
PM025066, *Site Safety Grounding and Lightning Protection*	
PM025089, *Site Grounding Electrode System*	
WP 04-AD3005, *Administrative Control of System Lineups*	
WP 04-AD3011, *Equipment Lockout/Tagout*	
WP 04-AD3012, *Temporary Plant Modification Control*	
WP 04-AD3030, *Pre-Job and Post Reviews*	

REFERENCES	
DOCUMENT NUMBER AND TITLE	KEY STEP
WP 04-CO.01-1, *Conduct of Operations*	
WP 04-CO.01-9, *Conduct of Operations Program-Lockouts/Tagouts*	
WP 04-CO.01-18, *Conduct of Operations Program – Equipment and Piping Labeling*	
WP 04-ED1022, *Ground Fault Circuit Interrupter Testing*	
WP 09, *Conduct of Engineering*	
WP 09-11, *NWP Configuration Management Plan*	
WP 09-CN3007, *Engineering and Design Document Preparation*	
WP 09-CN3021, *Component Indices*	
WP 10-2, *Maintenance Operations Instruction Manual*	
WP 10-5, *WIPP Welding Guide*	
WP 10-AD3005, *Control and Use of Maintenance Locks*	
WP 10-AD3016, *Ladder Control*	
WP 10-WC3010, *Preventive Maintenance Controlled Document Processing*	
WP 10-WC3011, *Work Control Process*	
WP 12-FP.01, *Fire Protection Program Manual*	
WP 12-IS.01-4, *ISP-Emergency and Personal Protective Equipment*	
WP 12-IS.01-5, *ISP-Hazardous Locations and Working Surfaces*	
WP 12-IS.01-6, *Industrial Safety Program - Visitor, Vendor, User, Tenant, and Subcontractor Safety Controls*	
WP 12-IS.01-7, *Industrial Safety Program - General Electrical Safety*	
WP 12-IS.01-7HV, *Industrial Safety Program - Craft Manual - Electrical Safety*	
WP 12-IS.01-14, *Industrial Safety Program – Blind Penetrations*	
WP 12-IS3002, *Job Hazard Analysis Performance and Development*	
WP 13-1, *Nuclear Waste Partnership LLC Quality Assurance Program Description*	
WP 14-TR.01, *WIPP Training Program*	
WP 15-GM.02, *Worker Safety and Health Program Description*	
WP 15-GM.03, *Integrated Safety Management System Description*	
WP 15-GM1002, *Issues Management Processing of WIPP Forms*	
WP 15-PA.01, *Operating Experience/Lessons Learned Program*	
WP 15-PC3609, *Preparation of Purchase Requisitions*	