SAND2012-8505P

FMOC

Specification Section 16475 Primary System Safety Requirements

October 02, 2012

Revision 1

SAND2012-XXXX P

This document has undergone formal review and approval and been reviewed by a Derivative Classifier, and its contents have been deemed unclassified/unlimited release.

Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Change Log

Rev	By	Date	Type	Change Description	Pages Changed
1	EB/LEO	10/02/12	Subst.	Incorporated revisions from Erika Barraza in sections 1.03 part 3. Edited and formatted Specification into FMOC branding. Changed references from PCD-001 to PCD-005 and deleted attachment OP-359, which is a section from PCD-001.	All

CONSTRUCTION STANDARD SPECIFICATION

SECTION 16475

PRIMARY SYSTEM SAFETY REQUIREMENTS

Page

PART 1 - GENERAL 5

1.01 SUMMARY 5
1.02 REFERENCES 5
1.03 SYSTEM DESCRIPTION 6
1.04 QUALITY ASSURANCE 7

PART 2 - PRODUCTS 8

2.01 HIGH VOLTAGE TOOLS AND TESTERS 8
2.03 EYE AND FACE PROTECTION 8
2.04 RUBBER PROTECTIVE EQUIPMENT 9
2.05 GROUNDING CLUSTERS 10
2.07 PROTECTIVE CLOTHING 11

PART 3 - EXECUTION 11

3.01 GENERAL 11
3.02 LOCKING AND TAGGING PROCEDURE 11
3.03 TESTING AND PHASING OF CONDUCTORS 12
3.05 CUTTING INTO CABLE 13
3.06 CONFINED SPACE AND SUBSTRUCTURE WORK 14
3.07 WORK ON ENERGIZED FEEDERS AND EQUIPMENT 14

CONSTRUCTION STANDARD SPECIFICATION

SECTION 16475

PRIMARY SYSTEM SAFETY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. The work covered by this specification consists of the safety aspects of performing operations during the installation or modification of the primary distribution systems. Primary distribution systems are defined as all power systems designed to be operated at more than 600 volts. It describes the minimum requirements necessary for the protection of personnel and equipment. Any additional safety requirements deemed necessary to assure personal safety shall be implemented. In no case will any of the precautions listed herein be deleted without prior approval by the Sandia Delegated Representative (SDR).

B. The requirements listed in this specification have been compiled to help prevent accidents. It is the responsibility of the contractor to ensure their personnel follow all system safety requirements. Specific requirements are listed in this specification for certain procedures. However, due to the nature of many jobs associated with the primary distribution system, not every procedure is described. It is imperative the contractor and their personnel exercise caution and good judgment in maintaining a safe work environment. **No job is so important that it may be performed without due regard for personnel, equipment, and safety.**

C. Related Specification: Section 01065, *Environment, Safety, and Health for Construction and Service Contracts*

1.02 REFERENCES

A. American National Standards Institute (ANSI)

1. Z87.1 Practice for Occupational and Educational Eye and Face Protection

2. Z89.1 Requirements for Protective Headwear for Industrial Workers

B. American Society of Testing and Materials (ASTM)

1. D120 Standard Specifications for Rubber Insulating Gloves
2. D178 Standard Specifications for Rubber Insulating Matting
3. D1048 Standard Specifications for Rubber Insulating Blankets
4. D1049 Standard Specifications for Rubber Insulating Covers
5. D1050 Standard Specifications for Rubber Insulating Line Hose
6. D1051 Standard Specifications for Rubber Insulating Sleeves

1.03 SYSTEM DESCRIPTION

A. Qualified Personnel: All primary system work shall be performed by a qualified, high voltage (HV) contractor, in a manner consistent with this specification. The contractor and his personnel performing such work shall be knowledgeable of the installation and maintenance requirements of primary systems. They shall have HV experience and shall have routinely worked on these types of systems.

1. All contractor personnel shall become familiar with this specification, the referenced documents, and all state and municipal safety regulations as applicable.

2. The contractor shall designate an employee as Safety Officer on the work site who shall be responsible for implementation and supervision of all health, safety, environmental, and fire protection regulations. The requirements of Section II, *Standard Terms and Conditions for Fixed Price Construction Contracts* shall be included in with safety requirements listed in this specification.

3. The contractor doing the HV work must meet the certification requirements per Sandia Construction Specification 16001, *Electrical Work*, section 1.05.

B. Outage Coordination Meetings: The contractor and associated subcontractors shall attend outage coordination meetings for each and every scheduled outage associated with his/her work. A step-by-step outage procedure, including safety precautions, will be discussed at the outage coordination meeting. The contractor will be notified to attend the outage coordination meeting by the SDR.

C. Outage Notification: The SDR has a calendar of scheduled primary system outage dates. The contractor shall review these dates with the SDR and notify the SDR in writing no less than 21 days prior to the next available outage date. (This is not a guarantee the outage will occur on that date.)

D. Work Related Equipment:

1. The contractor shall furnish all the safety equipment to properly perform the work in a reliable and safe manner. The contractor shall furnish all equipment, including, but not limited to, material, personal safety equipment, plywood, barricades, warning lights, grounding clusters, "GROUND CLUSTERS INSTALLED" signs, blowers, oxygen and combustible gas monitor, generators, fire extinguishers, tools, and testers in accordance with this specification, and as required to complete the work.

2. To avoid nonproductive outages, cancellation of outages, or delays during outages, the contractor shall submit evidence to the SDR that he/she has all of the equipment and safety items available at the work location required for the primary system work. This evidence will be required prior to the written outage notification.

3. It is the contractor's responsibility to maintain his equipment in a safe working condition and to ensure the equipment has been properly and routinely tested to meet and/or exceed the operations for which they were designed. At a minimum the equipment shall be inspected and tested under the conditions and at the intervals stated in the standard specification that governs the equipment's particular use.

4. All equipment shall be used per the manufacturers' instructions.

1.04 QUALITY ASSURANCE

A. The latest issues of the following documents form a part of this specification as they apply to safety.

1. American National Standards Institute (ANSI)

2. American Society for Testing and Materials (ASTM)

3. National Electrical Code® (NEC) (NFPA© 70)

4. National Electrical Safety Code® (NESC)

5. National Fire Protection Association Standards (NFPA 70E)

6. Occupational Safety and Health Act (OSHA)

PART 2 - PRODUCTS

2.01 HIGH VOLTAGE TOOLS AND TESTERS

A. HV tools, testers, and their accessories shall be rated for the circuits and equipment to which they will be connected, and shall be suitable for the environment in which they will be used. Capacitive-type testers, which give a discrete analog or digital voltage reading, and are rated for the circuit voltage being tested, shall be used to test Elastimold® T-splices, and other non-shielded points, where no means exist to directly connect testers to the circuit being tested. The tool must be able to test phase-to-phase and phase-to-ground conditions. Ross Engineering Corp. High Voltage AC Voltmeter, Model VM 50D (Digital) or VM 50E (Analog) fulfill these requirements. The contractor shall check for proper operation of the test equipment immediately before and immediately after the test. If a known test source is not readily available, the contractor shall have the appropriate "test-tester" to check for proper operation of the tester.

2.02 PROTECTIVE HEADWEAR

A. Head protection shall be worn while in and working below the bucket of a bucket truck or aerial lift, when working in a substation yard, and when working inside a confined space. Hard hats shall comply with ANSI Z89.1, "Requirements for Protective Headwear for Industrial Workers". Hard hats shall be Class E minimum for work on primary systems. Class E hard hats are intended to reduce the force of impact of falling objects and to reduce the danger of contact with exposed high-voltage conductors. Representative sample shells are proof-tested at 20,000 volts phase-to-ground. Personal protective equipment (PPE) shall comply with NFPA 70E, Table 3-3.8 "Standards on Protective Equipment".

B. **Note:** This voltage is not intended to be an indication of the voltage at which the headgear protects an individual. Hard hats shall be labeled on the inside of the shell to indicate compliance with this standard. This labeling shall contain the name of the manufacturer, the ANSI designation, and the class of the hard hat. The head protection shall be examined by the craftsman for chips, cracks, and any flaws in the material or workmanship prior to each use.

2.03 EYE AND FACE PROTECTION

A. Protective equipment for the eyes or face shall be used where there is danger of injury to the eyes or face from electrical arcs or flashes, or from flying objects or falling objects from an electrical explosion. Eye and face protective equipment shall comply with ANSI Z87.1, "Practice for Occupational and Educational Eye and Face Protection." All protectors shall bear a legible and permanent "Z87" logo to indicate compliance with this standard. If the eye or face protection devices exhibit broken parts, heat distortion, or excessive scratches on the lens, it shall not

be used. PPE shall comply with NFPA 70E, Table 3-3.8 "Standards on Protective Equipment."

2.04 RUBBER PROTECTIVE EQUIPMENT

A. This section lists the requirements for rubber protective equipment used for protection of workers from accidental contact with energized electrical conductors, equipment, or circuits. This includes, but is not limited to, **rubber insulating blankets, rubber insulating covers** (including insulator hoods, dead-end protectors, cable end covers, and miscellaneous covers), **rubber insulating line hose, rubber insulating matting** (for use as a floor covering), **rubber insulating sleeves, and rubber insulating gloves.** Rubber protective equipment shall be Class 1 minimum for work on circuits up to 5,000 volts phase-to-phase (Class 1 rubber protective equipment is rated for a maximum use voltage of 7,500 volts phase-to-phase, however, as an added safety factor this equipment shall not be used on circuits above 5,000 volts phase-to-phase). Class 2 rated rubber protective equipment is required for work on circuits from 5,001 volts phase-to-phase to 15,000 volts phase-to-phase (Class 2 rubber protective equipment is rated for a maximum use voltage of 17,000 volts phase-to-phase; however, as an added safety factor, this equipment shall not be used on circuits above 15,000 volts phase-to-phase). Rubber protective equipment shall comply with the following applicable specifications:

1. Blankets: ASTM D1048-1999, Standard Specification for Rubber Insulating Blankets

2. Hoods: ASTM D1049-1998, Standard Specification for Rubber Insulating Covers

3. Line Hoses: ASTM D1050-1990, Standard Specification for Rubber Insulating Line Hose

4. Mats: ASTM D178-2001, Standard Specification for Rubber Insulating Matting

5. Sleeves: ASTM D1051-1995, Standard Specification for Rubber Insulating Sleeves

6. Gloves: ASTM D120-1995, Standard Specification for Rubber Insulating Gloves.

B. **Note: Leather protectors shall be worn over rubber insulating gloves at all times.**

C. Rubber protective equipment shall be marked clearly and permanently with the name of the manufacturer or supplier, the appropriate ASTM specification, type,

class, and shall comply with ASTM standards for testing and testing intervals. PPE shall comply with NFPA 70E, Table 3-3.8 "Standards on Protective Equipment."

2.05 GROUNDING CLUSTERS

A. Grounding clusters shall have ground clamps that are designed specifically for grounding the intended equipment. All ground clamps shall have been electrically tested by the grounding equipment manufacturer for its intended use. The contractor shall provide the manufacturer's certified test data upon request.

B. Grounding clusters for three-phase live front equipment shall be assembled per the manufacturer's recommendations of 6 foot (1.829m), No. 2/0 American Wire Gauge (AWG) copper ground cables, terminal block, and ground clamps. The cluster shall be rated at 21,000 Amps for 15 cycles minimum. Hastings Fiber Glass Products, Inc. grounding equipment catalog No. 6718 meets these requirements.

C. Grounding clusters for three-phase overhead conductors shall be assembled of a 3-wire ground cluster with C-Head ground clamps utilizing pressure type-bolted terminals and 6 foot (1.829m) by 1-½ inch (38.1 mm) fiberglass poles. The cluster shall be rated 21,000 Amps for 15 cycles minimum. Hastings Fiber Glass Products, Inc. grounding equipment catalog No. 11196 meets these requirements. Interconnect ground cluster and C-Head ground clamps with No. 2 AWG (minimum) copper welding conductor, length as required to properly ground the system being worked on.

D. Grounding clusters required for other equipment not listed herein (i.e. live-front and dead-front: Transformers, switchgear, panelboards, and switchboards) shall have ground clamps specifically designed for the intended equipment. These clusters shall be rated at 21,000 Amps for 15 cycles minimum.

2.06 HOT STICKS AND SHOT GUNS

A. Hot sticks and shot gun (insulating devices) shall be used to maintain the necessary distance between the electrician and the energized circuit or equipment (consider every circuit energized until it has been tested, locked, tagged, and grounded). The hot stick and the shot gun shall have a minimum rating for the voltage being worked on.

B. Hot sticks and shot guns shall be visually inspected for:

1. Cracked or distorted end fittings

2. Hairline cracks or scars in the insulation

3. Blisters in poorly applied coatings that could trap moisture

4. If any of these conditions or other deficiencies are observed, the equipment shall not be used.

2.07 PROTECTIVE CLOTHING

A. Protective clothing shall be used and selected in accordance with the requirements identified and in accordance with NFPA 70E, latest edition, Part II Chapter 3.

PART 3 - EXECUTION

3.01 GENERAL

A. No electrical work shall be performed on energized circuits unless specified on the contract drawings and as specified herein. Consider every circuit as energized until it has been locked out, tagged, tested, and grounded.

B. In addition to the requirements listed in this section the contractor shall strictly follow the requirements of NFPA 70E, latest issue, "Electrical Safety Requirements for Employee Workplaces."

C. Two qualified HV journeyman electricians with valid NMCID EL1-J certification who work for a contractor are required for all energized HV operations.

D. The contractor shall not (except for a safety emergency) de-energize any portion of the HV system that will cause an outage to any SNL facility. SNL maintenance personnel will perform all switching.

3.02 LOCKING AND TAGGING PROCEDURE

A. This section describes the procedure for locking out power systems for the protection of personnel and equipment. In addition, the requirements of NFPA 70E, Part II, Chapter 5, "Lockout/Tagout Practices and Devices" shall be strictly followed.

B. **Note: When working with SNL personnel it is the responsibility of the contractor personnel to become familiar with SNLs PCD-005, *Performing Lockout/Tagout (LOTO)*.**

C. The SNL Maintenance organization will disconnect all power at its closest disconnect means.

D. A positive means of locking out all power at their points of disconnect shall be provided. Locks shall be used by all personnel who could be endangered by the energization of equipment they are working on or near. Padlocks shall be installed

at each disconnect point prior to the time of work on the de-energized equipment. Each person shall attach his personal lock so he/she is assured the system is locked out. The locks shall be installed such that the system cannot be re-energized until all locks have been removed. If controls are located or designed to accommodate only one lock, a multiple-locking clasp shall be used.

E. Lockout tags listing the name and phone number of the individual authorized to place and remove the lock, date service was locked out, and why service is locked out shall be affixed at each lockout location. The lockout tags will be used only to supplement the lockout and identify the purpose. They shall not be used as a substitute for a lock.

F. Removal of a lock and tag shall be done only by the person who installed the lock and tag unless otherwise allowed per PCD-005, *Performing Lockout/Tagout (LOTO).*

G. Locks, lockout clasps, and lockout tags are to be supplied, installed, and removed by the contractor's personnel working on the system.

3.03 TESTING AND PHASING OF CONDUCTORS

A. A minimum of two HV electrical contractor personnel shall be at the specific work location for testing of conductors for energization and for phasing of circuits. The person(s) actually doing the work in this section shall wear the proper voltage rated rubber insulating gloves, eye protection, and protective headwear. Nomex® coveralls or 100 percent cotton clothing is highly recommended for testing and phasing operations.

B. Check to verify test equipment is working properly prior to, and after each use.

C. Test equipment must be rated for voltage being worked on. Test equipment must be tested for proper operation before being used.

D. Always test phase-to-phase and phase-to-ground when testing a circuit or equipment for de-energization. Test all combination of circuit paths each time you test a circuit. Fusing is not a permissible method of testing a circuit for energization.

E. For voltages over 46 kV, use an approved voltage detector and a minimum of two insulating devices (insulated bucket truck and hot sticks) are required.

3.04 GROUNDING OF CONDUCTORS

A. After the "lockout" procedures described in this specification are performed, the procedures in this section shall be followed for all conductors that are to be worked, including new cables not connected.

B. Grounding is required when working on any HV circuit.

C. The grounding of circuits and equipment is essential and no hands-on work on the circuit and equipment shall begin until the circuit and equipment has been de-energized, locked, tagged, tested, and grounded.

D. During the installation of grounding clusters, two qualified journeyman electricians are required when installing grounding clusters, wearing safety glasses, hard hat, and properly rated HV insulated gloves.

E. After the circuit has been de-energized and tested, attach one lead of the approved grounding cluster to the ground bar/conductor and tighten securely. Attach the other clamps to each phase using a shot gun if possible, and tighten securely.

F. After grounding clusters are installed, the contractor shall furnish and place a "GROUNDING CLUSTERS INSTALLED" warning sign in a conspicuous location at the grounding site.

G. When work is complete, remove the grounding cluster and the "GROUNDING CLUSTERS INSTALLED" sign. Using a shot gun, if possible, disconnect the phase connections first, and then remove the clamp from the grounding bar/conductor.

H. If it is determined by the HV crew doing the work and SNL that it is impractical or will present a safety hazard to ground a circuit or piece of equipment, the grounds can be left off but the circuit must then be worked as if it were energized.

3.05 CUTTING INTO CABLE

A. The following steps shall be performed when cutting into cable that cannot be tested, at the specific work location, as being de-energized (for example, a cable that goes continuously through a manhole with no termination point).

B. A minimum of two journeyman HV electrical contractor personnel shall be at the specific work location for this procedure. The person(s) actually doing the work in this section shall wear rated rubber insulating gloves, eye and face protection, and protective headwear.

C. The cable to be cut shall be identified as positively as possible. Lockout, tag, and ground the cable at the point of disconnect according to the requirements of this specification.

D. **Note:** Utilize a suitable penetrating device such as a **spiking clamp**, or a **remote actuated cable cutter** to allow the electrician to remain outside the manhole or confined space while cutting or penetrating the cable.

E. Securely ground the penetrating device with No. 2/0 AWG copper ground cable and a ground clamp to a grounding point.

F. Use hot sticks or appropriate insulating handles to install the penetrating device around the cable and while penetrating the cable. Maintain a safe distance when performing this operation.

3.06 CONFINED SPACE AND SUBSTRUCTURE WORK

A. For the purpose of this specification, confined space is defined as an area large enough and configured in such a way an individual can enter and perform assigned work, has limited or restricted means for entry or exit, and is not designed for continuous occupancy. Confined spaces include, but are not limited to, storage tanks, vessels, manholes, bins, boilers, sewers, utility vaults, tunnels, pipes, pits, vaults, and in some instances, excavations.

B. Requirements for confined space entry that shall apply are detailed under section 01065, *Environment, Safety and Health Requirements for Construction and Service Contracts*.

C. Fall Arrest and Retrieval Equipment: A full-body harness shall not be required when working in an energized electrical manhole. The Confined Space Entry Permit shall list all requirements and exceptions for fall arrest and retrieval equipment. Refer to section 01065, "*Environment, Safety and Health Requirements for Construction and Service Contracts*," when fall arrest and retrieval equipment is required.

D. Fire Protection for Confined Space Work: Prior to entering any confined space containing oil-insulated equipment (i.e., transformers, switches), a 20-pound dry chemical fire extinguisher shall be made available outside the entrance. Fires in confined spaces are to be fought from the doorway or area access opening and only with the door or hatch in the open position. Personnel should immediately leave the room or area of a fire after using an extinguisher.

E. Protection of Equipment and Material in Electrical Manholes/Vaults: Contractor personnel shall not climb into or out of substructures by stepping on cable or hangers.

3.07 WORK ON ENERGIZED FEEDERS AND EQUIPMENT

A. If there are no instructions on the drawings detailing work that may be done with energized feeders and equipment, adhere to the following table.

TABLE

Work on Energized Feeders and Equipment in Substructures

	Work Description	*Circuit Status During Work
1.	Checking cable current	E
2.	Inspection of cables and substructure interior	E
3.	Terminating cables into switches	R
4.	Rearranging position of cables on racks	P
5.	Splicing of cables or terminating stress cones	P
6.	Pulling in new cables	D
7.	Pulling out old cables	D
8.	General clean-up of bottom of substructure	E
9.	Pumping out water from substructure	E
10.	Working on substructure cover or ring	E
10.	Taping cables for fire protection	P
12.	Hi-pot testing of cables	P
13.	Labeling cables (if cable rearrangement is required)	P
14.	Labeling cables (if cable rearrangement is not required)	E
15.	Voltage testing of cables for phasing	N1

*CIRCUIT STATUS LEGEND

E All cables may be energized during all work.

P Only cables being worked on shall be de-energized.

R All cables attached to equipment being worked on shall be de-energized.

D Plywood (¼-inch minimum)or rubber blankets may be installed to protect existing cables when installing new cable without de-energizing the existing feeders. Factors to be considered include, but are not limited to, manhole size, and location of rigging equipment.

N1 Only feeders that are being phased will be re-energized.

END OF SECTION