



Specification Section 13100 Lightning Protection

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**Sandia
National
Laboratories**



U.S. DEPARTMENT OF
ENERGY



CONSTRUCTION STANDARD SPECIFICATION

SECTION 13100

LIGHTNING PROTECTION

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Change Log

Rev	By	Date	Type	Change Description	ID
1	EB/KLB	5/4/12	Subst	Revised referenced standard drawings and other references, removed UL certification from Submittals section, revised Quality Assurance, Products, and Execution sections to better comply with current requirements. Added a reference to newest SNL Explosives Manual.	

CONSTRUCTION STANDARD SPECIFICATION

SECTION 13100

LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes furnishing and installing a complete lightning protection system or modifications to an existing lightning protection system in accordance with the standards and codes specified and as shown on the Sandia National Laboratories (SNL) furnished drawings. An integral system is required, consisting of air terminals mounted directly on the structure to be protected.
- B. When specifically requested in the contract documents, shop drawings showing the complete installation shall be furnished as part of the scope of work in lieu of the SNL drawings. Drawings shall be created using Intergraph Microstation format according to SNL CADD standards.
- C. This specification is applicable to structures (including buildings) handling or storing explosives, flammable vapors and gases or liquids that can give off flammable vapors, radioactive material, and other hazardous materials.
- D. Periodic maintenance and testing of an existing lightning protection system are not covered by this specification.
- E. The lightning protection work shall be coordinated with electrical grounding requirements and supplemental surge protection of electrical service(s), telephone service, antenna cables, etc.
- F. Related Sections - Refer to the following sections for related work:
 - 1. Section 02200, "Earthwork" for excavation and backfilling for counterpoise and buried conductors.
 - 2. Section 16001, "Electrical Work".
 - 3. Section 16289, "Surge Protection Devices"
 - 4. Standard Drawings:
 - a. AE5014STD, "Lightning Rod Roof Mounting"
 - b. AE5015STD, "Lightning Rod Cable Roof Mounting"
 - c. ES7004STD, "LPS Test Well Detail"

- G. Alternate lightning protection design approaches such as "dissipation array" and "early streamer" systems are not acceptable.
- H. Mast/overhead shield wire (catenary) systems shall be installed only when specifically mandated in contract documents. (Note: Normally these will only be installed with structures containing explosive or flammable materials.)

1.02 REFERENCES

Comply with the following applicable standards and codes:

- A. All structures:
 - 1. Department of Energy (DOE)
 - a. DOE O 420.1A – Facility Safety
 - b. DOE G 420.1-1 – Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide
 - 2. National Fire Protection Association (NFPA®)
 - a. NFPA 70 - National Electrical Code (NEC)
 - b. NFPA 780 - Lightning Protection Code
 - 3. Underwriters Laboratories Inc. (UL)
 - a. UL 96 - Standard for Lightning Protection Components
 - b. UL 96A - Standard for Installation Requirements for Lightning Protection Systems
 - c. UL 467 - Standard for Electrical Grounding and Bonding Equipment
- B. Additional requirements for structures containing explosives:
 - 1. U.S. Army
 - a. AMC-R 385-100, Chapter 8, Lightning Protection - Army Material Command "Safety Manual"
 - 2. Department of Defense (DOD)
 - a. DOD 6055.9 - STD, Chapter 7, Lightning Protection - Ammunition and Explosive Safety Standards
 - 3. Department of Energy (DOE)
 - a. DOE M 440.1-1 - DOE Explosives Safety Manual
 - 4. Sandia National Laboratories
 - a. MN471011, SNL Explosives Safety Manual

- C. Additional requirements for the handling of flammable or combustible liquids, combustible solids and dusts, and manufacture of organic coatings:
 - 1. International Fire Code Institute (IFCI)
 - a. Uniform Fire Code, Article 50.
- D. Additional requirements for Telecommunications, Alarm, and Automatic Data Processing Centers, and Radio Repeater Stations:
 - 1. Department of Defense (DOD)
 - a. MIL-HDBK-419: Military Handbook - Grounding, Bonding, and Shielding for Electronic Equipments and Facilities
 - 2. Department of Commerce
 - a. FIPS PUB 94: Federal Information Processing Standards Publication "Guideline on Electrical Power for ADP Installations".
- E. Where differences arise between the specified standards and codes, the installation shall comply with the more rigorous and demanding requirements, whether or not shown on the drawings. Similarly, comply with the more stringent requirements of this specification and drawings.

1.03 SYSTEM DESCRIPTION

- A. The extent of lightning protection work is indicated and detailed on drawings (if furnished), and by requirements of this specification. The types of lightning protection system components specified include the following:
 - 1. Conductors
 - 2. Air terminals
 - 3. Connectors
 - 4. Splicers
 - 5. Ground rods
 - 6. Bonding plates
 - 7. Ground Test Wells
- B. New Construction: Protect the entire building (or structure) including roof projections, chimneys, exhaust stacks, vents, antennas, roof-mounted equipment, ladders, cranes, cooling towers, and equipment or structures adjacent to the building.
- C. Existing Buildings and Structures: Modify the existing lightning protection system so additions to roof-mounted equipment and such are protected. For equipment removals and similar modifications ensure that main roof conductors are continuous and have at least two horizontal and downward paths to connections at

the counterpoise. When equipment is added to roofs and protected such that nearby air terminals now fall within the zone of protection of the new items, remove the older items and insure the crossleads and downloads remain serviceable.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with the conditions of the Contract and Section 01300, "Descriptive Submittals".
- B. Product data: Submit product data for each component. Include data for roof adhesive when used. Where applicable, also include recommended method(s) of installing air terminals, conductors, etc., to single-ply membrane roofs. (Note: This applies to new roofs. For existing roofs follow SNL specifications and procedures.)
- C. Shop Drawings: Submit scaled drawings of the lightning protection system and components for approval. Show conductor routing and accessories layouts including accessible ground wells and ground rods, counterpoise, air terminals, splicers, fasteners, and connectors.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lightning protection equipment, of types and sizes required whose products have been in use for not less than 3 years. All components of the lightning protection systems shall be new and suitable for the application in accordance with the specified standards and shall be UL listed and labeled.
- B. Installer's Qualifications: At least three years of successful installation experience on projects with lightning protection work similar to that required for this project shall be required. The installer shall be a current UL-listed company.
- C. All lightning protection systems inspections will be conducted by the Sandia Construction Observer. Do not conceal any portion of the lightning protection system, including counterpoise and reinforcing steel bonding, until approved by the Sandia Construction Observer.
- D. Field Measurements
 - 1. Resistance-to-ground measurement shall be made using the "three point" or "fall of potential" method.
 - 2. Measurements shall be taken for all new lightning protection systems at new or existing structures to confirm that the resistance-to-ground is not greater than 25 ohms.
 - 3. The resistance of required bonds shall not exceed 1 ohm.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle lightning protection components carefully to avoid damage. Do not install damaged components; replace and remove damaged units from project site. Store components in original wrappings and protect from dirt, weather and construction work traffic.

1.07 WARRANTY

- A. Lightning protection equipment shall be guaranteed against defective design, materials, and workmanship for the full warranty time offered by the manufacturer or supplier, but in no case less than one year from the date of system acceptance.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. New Mexico Site Only: Only copper conductors, air terminals, etc., and suitable hardware shall be used. All other SNL sites shall comply with the material requirement of the standards and codes specified in Section 1.02.
- B. For all structures containing explosives or flammable materials, regardless of height, use Class II materials per NFPA 780.
- C. Underground counterpoise conductors shall be bare stranded copper #4/0 AWG minimum (107.20 mm², Class B stranding).
- D. Lead-coated conductors shall be used in atmospheres corrosive to copper.
- E. Air Terminals: Air terminals shall be solid copper, minimum 1/2-inch (12.7 mm) diameter, nickel plated tip, and a minimum of 24 inches (60 cm) long. For corrosive locations (e.g. smoke stacks) use stainless steel air terminals. Air terminals for single-ply roof mounting shall have bases especially designed for this application (see Section 3.02.A.2).
- F. Ground Rods: Ground rod material shall be copper-clad steel or solid copper. Ground rods shall be not less than 3/4" (19.05 mm) in diameter and not less than 10 ft. (3.05 m) long except as noted on the contract documents.
- G. Connectors and Fittings:
 - 1. Use only heavy-duty bronze connectors, splicers, bonding plates, etc., with maximum available contact surface between this hardware and each conductor or equipment. If heavy-duty connectors and fittings are not available from supplier submit alternates for SNL approval before installation.
 - 2. Each conductor shall be held in place with at least two hex head bolts.

3. Bonding plates shall have a minimum of 3 square inches of contact surface.
 4. For pipes, railings, fence post, etc. up to approximately 4.5 inches (11.43 cm) in diameter use heavy-duty bronze pipe clamps, where available, in lieu of bonding straps.
 5. All main size connections shall contact cable for a length of 1.5 inches (3.81 cm) minimum.
 6. Split-bolt type connectors shall not be used.
 7. Connections below grade, other than in test wells, and all inaccessible splices shall use the exothermic welding process or approved irreversible compression method. Where shown on the drawings, exothermic welds and approved compression connections shall be used above grade, particular for connections to building steel and similar items.
 8. Lugs shall be two bolt, two hole.
- H. Test Wells: Test wells shall be rectangular in shape, 12 inches by 17 inches, 12 inches deep with an incidental traffic load rating of 20,000 psi. See standard drawing, ES7004STD "LPS Test Well Detail."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces and conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected. Contact the Sandia Delegated Representative (SDR) for resolution of unsatisfactory conditions.

3.02 INSTALLATION

- A. Ordinary Structures (not associated with explosive or flammable materials, etc.).
1. Install lightning protection systems, including modifications to existing systems, as indicated on the drawings and according to manufacturer's written instructions, UL 96A, and NFPA 780, and other referenced codes and standards.
 2. Install air terminals as high as possible and such that the zone of protection is at least 10 inches (25 cm) higher than the structure, equipment, etc., they are protecting. For air terminals on single-ply roofing use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. (This applies to new roofs; for existing roofs follow SNL specifications and procedures.)

3. A ground loop (counterpoise) and ground rods shall be installed for all new structures which require a lightning protection system. This loop and the top of ground rods shall be installed at least 2.5 feet (0.762 m) deep in soil and between 3 feet (0.9 m) and 8 feet (2.5 m) from the exterior of building or structure. Install marking tape 1 foot (0.30 m) below grade above ground loop. Ground rods shall be installed at all corners of the building or structure and around the building or structure with maximum spacing of 35 feet (10.67m) between ground rods. The minimum separation between any two rods shall be equal to the sum of the rods' length. To reduce resistance-to-ground, unless shown otherwise on drawings, connect reinforcing steel of the concrete slab in contact with soil (or vertical wall when a basement is provided) to the ground loop at each corner of the structure and at intervals of approximately 35 feet (10.67 m) around the structure with a main size conductor. Use exothermic weld connections for connecting reinforcing steel together and to the ground loop. To facilitate ground resistance testing, ground rod test wells shall be installed as shown per section 2.01 (G) of this specification.
4. Install a ground test well (Quazite boxes) at each corner of the counterpoise (4 each minimum) but do not duplicate ground wells required by other Sections. A ground rod shall be installed at each location and installed at a depth of 10 inches below grade (all other LPS ground rods will be installed at depth of counterpoise). A "down lead" from the building LPS system as well as a "pigtail" from the building counterpoise system shall be extended into the test well and terminated at the top of the ground rod utilizing reversible mechanical connectors as shown on the drawing. Each conductor shall be clearly labeled and identified as either "LPS Down-Lead" or "Counterpoise-Pigtail". For buildings with an irregular shape (not having four distinct corners), consult with the SNL designated LPS subject matter expert for quantity and placement of test wells.
5. For concrete structures, bond reinforcing steel to down conductors and roof conductors as required by NFPA 780.
6. Bond all metallic underground services entering the structure, and other underground and above ground metallic objects within 6 feet of the structure, together with the ground loop using the same size of conductor as the ground loop.
7. Do not use the structural steel framework as a main conductor in lieu of a copper down conductor(s).
8. Make the steel framework of buildings or structures electrically continuous by bolting, riveting, or welding the steel frame, unless a specific method is noted on the drawing. Where a water system enters the building, connect the structural steel framework and the water system at the point of entrance by a ground connector. Secure connections to pipes by means of ground clamps with lugs. Secure connections to structural framework by exothermic

welding. Secure all connections between bottom of columns and ground connections to ground loop from not less than one-half of all the columns distributed equally around the perimeter of the structure. When no water system enters the structure, extend ground connections from all steel columns.

9. For externally routed down conductors, protect each conductor from possible damage with an 6 foot-long wooden or PVC pipe protector above grade level. Where conductors are run through metal pipe, or otherwise protected by metal strips, the conductor shall be bonded to each end of the metal pipe.
10. Bond ladders at top and bottom and bond handrails at each end but not more than 50 feet (15.24 m) apart. Protect handrails, ladders, HVAC equipment, etc., with air terminals and main conductors when metal thickness is less than $\frac{3}{16}$ -inch (4.76 mm). If HVAC piping or ducting protrudes outside the zone of protection, bond at bottom of pipe/duct and place air terminal at the top of the pipe or duct.
11. Attach lightning protection components to HVAC equipment and roof and wall metallic items with sheet metal screws. Apply sealant to prevent ingress of moisture around screws. Placement of air terminals on roof equipment is identical to that of roof (e.g. air terminals must be within 2 feet (0.61 m) of the corner of equipment). Connect guy wire supports for exhaust stacks and poles to the lightning protection system at their lower ends.
12. All reinforcing steel in roofs, walls, floors, and slabs of building or structure shall be tied tightly together with metal ties such that they are in electrical contact at least every 3 feet (0.91 m) in each direction. Also, each level of reinforcing steel at roofs, floors, and slabs shall be similarly tied to the reinforcing steel of exterior walls at least every 3 feet (0.91 m) along the length of the wall.
13. Position splices flat with roof surface. Install all LPS components to reduce tripping hazard

B. Structures Containing Explosives, Flammable Materials

1. All foregoing installation requirements for ordinary structures also applies to structures containing explosives, flammable materials, etc., except if modified by the more stringent requirements of the standards and codes specified in Section 1.02B and C. The term structure also applies to vessels, tanks or other containers in which these materials are contained.
2. Install lightning protection systems, including modifications to existing systems, as indicated on the drawings and according to manufacturer's written instructions. Comply with the specific requirements of the standards and codes specified in Sections 1.02 B and C and NFPA 780, Appendix K. A ground loop (counterpoise) is required for all installations.
3. Igloo-Type Magazines: In earth-covered reinforced concrete, igloo-type magazines, make the reinforcing steel electrically continuous by welding

unless a specific method is noted on the drawings. Install a ground loop (counterpoise) with ground rods and connect the ground loop to the horizontal reinforcing rods below the floor line of the wall system as shown on the drawings but not less than two diagonally opposite connections. Make the steel door frame and access panels electrically continuous with the reinforcing steel. Connect the steel door to the steel frame by means of a flexible copper strap or cable equivalent to #2 AWG (33.62 mm²) conductor or greater. (Note: These requirements also apply to above ground "Explosive Storage Magazine Structures".)

- END OF SECTION -