SECTION 26 4115

LIGHTNING PROTECTION for Explosive facilities

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LANL MASTER SPECIFICATION SECTION

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| Rev. 5 Summary of Changes:  To align with ESM Chapter 7 Section D5090 Rev. 6, removed material in NFPA 780, reference to DOE-STD-1212, and calculated values for the soil contact resistance. Deleted chemical ground rods, backfill, test well boxes, testing. Other changes throughout. |

This template must be edited for each project.  In doing so, specifier must add job-specific requirements.  Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.  Once the choice is made or text supplied, remove the brackets.  The specifications must also be edited to delete specification requirements for processes, items, or designs that are not included in the project -- and specifier’s notes such as these.  Editing product info (manuf., M/N) or acceptance of valid substitution requests while meeting required salient features is not a variance unless master states “no substitution.” To seek a variance from requirements in the specifications that are applicable, contact the Engineering Standards Manual Electrical[POC](http://engstandards.lanl.gov/POCs.shtml#elec). Please contact POC with suggestions for improvement as well.  
  
When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General requirements.  
  
Specification developed for ML-4 projects.  For ML-1, 2, and 3 applications, additional requirements and independent reviews should be added if increased confidence in procurement or execution is desired; see ESM Chapter 1 Section Z10 Specifications and Quality Sections.  
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1. GENERAL
   1. SECTION INCLUDES
      1. Provide lightning protection system for structures that are used for the storage or handling of explosives, including the following:

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Edit the following to match project requirements. Use mast or catenary systems to protect above-ground explosives facilities; integral strike termination device systems may be used to protect earth-covered magazines. Ref.: [UFC 3-575-01](https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-3-575-01), Lightning and Static Electricity Protection Systems.

Use “Faraday-like” shield system to protect the interior and contents of all structures that are used for the storage or handling of explosives.

To seek variance from these requirements, contact the ESM Electrical POC or the LANL Lightning Protection SME.

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* + - 1. [Mast] [Catenary] [Integral strike termination device] primary protection system to protect the above-ground structure.
      2. Integral strike termination device secondary protection system to protect earth-covered magazines.
      3. Faraday-like shield system to protect the interior and contents of the structure from high electric fields.
      4. Interconnecting lightning protection conductors.
      5. Grounding and bonding for lightning protection.
      6. Lightning protection grounding electrode system.
      7. Surge suppressors on specified conductors entering, or leaving, the structure.
  1. LANL-PERFORMED WORK
     1. LANL will inspect the lightning protection system for acceptance.
  2. PERFORMANCE REQUIREMENTS
     1. Protect the entire building including roof projections, chimneys, roof-mounted equipment, associated exposed structures, electrical systems, antennas, alarm services, and telecommunications services.
     2. Provide lightning protection system that meets:
        1. NFPA 780, Standard for the Installation of Lightning Protection Systems.  
           Note: Chapter 8 contains the requirements for structures that house explosives.
  3. SUBMITTALS

Submit the following in accordance with project submittal procedures.

* + 1. Action Submittals
       1. Catalog data for each component of the lightning protection system, including data substantiating that material complies with specified requirements. Include data for roof adhesive when used.
       2. Subcontractor certifications for installing lightning protection systems.
       3. Any repairs that have been made to a lightning protection system after inspection.
       4. Final inspection report.
  1. QUALITY ASSURANCE
     1. Engage a qualified installer to provide the lightning protection system. Installer shall have either a current LPI Master Installer certification or current UL listing (Category OWAY) for Lightning Protection Installation. The installer shall have completed not less than 5 lightning protection installations of similar scope to this project.
     2. LANL will inspect the lightning protection system for acceptance in accordance with the contract documents. Provide products that are NRTL-listed to UL 96 for lightning protection use.
  2. SEQUENCING AND SCHEDULING
     1. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection systems, and building finishes.
     2. Coordinate inspections so lightning protection conductors and bonding connections will be inspected and photographically documented before being concealed.

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Edit the following article to match project requirements.

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* 1. Receiving, Storing, and Protecting
     1. Receive, store, protect, and handle products according to NECA 1—*Standard Practices for Good Workmanship in Electrical Construction*.
     2. Handle conductors to prevent nicking, kinking, gouging, flattening, or otherwise deforming or weakening conductor or impairing its conductivity.
     3. Store poles on decay-resistant treated skids at least 1 foot above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
     4. Wood Poles: Do not drag wood poles along the ground. Do not handle with tongs, hooks, or other pointed tools. Do not apply tools to ground line section of poles.
     5. Keep factory applied wrappings on metal poles until immediately before pole installation. Handle poles with web fabric straps.

1. PRODUCTS
   1. PRODUCT OPTIONS AND SUBSTITUTIONS
      1. Alternate products may be accepted, follow Section 01 2500 *Substitution* *Procedures*.
   2. LIGHTNING PROTECTION Material - General
      1. Provide lightning protection materials and components conforming to NFPA 780 and UL 96 - *Lightning Protection Components*.
      2. Provide lightning protection materials that are galvanically compatible with each other and with surfaces on which they are mounted or which they contact. In general use aluminum conductors and fittings. Use copper conductors and fittings where required for galvanic compatibility or as specified on the design drawings.
         1. Metals acceptable for contact with aluminum include aluminum, magnesium, zinc, galvanized steel, stainless steel, lead, and wrought iron
         2. Metals acceptable for contact with copper include copper, nickel, brass, tin, lead, stainless steel, and MonelTM.
         3. Provide conductors with protective coatings or oversize conductors where unusual conditions exist which would cause corrosion of conductors.
      3. Provide lightning protection materials that are protected against deterioration due to corrosive environments at the local point of installation.
         1. Local points of installation where corrosive environments may exist are, but are not limited to, the top of a chimney or vent emitting corrosive gases, or the top of heavy-duty stacks.
         2. Hot-dipped, lead-coated materials are not permitted without prior permission of the LANL AHJ.

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Edit the following article to match project requirements. This paragraph is typically used for modifications to existing systems.

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* + 1. Existing lightning protection material and components meeting the requirements of this Section, and are in visually good condition, may be re-conditioned and re-used in the existing installation only. Re-conditioning includes removal of adhesive, removal of corrosion, and wire brushing contact areas.

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Delete the following article when a “catenary cable system” is not contemplated.

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* 1. Catenary Cable SYSTEM Materials
     1. Catenary Cable:
        1. Provide non-corrosive, copper-coated, high-strength steel cable, conforming to ASTM B228, *Standard Specification for Concentric-Lay-Stranded Copper-Clad Steel Conductors*.
        2. Minimum cable size: 3/8-inch diameter with seven 8 AWG strands. Provide larger cables as indicated on the Drawings.

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The following paragraph specifies wood poles. Other pole materials, such as concrete or metal, may be more appropriate for a particular project. The designer/specification writer should coordinate such issues with the LANL lightning protection SME.

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* + 1. Wood Poles:

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Edit the following to meet project requirements.

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* + - 1. Provide wood poles conforming to ANSI 05.1; treated [Douglas fir] [Southern pine] poles of [minimum length and class indicated]. [ ] feet length minimum, Class [ ] minimum.]
      2. Select poles for straightness. Provide poles that present a neat appearance after installation and do not have sweeps or short crooks exceeding 50 percent of the maximum sweeps or short crooks permitted in ANSI Standard 05.1.
      3. Provide poles that comply with ANSI Standard 05.1 and are machine-trimmed by turning; pressure treated in accordance with AWPA Standards C1 and C4; and are treated with oil-borne preservatives and petroleum conforming to AWPA Standard P9, Type B or D only.
      4. Mark each pole in accordance with the requirements of ANSI Standard 05.1. Locate markings on the face of the pole approximately 10 feet from the butt of the pole. Where specifically approved, the marking on the face of the pole may be at other locations standard with pole manufacturer.
      5. The quality of each pole shall be ensured with “WQC” (wood quality control) brand on each piece, or by an approved inspection agency report.
      6. Provide poles with a 30-degree, one-way roof.
    1. Pole Hardware
       1. Provide pole hardware required for a complete installation.
       2. Finish: Hot‑dipped galvanized after fabrication.
       3. Eye Bolts and Nuts: ANSI C135.4.
       4. Anchor Rods and Nuts: ANSI C135.2.
       5. Bolts and Nuts: ANSI C135.1.
       6. Eyenuts and Eyelets: ANSI C135.5.
       7. Guy Strand: High strength 7-strand steel cable galvanized to ASTM A467, Class A or B. Catenary cable may be used if of suitable strength.
       8. Cable Terminations: Three‑bolt clamp type.
       9. Guy Guards: 8-foot-long plastic, colored yellow.
    2. Anchors and Anchor Rods
       1. Earth anchors shall be of the [8-inch] [ -inch] [8-way expanding] [ ] type, designed for use with [3/4-inch] [1-inch] [ -inch] anchor rods. Rated holding power for the anchors shall be:
          1. Sand: 10,000 lb.
          2. Clay: 18,500 lb.
          3. Hardpan: 26,500 lb.
       2. Anchor rods shall be [3/4-inch] [1 inch] diameter, [8] [10] [ ] feet long, twin-thimble-eye threaded, hot-dip galvanized steel. The ultimate strength of the rods shall be at least [23,000 lb] [ lb]. The threaded end section of the rod shall be at least [3-1/2] [ ] inches long.
       3. Rock anchors shall be [2-1/4] [ ] inches in diameter with [1” x 53”] [ ] anchor rods attached. The anchors shall be designed for installation in a rock hole drilled with a [2-3/8-inch] [ -inch] rock drill. The anchor shall be so designed that, after installation, the anchor will wedge against the rock as tension is applied by the guy.

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Delete the following article when a “lightning mast system” is not contemplated. This article specifies metal or wooden masts. Other mast materials such as concrete may be more appropriate for a particular project. The designer/specification writer should coordinate such issues with the LANL lightning protection SME.

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* 1. LIGHTNING MAST System Materials
     1. Metal Masts:
        1. Furnish metal lightning masts and accessories that comply with requirements indicated on the Drawings and as specified below.
        2. Provide masts that conform to AASHTO LTS-1 - *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.
        3. Provide tapered, round steel masts that are fabricated from tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46 ksi. Poles shall be one-piece construction up to 40 feet in length. Poles over 40 feet in length may be in two sections with an overlapping joint. Provide poles with hot dipped galvanized finish.
        4. Provide mast, reinforced concrete base, and anchorage rated for the indicated height with an 80-mph wind and a 1.3 gust factor.
        5. Provide two sets of welded 1/2-inch NEMA two-hole lug pattern grounding lugs on opposite sides of each mast, 12 inches above the base plate.
        6. Provide masts with anchor type bases and galvanized steel anchor bolts, leveling nuts and bolt covers.
        7. Provide fasteners and other appurtenances fabricated from corrosion resistant materials that are compatible with masts and will not cause galvanic action at contact points.
        8. For each mast, provide a mast-top tenon that is fabricated to support a lightning protection strike termination device and is securely fastened to the pole top.
     2. Wood Masts

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Edit the following paragraphs to meet project requirements.

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* + - 1. Provide wood poles conforming to ANSI 05.1; treated [Douglas fir] [Southern pine] poles of [minimum length and class indicated], [ ] feet length minimum, Class [ ] minimum.]
      2. Select poles for straightness. Provide poles that present a neat appearance after installation and do not have sweeps or short crooks exceeding 50 percent of the maximum sweeps or short crooks permitted in ANSI Standards 05.1.
      3. Provide poles that comply with ANSI Standard 05.1 and are machine-trimmed by turning; pressure treated in accordance with AWPA Standards C1 and C4; and are treated with oil-borne preservatives and petroleum conforming to AWPA Standard P9, Type B or D only.
      4. Mark each pole in accordance with the requirements of ANSI Standard 05.1. Locate markings on the face of the pole approximately 10 feet from the butt of the pole. Where specifically approved, the marking on the face of the pole may be at other locations standard with pole manufacturer.
      5. The quality of each pole shall be ensured with “WQC” (wood quality control) brand on each piece, or by an approved inspection agency report.
      6. Provide poles with a 30-degree, one-way roof.
    1. Pole Hardware
       1. Provide pole hardware required for a complete installation.
       2. Finish: Hot‑dipped galvanized after fabrication.
       3. Eye Bolts and Nuts: ANSI C135.4.
       4. Anchor Rods and Nuts: ANSI C135.2.
       5. Bolts and Nuts: ANSI C135.1.
       6. Eyenuts and Eyelets: ANSI C135.5.
       7. Guy Strand: High strength 7-strand steel cable galvanized to ASTM A467, Class A or B. Catenary cable may be used if of suitable strength.
       8. Cable Terminations: Three‑bolt clamp type.
       9. Guy Guards: 8-foot-long plastic, colored yellow.
    2. Anchors and Anchor Rods
       1. Earth anchors shall be of the [8-inch] [ -inch] [8-way expanding] [ ] type, designed for use with [3/4-inch] [1-inch] [ -inch] anchor rods. Rated holding power for the anchors shall be:
          1. Sand: 10,000 lb.
          2. Clay: 18,500 lb.
          3. Hardpan: 26,500 lb.
       2. Anchor rods shall be [3/4-inch] [1 inch] diameter, [8] [10] [ ] feet long, twin-thimble-eye threaded, hot-dip galvanized steel. The ultimate strength of the rods shall be at least [23,000 lb.] [ lb.]. The threaded end section of the rod shall be at least [3-1/2] [ ] inches long.
       3. Rock anchors shall be [2-1/4] [ ] inches in diameter with [1” x 53”] [ ] anchor rods attached. The anchors shall be designed for installation in a rock hole drilled with a [2-3/8-inch] [ -inch] rock drill. The anchor shall be so designed that, after installation, the anchor will wedge against the rock as tension is applied by the guy.

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Delete the following article when an “integral system” is not contemplated. Integral systems may only be used for underground magazines.

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* 1. System Materials
     1. Strike termination devices (air terminals):

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Edit the following for copper or aluminum material. Care should be taken if specifying copper strike termination devices. Copper devices should not be connected to aluminum conductors due to corrosion, especially from rain runoff. Aluminum components should not be used where embedded in concrete or masonry or attached to a surface coated with alkali-based paint.

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* + - 1. Copper: Provide 1/2 inch-diameter, rounded-tip, solid-copper strike-termination devices.
      2. Aluminum: Provide 5/8 inch-diameter, rounded-tip, solid aluminum strike-termination devices.
      3. Strike-termination device tips shall have a tip radius of curvature of from 3/16 inch to 1/2 inch.
      4. Provide a cast base for each strike-termination device that matches the device material, has a bolted pressure type cable connector, will support the terminal in a vertical position, and is suitable for the surface to which it will be attached.
    1. Conductors

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Edit the following to match project requirements. If structure is more than 75 feet in height, change conductor to Class II material as described in NFPA 780.

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* + - 1. Copper Main Conductor: Provide copper cable with minimum 17 AWG strand size and a minimum cross-sectional area of 57,400 circular mils.
      2. Aluminum Main Conductor: Provide aluminum cable with minimum 14 AWG strand size and a minimum cross-sectional area of 98,600 circular mils.
      3. Copper Bonding Conductor: Provide copper cable with minimum 17 AWG strand size and a minimum cross-sectional area of 26,240 circular mils.
      4. Aluminum Bonding Conductor: Provide aluminum cable with minimum 14 AWG strand size and a minimum cross-sectional area of 41,100 circular mils.
    1. Provide bolted pressure type connectors; finger, crimp, or pressure saddle style cable connectors are not acceptable.
    2. For installations on standing seam metal roofs provide strike termination device bases and cable fasteners that clamp to the standing seams and are compatible with the roofing system and the lightning protection system materials.
    3. Provide cast swivel couplings as required to install strike termination devices vertically.
    4. For installations on membrane roofing or other surfaces that must not be penetrated provide attachments for strike termination device bases and cable fasteners that do not depend on adhesive alone for proper performance.
       1. Provide adhesives for cable fasteners and strike termination device bases that are compatible with surface or roofing material to which bases or fasteners are to be attached.
       2. Provide bases and fasteners that will stay in position and prevent overturning by using gravity or mechanical attachment.
    5. Manufacturers: East Coast Lightning Equipment, Harger Lightning Protection, Thompson Lightning Protection.
  1. GROUNDing System Material

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Edit the following article to match project requirements; delete if not required. A ground ring shall be installed around the structure. Two ground rods shall augment the ring per NFPA 780 8.4.2.2. Test wells serve no purpose in the absence of a testing requirement.

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* + 1. Ground Rods
       1. Provide ground rods as shown on the Drawings.
       2. Furnish ground rods that comply with ANSI C135.30 with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core, approximately 10 feet long, 3/4 inches in diameter.
       3. Manufacturers: Blackburn, Thomas & Betts, Harger.

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Edit the following to match project requirements; delete if not required. In most cases, Chemical Ground Rods should be deleted. A Ring is the preferred method.

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* + 1. Ground Conductor
       1. Provide bare stranded, soft-temper-copper conductor meeting ASTM B8, *Standard Specification for Concentric-Lay Stranded Copper Conductors*.
       2. Provide conductor size as indicated on the Drawings or specified in this Section, 1/0 AWG minimum.
       3. Manufacturers: WYO-BEN Inc., ERICO
  1. Connectors
     1. Bolted Ground Connectors
        1. Provide copper alloy bolted connectors with silicon bronze hardware for making cable connections to pipes, ground rods, exposed structural steel, roof deck, and wall panels.
        2. Manufacturers: Blackburn, Burndy, O.Z.
     2. Exothermic-Weld Connections
        1. Provide molds and welding material in kit form for making exothermic weld connections.
        2. Match mold and weld material to material types, shapes, and sizes to be joined.
        3. Manufacturer: ERICO Cadweld
     3. Compression Grounding Connectors
        1. Provide wrought-copper connectors, terminals, and splices for making compression grounding connections on concentric lay ground electrode cable and bonding connections to reinforcing steel.
        2. Furnish connectors that have been tested successfully according to the requirements of IEEE Std. 837 - *IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding*.
        3. Provide hydraulic compression tools and dies that match the connectors.
        4. Match connector and die size to material shapes and sizes to be joined.
        5. Manufacturer: Blackburn, Burndy

1. EXECUTION

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Delete the following article when existing construction is not affected.

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* 1. EXISTING WORK
     1. Disconnect and remove abandoned lightning protection system components.
     2. Existing lightning protection material and components that meet the requirements of this Section and are in good condition may be re-conditioned and re-used. Re-conditioning includes removal of adhesive, removal of corrosion, and wire brushing contact areas.
     3. Inspect and repair the parts of the existing lightning protection system on the structure that are to remain in service.
        1. Perform continuity tests to verify that lightning grounding electrode system is connected to the electrical system grounding electrode system.
        2. Perform resistance measurements of all bonding connections to verify that the resistance of any object bonded to the existing lightning protection system does not exceed 200 milliohms.
     4. Visually inspect existing surge suppression devices on electrical services, electrical mains, electrical circuits, and communications, alarm, control, and antenna systems for indication of damage. Notify the STR of any missing or damaged surge suppression devices.
  2. EXAMINATION
     1. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.
     2. Verify that power, control, communications, and alarm services and circuits entering the structure are installed underground for not less than 50 ft. from the point they are exposed to lightning.
  3. INSTALLATION–General
     1. Install lightning protection system as specified in this Section, and as shown on the Drawings.
     2. Install lightning protection components according to the manufacturer's written instructions.
     3. Install strike termination devices on ridges, parapets, and around the perimeter of buildings with flat roofs at spacing as shown on the drawings. Install supplemental strike termination devices as shown on drawings. Permanently and rigidly attach strike termination devices to prevent overturning. Install swivel adapters as required to position strike termination devices vertically.
        1. On standing-seam metal roofs use attachments for strike termination device bases and cable fasteners that clamp to the standing seams.
        2. On membrane roofing or other surfaces that must not be penetrated, attach strike termination device bases and cable fasteners using materials and methods that do not depend on adhesive alone for proper performance. Coordinate with roofing material installer.
        3. Acceptable installation methods on membrane roofs include:
           1. Mechanical fastening to nailer blocks that are pre-installed by the roofing Subcontractor. Coordinate locations with the roofing Subcontractor.
           2. Approved top-fill ballast pans (6-inch diameter for strike termination devices and 3-inch diameter for cable fasteners) that are filled with structural-density concrete then attached with adhesive to the membrane roof.
        4. Use adhesives that are recommended by manufacturer of the cable fasteners and strike termination device bases and are approved by manufacturer of the roofing material. Prepare roof surface and apply adhesives according to manufacturer's instructions.
     4. Install roof conductors so they will be visible for inspection and testing.
     5. Install down-conductors at locations compatible with the building structure and architectural design with consideration given to the location of ground connections.
        1. Course exposed down conductors over the extreme outer portions of the exterior of the building, such as corners.
     6. Install an accessible down-conductor disconnect in each down conductor except the one nearest the building electrical service; use 4-bolt, tubular splice fittings.
     7. Cover down-conductors that are subject to physical damage or displacement with Schedule 80 PVC conduit. Cover down conductors from grade level up to 6 ft. above grade. Support conduit with conduit clamps spaced not more than 36 inches apart.

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Edit the following article to match project requirements.

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* 1. LIGHTNING PROTECTION GROUNDING ELECTRODE SYSTEM
     1. Ground Ring Electrode: Install a ground ring around the building or structure. Use minimum 1/0 AWG ground cable located 5 ft. outside the building perimeter and at least 6 ft. from any electrical system or communications system grounding. Install the ground ring at least 3 ft. below grade.
     2. Ground Rod Electrodes: Augment the Ground Ring with two ground rods, at opposite corners.
     3. Connect the lightning ground ring to the electrical grounding electrode system at a point that is outside of the building.

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Edit the following article to match project requirements.

Exothermic-weld connections are not preferred and should only be used when there are no other available means to make the connection.

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* 1. LIGHTNING PROTECTION CONNECTIONS
     1. Clean contact surfaces to which lightning protection connections are to be made. Remove non-conductive coatings such as paint, enamel, and oil film.
     2. Use the following connection methods unless otherwise specified or indicated on the Drawings:
        1. Use bolted connectors for connecting to ground rods.
        2. [Use exothermic-weld connections for underground or concealed connections of dissimilar materials.]
        3. [Use exothermic-weld or compression grounding connections for underground or concealed connections of like materials. Do not use compression grounding connectors for rope lay lightning conductor connections or for lightning protection ground rod connections.]
        4. Use bolted connections for accessible connections where separability is required for future maintenance. Use compression connections for other above-grade joints.
        5. Use high strength silicon bronze bolts, nuts, flat washers and toothed lock washers for making bolted connections.
     3. Tighten lightning protection connectors, screws, and bolts in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B. Use a calibrated torque wrench.
     4. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.
     5. Install exothermic welds in accordance with manufacturer's instructions and recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
     6. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
        1. Use electroplated or hot‑tin‑coated materials to assure high conductivity and make contact points closer in order of galvanic series.
        2. Make connections with clean bare metal at points of contact.
        3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.
        4. Make aluminum to galvanized steel connections with tin‑plated copper jumpers and mechanical clamps.
        5. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
     7. Protect lightning protection connections to prevent them from being painted or covered with material such as fire proofing or roofing adhesive.
  2. SURGE Protective Devices
     1. Refer to Section 26 4300 *Surge Protective Devices*.
  3. FARADAY Shield INSTALLATION
     1. Bond reinforcing steel in floor slab to reinforcing steel in foundation. Bond reinforcing steel in floor slab to reinforcing steel in exterior walls or to metal wall panels. Bond reinforcing steel in exterior walls or metal wall panels to reinforcing steel in roof or to metal roof deck. Distance between bonds must not exceed 36 inches. Use not smaller than 6 AWG bonding conductor and bonding fittings. Reinforcing bar splices that are overlapped at least 20 bar diameters and wire tied are acceptable bonds.
     2. Bond metallic pipe, conduit, duct, and similar entries to the reinforcing steel at the perimeter of the Faraday cage. Distance between bonds must not exceed 36 inches. Use not smaller than 6 AWG bonding conductor and bonding fittings.
     3. Bond door frames to wall and floor reinforcing bars. Bond interval must be 36 inches or less. Use not smaller than 6 AWG bonding conductor and bonding fittings.
     4. Bond doors to door frames. Bond interval must be 18 inches or less along the hinge side. Use tinned-copper braid not smaller than 1 inch wide, 1/8 inch thick. Fasten braid using hex head stainless steel screws threaded into in tapped holes in the doors and door frames.

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Delete the following article when a catenary system is not contemplated.

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* 1. Catenary System INSTALLATION
     1. Install support poles at locations indicated on the Drawings.
        1. Plug unused holes in poles using treated wood dowel pins. Treat field‑cut gains and field‑bored holes with preservative.
        2. Shorten poles when required by cutting from top end. Apply hot preservative to shortened end of pole.
        3. Dig setting holes large enough to permit use of tampers to full depth. Place earth in maximum 6-inch layers and pack to 95 percent density.
        4. Embed poles at depths indicted in Table 1 below.
        5. Rake poles located at corners, angles, and dead ends so that poles are vertical after line installation.
        6. Do not install poles along the edge of cuts and embankments or where soil may be washed out.

**Table 1 - Pole Embedment Depth Requirements (all in feet)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Soil | | Solid Rock | |
| Pole Length | Embedment Depth1 | Pole Top  Height | Embedment Depth2 | Pole Top Height |
| 30 | 5.5 | 24.5 | 3.5 | 26.5 |
| 35 | 6.0 | 29.0 | 4.0 | 31.0 |
| 40 | 6.0 | 34.0 | 4.0 | 36.0 |
| 45 | 6.5 | 38.5 | 4.5 | 40.5 |
| 50 | 7.0 | 43.0 | 4.5 | 45.5 |
| 55 | 7.5 | 47.5 | 5.0 | 50.0 |
| 60 | 8.0 | 52.0 | 5.0 | 55.0 |
| Notes:  1. Soil embedment depths must apply:  a. Where the poles are to be set in soil.  b. Where there is a layer of soil more than 2 feet deep over solid rock.  c. Where the hole in solid rock is not substantially vertical or the diameter of the hole at the surface of the rock exceeds approximately twice the diameter of the pole at the same level.  2. Solid rock embedment depths only apply where the poles are to be set in solid rock and where the hole is substantially vertical, approximately uniform in diameter and large enough to permit the use of tamping bars the full depth of the hole.  3. Mixed: When there is a layer of soil 2 feet or less depth over solid rock, the depth of the hole must be the depth of the soil in addition to the Solid Rock Embedment Depth value.  4. On sloping ground, the depth of the hole must be measured from the low side of the hole. | | | | |

* + 1. Conductors: Install and sag per NESC. Guidance also in ESM [Chapter 7](https://engstandards.lanl.gov/ESM_Chapters.shtml#esm7) Section G4010.
    2. Anchors and Guys
       1. Place anchors in line with strain. The length of the guy lead (distance from base of pole to the top of the anchor rod) shall be as indicated.
       2. Set anchors in place with anchor rod aligned with, and pointing directly at, guy attachment on the pole with the anchor rod projecting 6 to 9 inches out of ground to prevent burial of rod eye.
       3. Complete anchor and buy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section.
       4. Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts shall be M-F style and not Palnut style.
       5. Install a full round bright yellow polyethylene guy guard at least 8 feet long on each guy wire.
    3. Connect each guy wire to the grounding electrode ground ring.

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Delete the following article when a lightning mast system is not contemplated.

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* 1. LIGHTNING PROTECTION MAST Installation
     1. Install lightning protection masts at locations indicated on the Drawings.
     2. Construct concrete foundations with 4000 psi minimum, 28-day concrete and reinforcing per Section 03 3001 Reinforced Concrete. Comply with details on the Drawings and pole manufacturer's recommendations for foundation dimensions, reinforcing, anchor bolts, nuts, and washers.
     3. Cure concrete foundations for 7 full curing days before erecting poles.
     4. Use fabric web slings to raise and set poles.
     5. Torque anchor bolt nuts and other pole hardware as recommended by manufacturer.
     6. After pole is leveled, pack non-shrink grout between anchor base and concrete foundation to provide a full bearing surface.
     7. Install two ground conductors from each mast to the grounding electrode ground ring.

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Use integral systems only for explosives facilities consisting of earth-covered magazines. Delete the following article when an “integral system” is not contemplated.

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* 1. Integral System INSTALLATION on Earth-covered magazine
     1. Where one or more metal ventilator provides a salient point above the structure, install and strike termination device on each ventilator. Connect strike termination devices to the ground ring with at least two horizontal or downward leading main conductors.
     2. On the portal wall install a strike termination device within 2 feet of each end. Install additional strike termination devices do the spacing between strike termination devices will not exceed 20 feet. Connect strike termination devices to the ground ring with at least two horizontal or downward leading main conductors.

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Edit the following to match project requirements. In most cases, 3.12 (B) should be deleted, as it is often not possible to get a meaningful test result after the grounding electrode system has been installed. This is due to the distance requirements for the voltage and current probes of the three-point fall-of-potential testing method.

If the structure that is to be protected is in an area where the grid cannot be effectively tested, an analytical method should be used during the design process to obtain a result in lieu of empirical testing.

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* 1. FIELD QUALITY CONTROL
     1. Inspect the primary protection system to determine:
        1. That all required bonds are in place and are secure.
        2. That the AC power lines, communications, and data lines that enter the facility, as described in NFPA 780, have surge suppression devices that are properly installed.
        3. Take corrective action to correct deficiencies. Provide certified inspection and test results and instrument specifications and calibration information to the LANL STR.
     2. Inspect and document the construction of the Faraday-like shield system(s) as follows:
        1. Make construction photographs showing electrical continuity of walls, floor and ceiling before work is covered with concrete or other building materials.
        2. Request LANL inspection of electrical continuity of walls, floor and ceiling before work is covered with concrete or other building materials.
        3. Make construction photographs (digital preferred) showing bonding of all metallic penetrations of walls, floor and ceiling before work is concealed.
        4. Request LANL inspection of bonding of all metallic penetrations of walls, floor and ceiling before work is concealed.
        5. Take corrective action to correct deficiencies. Provide certified inspection results and construction photographs to the LANL STR.
     3. Inspect and test the Faraday-like shield system(s) to determine:
        1. That there is proper bonding or electrical continuity of the walls, ceiling, and floor by measuring the transfer impedance versus frequency using an appropriate test instrument and procedure.
        2. That there is proper bonding of all conductive penetrations of the Faraday-like shield by inspection of building documentation, inspection of the facility, inspection of construction photographs, and by resistance readings.
        3. That the AC power lines, communications, and data lines, as described in NFPA 780, that penetrate the Faraday-like shield have surge suppression devices that are properly installed.
        4. Take corrective action to correct deficiencies. Provide inspection results to the LANL STR.
     4. A final inspection of the lightning protection system will be conducted by a LANL-approved lightning protection system inspector prior to system acceptance.
     5. Notify the LANL STR 10 working days in advance of the expected completion of the lightning protection system installation. Inspection can be scheduled in parts or by area depending on the system and construction schedule.
     6. Promptly correct all deficiencies, as required by the STR.

END OF SECTION

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Do not delete the following reference information. \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project specification section is based on LANL Master Specification Section 26 4115 Rev. 5, dated April 28, 2023.