

LIGHTNING PROTECTION REQUIREMENTS FOR DOD AMMUNITION AND EXPLOSIVES FACILITIES

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OVERVIEW OF PRESENTATION

- Case for Lightning Protection System (LPS) on Ammunition and Explosives (AE) Facilities
- DOD Criteria for LPS on AE Facilities
- Lightning Protection Principles
- Distinctive AE Requirements
 - Lightning protection systems
 - Inspection and testing
 - Records and training
- Common Deficiencies of LPS Installations



CASE FOR LPSs ON DOD AE FACILITIES

- July 10, 1926, Lake Denmark Naval Ammunition Storage Depot
 - 600,000+ tons explosives
 - 21 people killed
 - About 200 buildings destroyed
 - DDESB established in 1928

- Lightning Incidents to International Arsenals and Storage Depots

- “Properly Maintained LPSs are required for AE Facilities.” DOD 6055.09-M, V2.E4.1. *DOD Ammunition and Explosives Safety Manual.*



DOD CRITERIA FOR LPS ON AE FACILITIES

- DOD 6055.09-M, *Ammunition and Explosives Safety Standards*
 - Applicable to DOD Components
 - Volume 2 contains electrical and LPS safety standards
 - Selects NFPA 780 as the LPS criteria for AE facilities (V2.E4.1.)

- NFPA 780, *Standard for the Installation of Lightning Protection Systems*
 - Industry standard for lightning protection
 - Chapter 4 – General requirements for ordinary facilities
 - Chapter 8 – Protection of structures housing explosive materials

- UFC 3-575-01, *Lightning and Static Electricity Protection Systems*
 - Not specific to AE facilities
 - Applicable to DOD facilities, including AE
 - Applies NFPA 780 as the LPS criteria
 - Directs that a risk assessment per NFPA 780 be performed
 - UL certificate required
 - Air Force requires commercial third-party certificate



DOD CRITERIA FOR LPS ON AE FACILITIES

- DA PAM 385-64, *Ammunition and Explosives Safety Standards*
 - Applicable to Army Components
 - Section IV of Chapter 17 has LPS requirements
 - Implements safety requirements of DOD 6055.09-M

- AFM 91-201, *Explosives Safety Standards*
 - Applicable to Air Force Components
 - Implements in full DOD 6055.09-M

- AFI 32-1065, *Grounding Systems*
 - Applicable to Air Force Components
 - Not specific to AE facilities. Attachment 5 specific to explosive facilities
 - Implements maintenance requirements of DOD 6055.09-M



DOD CRITERIA FOR LPS ON AE FACILITIES

- NAVSEA OP 5, *Ammunition and Explosives Safety Ashore*
 - Applicable to Dept. of Navy Components
 - Distribution to U.S. Government agencies and contractors

- DDESB TP 22, *Lightning Protection for Explosives Facilities*
 - Guidance for installation and maintenance of LPS
 - Provides clarification to DOD 6055.09-M and NFPA 780
 - Authored by DDESB (*Dr. Josephine Covino*)
 - Distribution to U.S. Government agencies and contractors

- Non-DOD LPS Standards for Explosives Facilities
 - DOE Manual 440.1-1A, *Explosive Safety Manual*
 - NASA Standard 8719.12, *Safety Standard for Explosives, Propellants, and Pyrotechnics*



LIGHTNING PROTECTION PRINCIPLES

- No lightning protection system is 100% effective. It is an matter of statistical probabilities and risk management.

- Per NFPA 780, two design methods for protection against lightning.
 - Roof types (cone of protection)
 - Rolling Sphere Method (RSM)

- RSM is widely used and required by:
 - DOD 6055.09-M, V2.E4.2
 - NFPA 780, 8.2.1.
 - DA PAM 385.64, 17-19.*b*.
 - AFMAN 91-201. 5.23
 - NAVSEA OP 5, 6-3.a.



LIGHTNING PROTECTION PRINCIPLES

RSM Principle: The attractive effect of the lightning rod is a function of a striking distance (ds) that is determined by the amplitude of the lightning current.

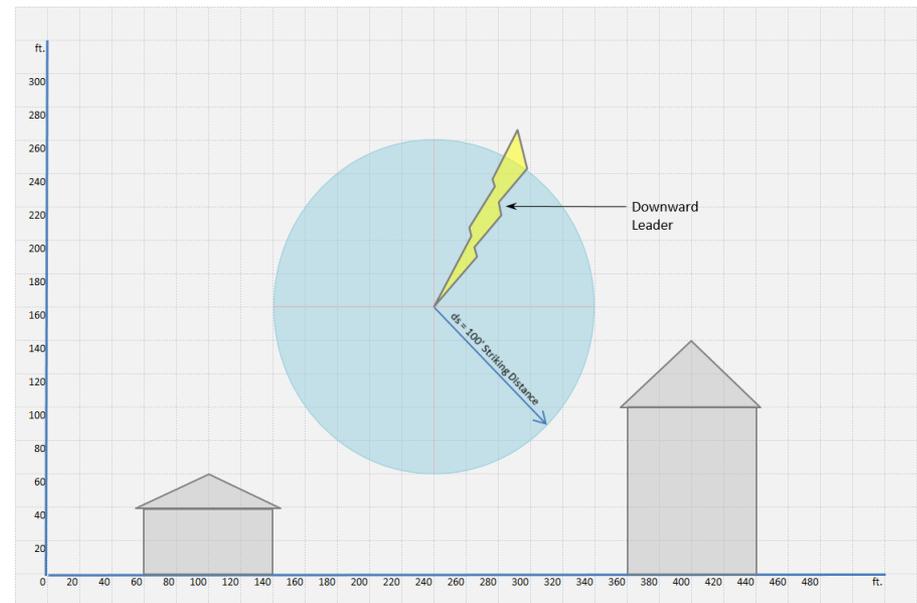
☐ Lightning Strike Magnitudes

- 99% exceed 3,000 A
- 90% exceed 8,000 A
- 50% exceed 28,000 A
- 10% exceed 80,000 A
- 1% exceed 200,000 A

(Per DDESB TP22)

☐ Striking Distance (ds) $r = 10 I_p^{0.65}$

| r | I_p |
|-----|-------|
| 20m | 3kA |
| 30m | 5.4kA |
| 45m | 10kA |
| 61m | 16kA |



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LIGHTNING PROTECTION PRINCIPLES

- Four Protection Levels (IEC 62305-3)

| Level | Min. I_p | % Eff. | RSM |
|-------|------------|--------|---------|
| I | 3kA | 99% | 66 ft. |
| II | 5.4kA | 97% | 100 ft. |
| III | 10kA | 91% | 150 ft. |
| IV | 16kA | 84% | 197 ft. |

- Example: LPS designed to LPL II is expected to intercept all strikes with an amplitude current of 5.4kA or greater. Lightning strikes below 5.4kA may bypass the protection system. So, a minimum current level is selected to achieve the maximum protection. Thus the more stringent requirements to protect against smaller amplitude lightning strikes than larger amplitude strikes.



DISTINCTIVE AE REQUIREMENTS

LPS

| LPS Requirement | Principle Criteria Reference |
|---|--|
| 100 ft. radius zone of protection | DOD 6055.09-M, V2.E4.2. NFPA 780, 8.2.1 DA PAM 385-64, 17-19.b. AFMAN 91-201, 5.23. NAVSEA OP 5, 6-3.a. |
| Power / comm. installed in metallic conduit and run underground 50 ft. before entering the facility <i>(Surge protection normally referenced within the same section is very critical and a requirement for all types of facilities with an LPS)</i> | DOD 6055.09-M, V2.E3.6.2. DA PAM 385-64, 17-26.b. AFMAN 91-201, 5.23.5. AFI 32-1065, 15.1. NAVSEA OP 5, 6-7.2. |
| Above ground metallic utility lines bonded to the structural steel of LPS at entrance to the facility | DOD 6055.09-M, V2.E3.6. DA PAM 385-64, 17-26.d. AFMAN 91-201, 5.23.5. AFI 32-1065, 15.2. NAVSEA OP 5, 6-6.3.3. |
| OH power line distances from AE facilities | DOD 6055.09-M, V2.E3.5. DA PAM 385-64, 8.13 |

DISTINCTIVE AE REQUIREMENTS

LPS

| LPS Requirement | Principle Criteria Reference |
|---|--|
| Ground ring electrode | NFPA 780, 8.4.1 DA PAM 385-64, 17-25. AFI 32-1065, A4.1.15. NAVSEA OP 5, 6-5.1. |
| Ground ring electrode must be sized to Class II material requirements | NFPA 780, 8.4.3 DA PAM 382-64, 17-25. AFI 32-1065, A4.1.15. NAVSEA OP 5, 6-5.1. |
| Railroad tracks must be bonded to the LPS | NFPA 780, 8.5.7 DA PAM 385-64, 17-22.f. NAVSEA OP 5, 6-6.3.1. |
| Metallic access doors and doorframes shall be bonded to the ground ring | NFPA 780, 8.5.5.1 NAVSEA OP 5, 6-6.3.4. |
| Metallic fences must be grounded or bonded to the ground ring electrode | NFPA 780, 8.8.1 DA PAM 385-64, 17-22.e. NAVSEA OP 5, 6-6.3.2. |
| Bonding techniques | NFPA 780, 8.5.4 NAVSEA OP 5, 6-6.1. |
| LPS for earth covered magazines | NFPA 780, 8.7.1 UFC 4-420-01, 3-8.6 DA PAM 385-64, 17-19.g. NAVSEA OP 5, 6-8.2. |



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DISTINCTIVE AE REQUIREMENTS

LPS

| LPS Requirement | Principle Criteria Reference |
|---|--|
| LPS for wharves and piers | NFPA 780, 8.7.2 NAVSEA OP 5, 6-8.2.3.1. |
| LPS inspection certificate by UL or another third-party | UFC 3-575-01, 3-1 |
| Air Force facilities with perimeters larger than 300 ft. and structural steel not used for air terminals must use a mast or catenary type LPS | AFI 32-1065, 14.5. |
| Naval facilities implement a primary and secondary ground system that must be bonded together at two locations | NAVSEA OP 5, 5-5; 6-5. |



DISTINCTIVE AE REQUIREMENTS

Inspection and Testing

| Criteria | LPS Inspection or Test | Intervals |
|---------------------------|------------------------------|--|
| DOD 6055.09-M, V2.E4.3.1. | Visual Inspection | One year or per the DOD Component and approved by DDESB |
| DOD 6055.09-M, V2.E4.3.2. | Electrical Tests | Maximum every two years or per the DOD Component and approved by DDESB |
| NFPA 780, 8.10 | Visual Inspection | Seven months |
| NFPA 780, 8.10.6.3 | Visual inspection of the SPD | Seven months or after any suspected lightning strike |
| NFPA 780, 8.10.7 | Electrical tests | 14 months |
| DA PAM 385-64, 17-28. | Visual inspection | 12 months |
| DA PAM 385-64, 17-28. | Electrical tests | Two years |



DISTINCTIVE AE REQUIREMENTS

Inspection and Testing

| Criteria | LPS Inspection or Tests | Intervals |
|--|--------------------------|--|
| AFMAN 91-201 (per AFI 32-1065, Table 1) | Visual inspection | 1-2 years as determined by MAJCOM EE |
| AFMAN 91-201 (per AFI 32-1065, Table 1) | Visual inspection of SPD | Six months and after a lightning strike |
| AFMAN 91-201 (per AFI 32-1065, Table 1) | Electrical tests | 24 months |
| NAVSEA OP 5, 6-9. | Visual inspection | 6 months (100% of air terminal if integral system) |
| NAVSEA OP 5, 6-9. | Electrical tests | 24 months (20% of air terminals if integral system) |



DISTINCTIVE AE REQUIREMENTS

Records and Training

| Criteria | Records and Training | Duration |
|---------------------------|---|---|
| DOD 6055.09-M, V2.E4.3.3. | Records and test measurements | Kept on file for at least six inspection cycles |
| DOD 6055.09-M, V2.E4.3.4. | Establish training requirements for LPS personnel | N/A |
| NFPA 780, 8.9 | Develop maintenance and inspection plan | N/A |
| NFPA 780, 8.10.7.7 | Document records & test data and available for inspection | Time period acceptable to the AHJ |
| DA PAM 385-64, 17-29. | Maintain inspection and test reports | For the last six inspection cycles |
| AFMAN 91-201, 5.24.3. | Maintain records and test data | For the last six inspection cycles |
| NAVSEA OP 5, 6-9. | Develop inspection and test plan; training for personnel in DOD LPS | N/A |



COMMON DEFICIENCIES

| Common Deficiencies | Principle Criteria Reference |
|--|---|
| SPDs not installed at the facility entrance and exit of power, data and comm. conductors | DOD 6055.09-M, V2.E3.6.1; E4.2.3. UFC 3-575-01, 3-4 NFPA 780, 8.6 DA PAM 385-64, 17-26.a, b. AFMAN 91-201, 5.23.5. AFI 32-1065, 15. NAVSEA OP 5, 6-7. |
| Aboveground metallic utility lines and pipes not bonded to the structural steel before entering the facility, or run underground the last 50 ft. | DOD 6055.09-M, V2.E3.6.1. DA PAM 385-64, 17-26.d. AFMAN 91-201, 5.23.5. AFI 32-1065, 15.2. NAVSEA OP 5, 6-6.3.3. |
| Power, data and comm. lines not run underground the last 50 ft. before entering the facility | DOD 6055.09-M, V2.E3.5.1; 6.2. DA PAM 385.64, 17-26.b. AFMAN 91-201, 5.23.5 AFI 32-1065, 15. NAVSEA OP 5, 6-7.2. |
| Down conductors not secured every 3 ft. | NFPA 780, 4.10 DA PAM 385-64, 17-19.e. |
| Down conductors not protected from physical damage up to 6 ft. above grade | NFPA 780, 4.9.11 AFI 32-1065, A4.1.8. |
| Main conductors bends less than 90 degrees, or have radius less than 8 in. | NFPA 780, 4.9.5 DA PAM 385-64, Table 17-4 AFI 32-1065, A4.1.5. |



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COMMON DEFICIENCIES

| Common Deficiencies | Principle Criteria Reference |
|---|--|
| Metallic doors and doorframes not bonded to the ground ring | NFPA 780, 8.5.5 DA PAM 385-64, 17-22.b.(2) NAVSEA OP 5, 6-6.3.4. |
| Metallic masses within sideflash distance of an LPS component not bonded to the LPS | NFPA 780, 8.5.2 DA PAM 385-64, 17-22.b.(1) NAVSEA OP 5, 6-6. |
| Fences shall be grounded and bonded where within 6 ft. of the AE facility, or within contact distance | NFPA 780, 8.8.1 DA PAM 385-64, 17-22.e. NAVSEA OP 5, 6-6.3.2. |
| Air terminals exceeding 24 in. in height not supplied with additional support | NFPA 780, 4.6.2.2.2 |
| Electrical testing and visual inspection not performed or reports not available | DOD 6055.0-M, V2.E4.3. NFPA 780, 8.10 DA PAM 385-64, 17-28. NAVSEA OP 5, 6-9. |
| UL or third-party certificate does not exist | UFC 3-575-01, 3-1 |
| OH electrical power lines too close to the AE facility | DOD 6055.09-M, V2.E3.5.2. DA PAM 385-64, 8-13 (Table 8-5) |



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COMMON DEFICIENCIES



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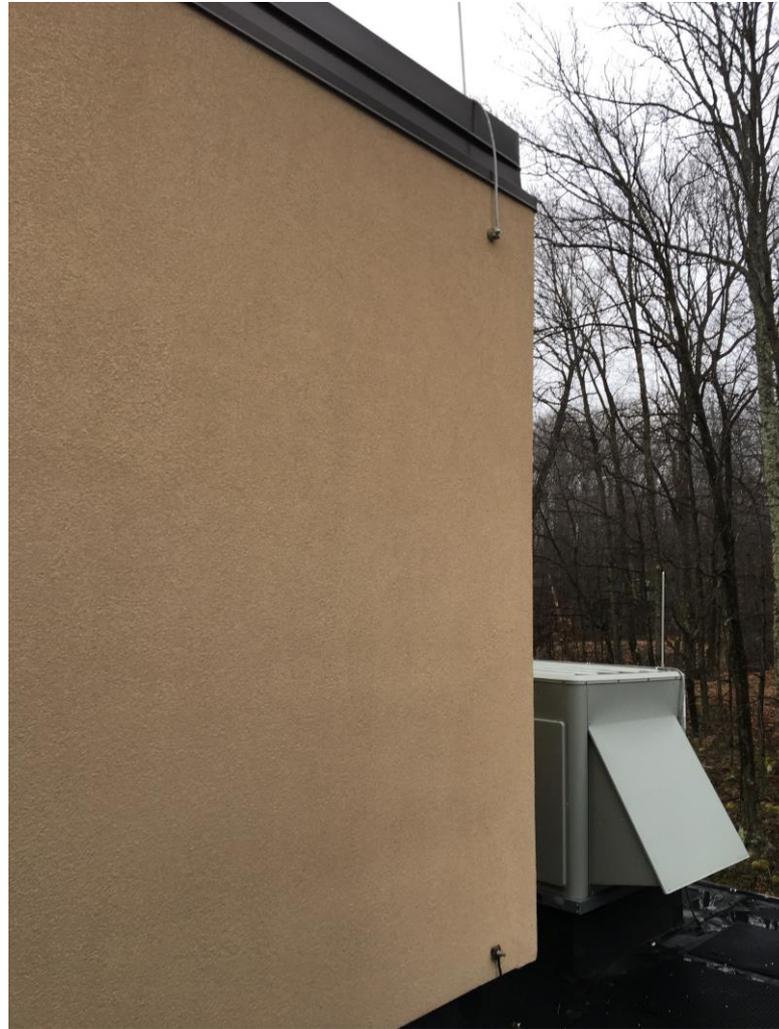
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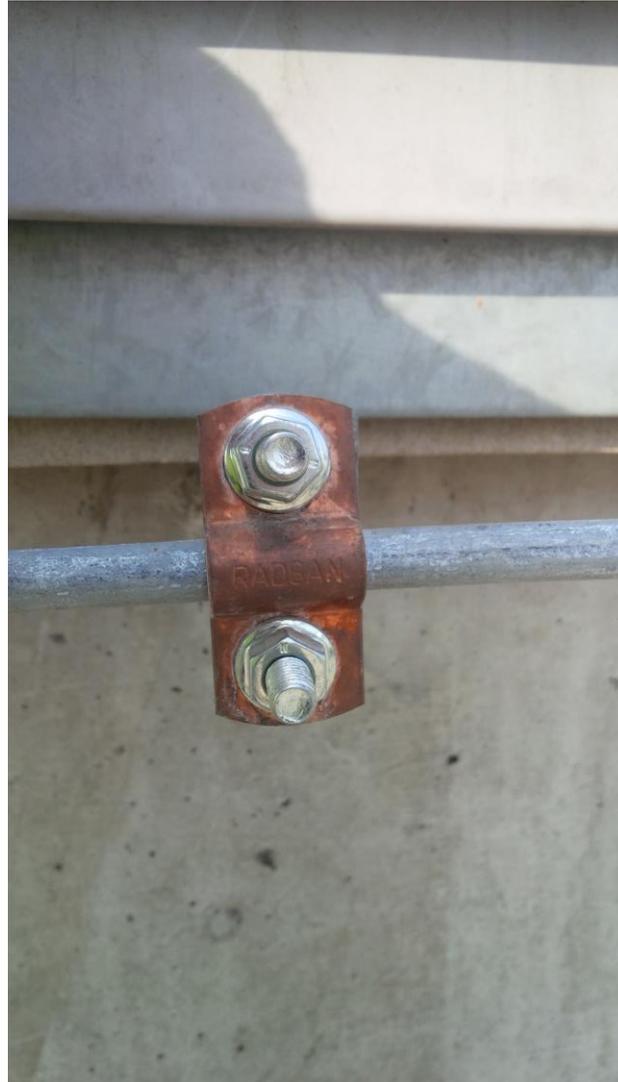
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Questions/Comments



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