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The Application of NFPA 780 and IEC 62305 in the United States

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Session 3: *Electrical Protection/ Surge Protection*

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Purpose

- Provide overview of application of IEC 62305 in the US from the perception of the USNC Technical Advisory Group
- Address misconceptions through a comparison with NFPA 780
- Discuss development of both standards
- Explain methods of adoption of IEC standards in the US
- Introduce development of LSA White Paper

IEC 62305 – Protection Against Lightning

- 4 Parts
- Most detailed Risk Assessment available (88-page document)
- Provides flexibility in design approaches
- Highly technical approach to lightning protection solutions

IEC 62305 – Protection Against Lightning

- Part 1: General Principles
- Part 2: Risk Management
- Part 3: Physical Damage and Life Hazard
- Part 4: Electrical and Electronic systems within Structures

Adoption of IEC Standards in US

- Adopt as written
  - Some Country Notes for Host Country should be Normative
- Modify to meet national requirements
  - Insert requirements in body of document
  - Include national differences in Normative Annex (ACP 61400-24)
- Adopt IEC requirements in national standard
  - NFPA 780

US Country Notes – IEC 62305-3 (81/688/CDV)

- 5.3.4 No bend of a LPS conductor shall form an included angle of less than 90 degrees, nor have a bend radius less than 200 mm
- 5.3.5 Connections to metal framework used as a natural down-conductor are made using bonding plates having a surface contact area of not less than 5 200 mm^2 or by welding or brazing
- 5.4.4 Reinforcing steel in concrete foundations is not the preferred electrode due to lack of control of interconnection quality.
- 5.4.2.2 Minimum length of horizontal earth electrodes is not required to be twice that required for vertical electrodes.

US Country Notes – IEC 62305-3

- 5.5.1 Components used shall be certified to Underwriters Laboratories Standard UL 96.
- 5.5.2 conductors are fixed to the structure upon which they are placed at intervals not exceeding 1 m.
- 5.6.2 (Table 8) Only copper, copper coated steel and stainless steel are acceptable for direct burial.

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Misconceptions in Literature

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Scope of NFPA 780 excludes electric generating facilities

- **1.1.2*** This document shall address lightning protection of the structure but not the equipment or installation requirements for electric generating, transmission, and distribution systems except as given in Chapter 9 and Chapter 12.
- **A. 1.1.2** Electric generating facilities whose primary purpose is to generate electric power *are excluded from this standard* with regard to generation, transmission, and distribution of power. … Installations not directly related to those areas and structures housing such installations can be protected against lightning by the provisions of this standard.
- *1.1.2 clearly states that NFPA 780 does address lightning protection of the structure. ONLY the equipment and installation requirements for electric generating, transmission, and distribution systems may be excluded.*

Surge Protection

- *NFPA 780 provides an exception … by stating that SPDs shall not be required where, under engineering supervision, it is determined that the surge threat is negligible or that the lines are equivalently protected or where installation of SPDs compromises safety.*
- *"… allows for such exceptions to the requirements for surge suppression on electrical utility, …*
- NFPA 780 is consistent with IEC 62305.
- Allows use of other protection methods to limit surge threats to a tolerable level
  - Meshed bonding, spatial shields for zones, equipment, lines, routing of conductors, etc.
- Neither standard supersedes utility standards for power generation or distribution unless specified by the AHJ. Does not preclude use.

Class of Components

- IEC 62561-1 Ed 2 (2017)
  - Class H (heavy duty) Class N (normal duty) components
  - Electrical test (10 x 350 µs)
    - H: *I*pk = 100 kA, Specific Energy = 2500 kJ/Ω
    - N: *I*pk = 50 kA, Specific Energy = 625 kJ/Ω
  - Static mechanical withstand capability test
    - Mechanical tensile force of 900 N ± 20 N, for 1 min.
- Size of conductor does not change based on height of structure

Class of Structure

- NFPA 780
  - Class I defines minimum material sizes to be used on structures ≤ 75 ft high
  - Class II defines minimum material sizes to be used on structures > 75 ft high
- UL 96 Ed 6
  - Static mechanical withstand capability test
    - Mechanical tensile force of 900 N ± 20 N, for 1 min.
- Conductor size changes based on length of conductor (height > 75 ft)

Lightning Protection Level / Class of LPS (Variables)

- Lightning parameters (IEC 62305-1 Table 3)
  - Peak current, charge, specific energy, rise/fall time
- Zones of protection (radius / angle / mesh spacing)
  - NFPA 780 varies by application
- Spacing between down conductors
  - NFPA 780 Avg 100 ft max, preference at corners
- Separation / sideflash distance
  - Details to follow
- Minimum length of earth electrodes
  - NFPA 780 Vertical rods driven to 10 ft depth, horizontal $\geq$ 12 ft min

Relationship between IEC 62305 and NFPA 780

- *Over time, the NFPA 780 standard has relied more and more on the IEC 62305 for guidance. References to IEC 62305 found throughout NFPA 780, increasing each edition.*
- Origin of NFPA 780 dates back to 1904 IEC TC 81 established in Stockholm in June 1980
- NFPA 780 identified as the primary implementing document in the US
- NFPA 780, Annex L Detailed Risk Assessment based on IEC 62305-2
- Ch 9 – Wind Turbines and Ch 12 – Solar Arrays coordinated with applicable IEC standards that implement IEC 62305 concepts
- Annex J Protection of Smart Structures incorporates concepts from IEC 62305-4
- Numerous IEC standards (including all 4 parts of IEC 62305) are cited as references to NFPA 780

IEC Separation Distance

$$s = \frac{k_i}{k_m} \times k_c \times l \qquad (\text{m})$$

k_i	depends on the selected class of LPS
k_m	depends on the electrical insulation material (air = 1, concrete, brick, wood = 0.5);
k_c	depends on the (partial) lightning current flowing on the air-termination and the down conductor (#DC = 1 (1), 2 (0.66), 3+ (0.44))
l	is the length, in meters, along the air-termination and the down-conductor from the point, where the separation distance is to be considered, to the nearest equipotential bonding point or the earth termination

NFPA 780 Sideflash Distance

$$D = \frac{h}{6n} \times K_m$$

- h = height of building or vertical distance fm nearest bond to LPS
- k_m = insulation medium (air = 1, concrete, brick, wood = 0.5)
- n = value related to the # of DCs spaced > 25 ft apart & < 100 ft from bond in question (#DC = 1 (1), 2 (1.5), 3+ (2.25)) ($k_C = 1/n$)
- Only 1 LPL in NFPA 780 (k_i=1)

Which is the best Standard?

- Depends on the application
- Both have their advantages
- Technical solutions / Engineering applications
- Clear repeatable design criteria and installation rules
- Less subjective / more predictable installation inspections

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