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# Applicability of IEC 62305 for Lightning Protection of U.S. Power Generation Facilities

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Session 2: *Power & Lightning (Surge) Protection*

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# Presentation Outline

- Current status of lightning protection for U.S. power generation facilities
- Comparative analysis of the NFPA 780 and IEC 62305 standards with an emphasis on the effect lightning current parameters have on each standard's approach to lightning protection design
- Merits of lightning protection per IEC 62305
- Conclusions drawn from comparative analysis

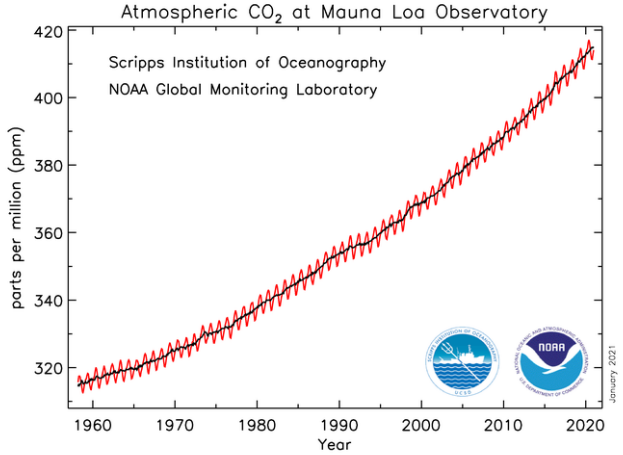
# Power Generation Utility Lightning Protection Standards

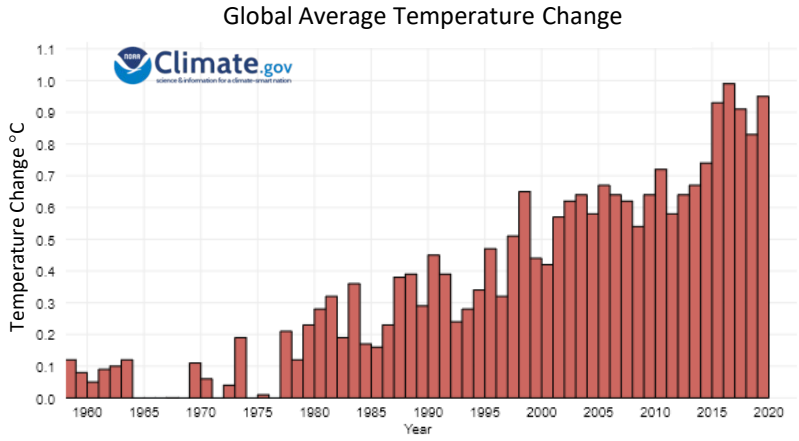
**IEEE 1243**, Guide for Improving the Lightning Performance of Transmission Lines

**IEEE 998**, Guide for Direct Lightning Stroke Shielding of Substations

**???????**, Power Generation Facility Lightning Protection Standard

# Lightning Occurrence Related to Increases in Atmospheric $CO_2$

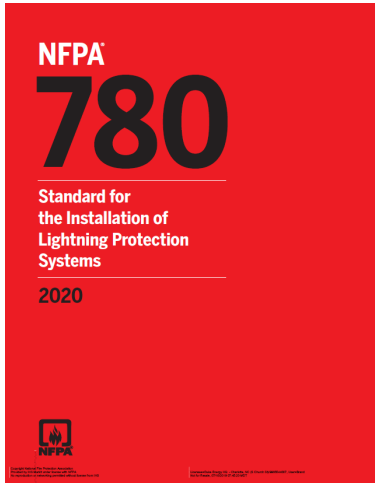


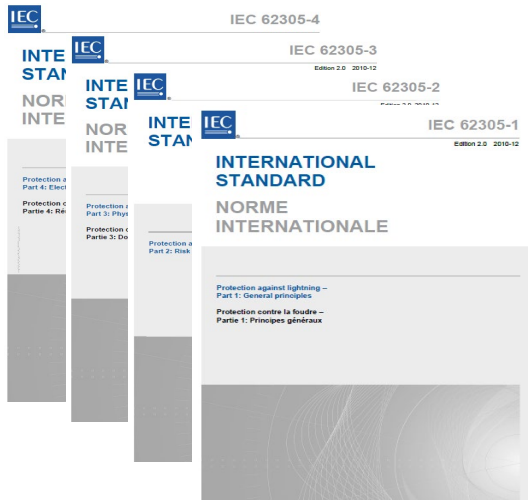




Atmospheric $CO_2$ continues to increase, resulting in warmer oceans and warmer air temperatures. Both of these trends lead to higher evaporation and heat transfer and thus higher frequency of convective storms increasing the probability of more lightning.

# U.S. Power Generation Facility Lightning Protection

NFPA 780 and IEC 62305 were chosen for comparative study for Lightning Protection of U.S. Power Generation Facility as these two standards are the two most widely accepted lightning protection standards.



# Lightning Risk Assessment

| NFPA 780 | IEC 62305 |
|---|---|
| • Risk assessment **optional**<br>• Risk assessment methodology provided in Annex L (not part of NFPA 780 requirements)<br>• Annex L provides simplified and detailed assessment guidelines<br>• IEC 62305-2 referenced as acceptable risk analysis procedure | • Risk assessment **mandatory**<br>• If calculated risk $(R)$ is greater than the tolerable risk, $(R_T)$, protection measures shall be adopted in order to reduce $R \leq R_T$<br>• Surge protective devices and shielding required<br>• Lightning protection level selected that reduces risk so that $R \leq R_T$ |

# IEC 62305 Design Criteria

| Lightning Parameter | | Lightning Protection Level | | | |
|---|---|---|---|---|---|
| Parameter | Unit | I | II | III | IV |
| Maximum Peak Current | kA | 200 | 150 | 100 | 100 |
| Minimum Peak Current | kA | 3 | 5 | 10 | 16 |
| Lightning Current Waveform (peak current rise time to decay time to half peak current) | µs | 10/350 | | | |
| Lightning Current Impulse Charge ($Q_{SHORT}$) | C | 100 | 150 | 75 | 50 |

# Maximum values of lightning current and flashover

Inadequate separation distance (S) between parts of the external lightning protection system and metal and electrical installation in the structure being protected can lead to uncontrolled flashover resulting in fire and/or damage to the installation and connected electrical loads. Per IEC 62305:

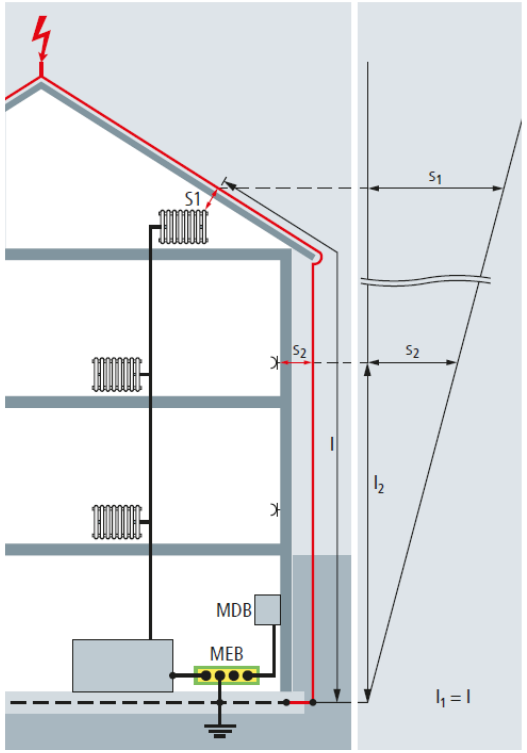
$$S = K_i \times \frac{K_c}{K_m} \times l$$

$K_i$ = factor that depends upon the chosen lightning protection class

$K_c$ = factor that depends upon the number of down-conductors

$K_m$ = factor that depends upon the electrical insulation material

$l$ = length of down-conductor from the point being considered to the closest equipotential bonding point

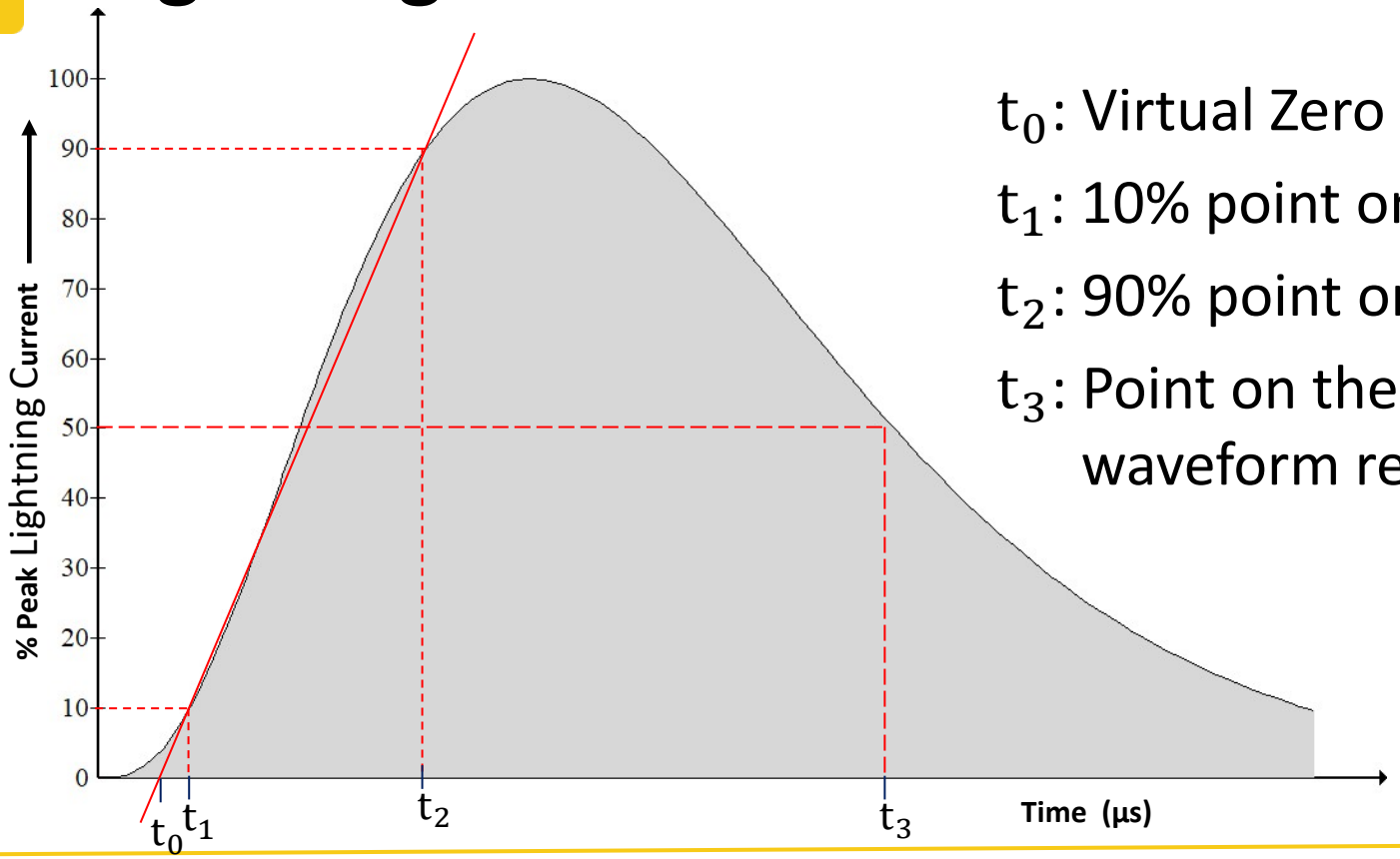


# IEC 62305-1, Table 4

## Minimum values of lightning current and related rolling sphere radius corresponding to LPL

| Lightning Protection Level (LPL) | I | II | III | IV |
|---|---|---|---|---|
| Minimum Peak Current (kA) | 3 | 5 | 10 | 16 |
| Lightning Striking Distance (Rolling Sphere Radius): $d_s(\text{m}) = 10 I_p^{0.65}$ | 20 | 30 | 45 | 60 |

# Lightning Current Waveform Parameters



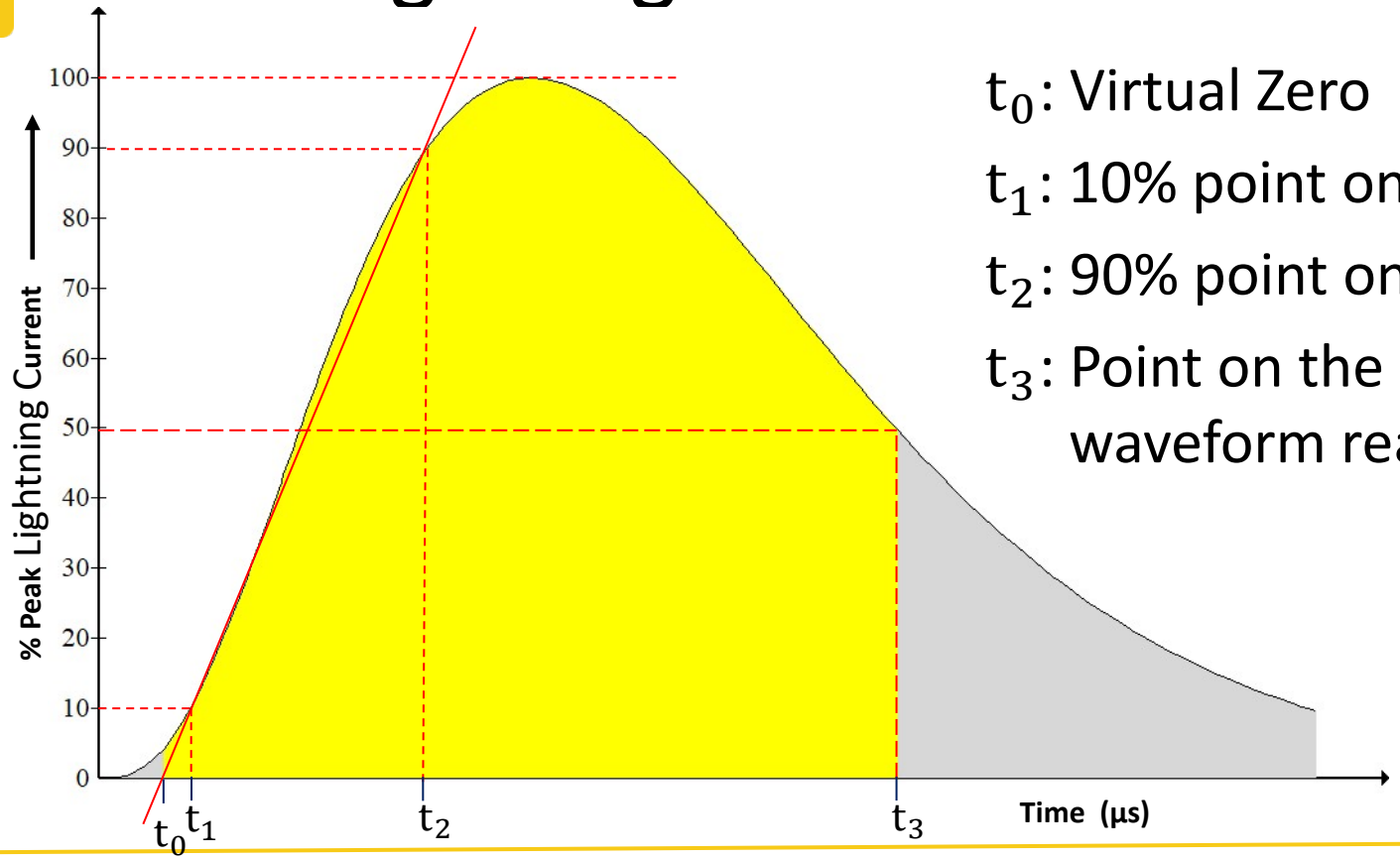

$t_0$: Virtual Zero

$t_1$: 10% point on the leading edge of the waveform

$t_2$: 90% point on the leading edge of the waveform

$t_3$: Point on the waveform during decay when the waveform reaches half of the peak value

# Direct Lightning Stroke and Total Charge Transfer



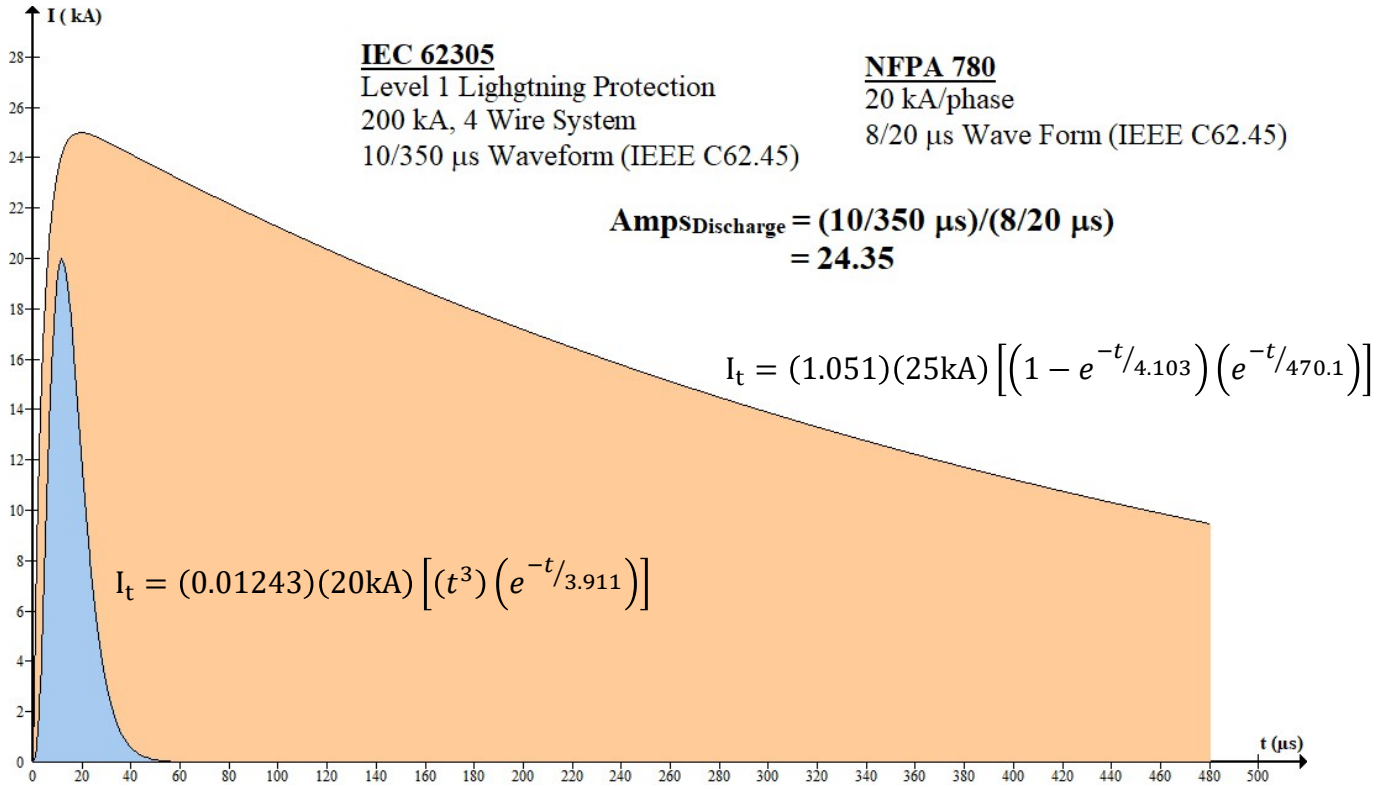

$t_0$: Virtual Zero

$t_1$: 10% point on the leading edge of the waveform

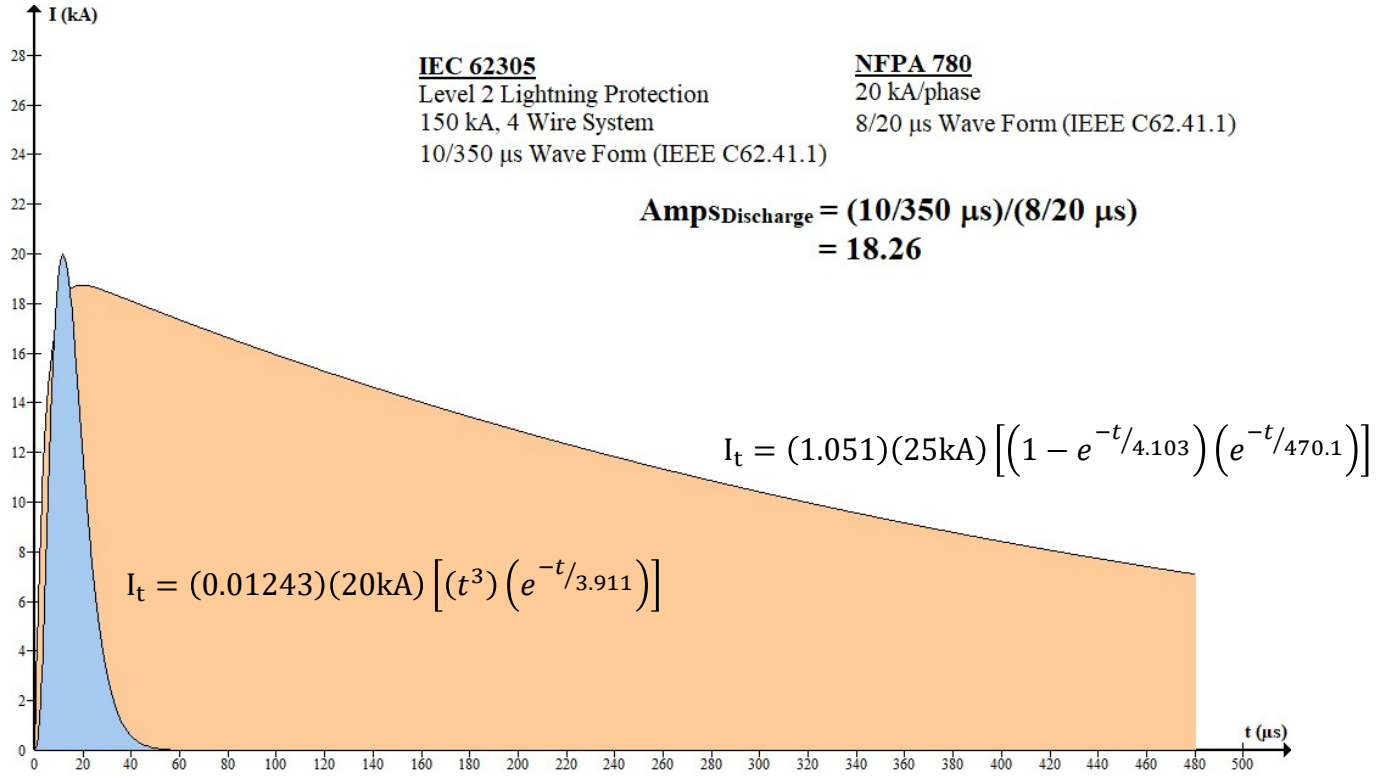
$t_2$: 90% point on the leading edge of the waveform

$t_3$: Point on the waveform during decay when the waveform reaches half of the peak value

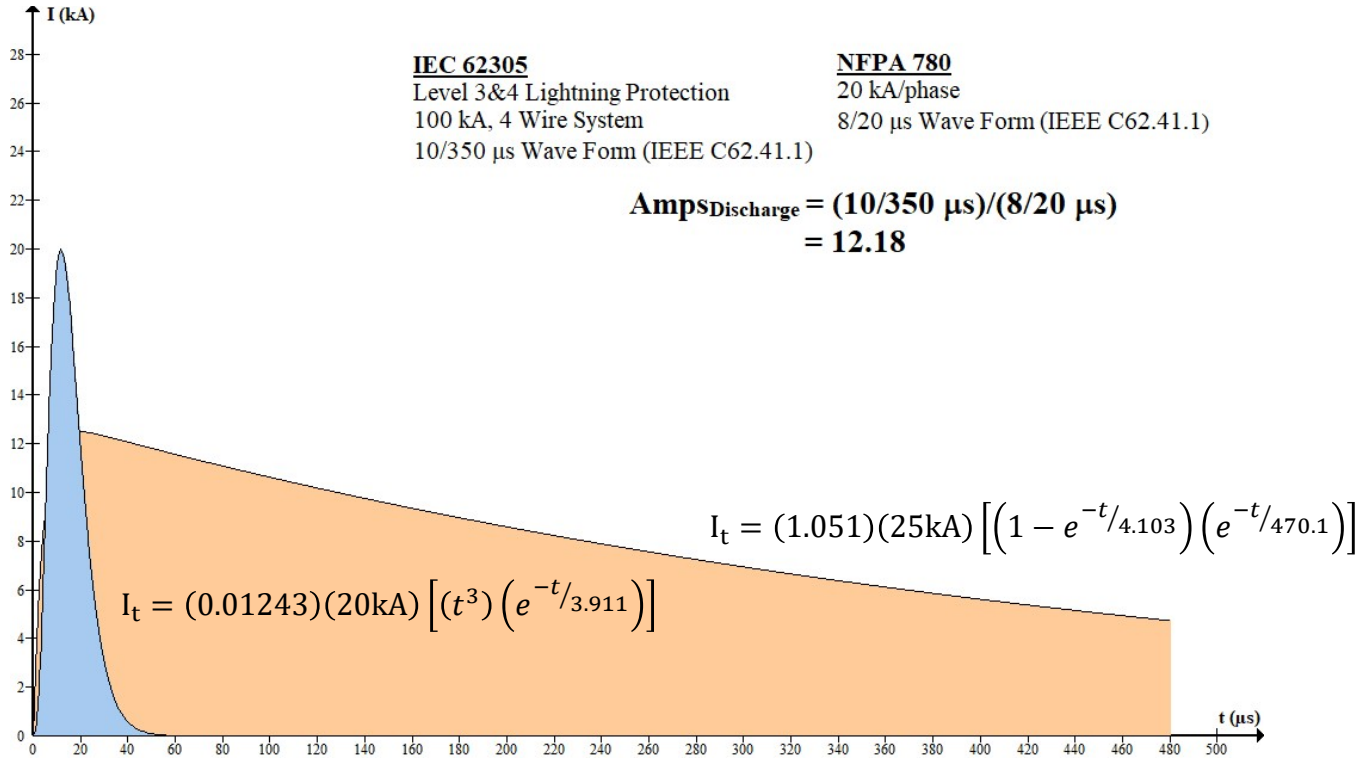
# 10/350 µs (Level 1) versus 8/20 µs lightning waveform



# 10/350 µs (Level 2) versus 8/20 µs lightning waveform



# 10/350 µs (Level 3 & 4versus 8/20 µs lightning waveform

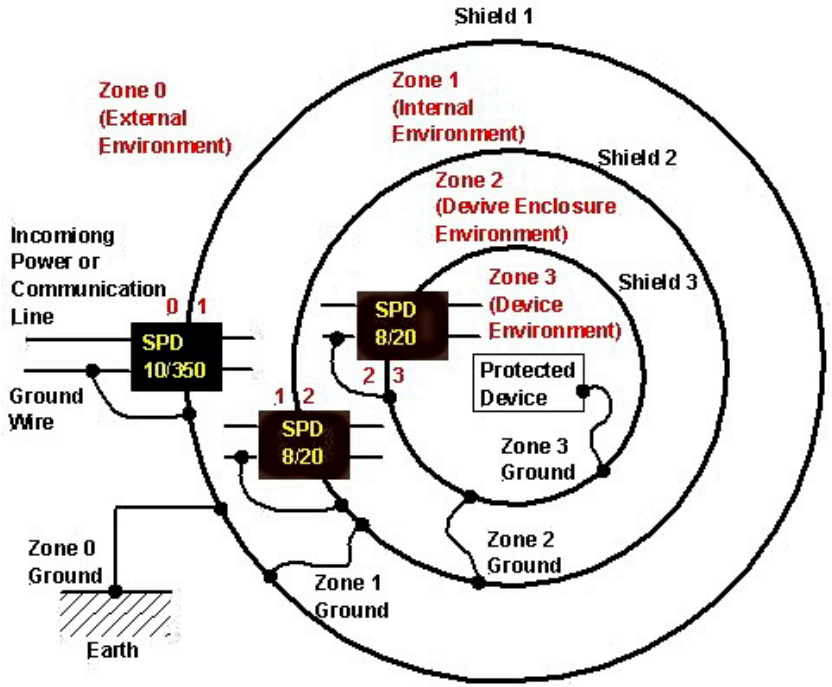



**IEC 62305**
Level 3&4 Lightning Protection
100 kA, 4 Wire System
10/350 µs Wave Form (IEEE C62.41.1)

**NFPA 780**
20 kA/phase
8/20 µs Wave Form (IEEE C62.41.1)

**$Amps_{Discharge}$ = (10/350 µs)/(8/20 µs)**
**= 12.18**

# Topological Shielding




- The concept of topological shielding provides protection of electronic equipment from lightning created large transient fields and currents that may be developed outside the cabinet or building.
- Topological shielding is a requirement of IEC 62305.
- NFPA 780 does not require topological shielding but does provide information discussion in the standard's Annex L.

# Merits of Lightning Protection per IEC 62305

- A lightning protection system designed based on scientific research versus observation and experimentation.
- A lightning protection system design resulting from a rigorous, detailed lightning risk analysis.
- A lightning protection system designed according to a four tier lightning protection level system per a specified lightning impulse current.
- Surge protection system designed to protect against direct lightning strokes using SPDs tested to withstand the internationally recognized 10/350 µs lightning waveform and using SPDs in topographical shielding design.

# Thank you for your attention!

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