Lightning Risk Assessment
Tailored to Applications Involving Structures Housing Explosives

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Paper Objectives

• Identify existing level of detail explosives applications are addressed in NFPA 780

• Recommend improvements to Annex L based on internationally agreed methods and scientific literature
Risk Assessment References

• NFPA 780
  • Cited by DoD explosives safety standards for baseline requirements
  • Clause 8.1.1 cites use of risk assessment to justify exclusion of LPS requirements

• Risks to personnel and property to be analyzed and documented, along with any methods used to reduce the risk to:
  • justify waivers for mission-critical applications
  • justify grandfathering of requirements
Risk Assessment Methods

• NFPA 780 Annex L
  • Detailed Assessment based on IEC 62305-2 methodology
• Strike QRA
  • DDESB developed quantitative assessment
• IEC 62305-2
  • Currently in maintenance review for Edition 3
NFPA 780 Annex L.6 Explosives Citations

• Loss value for risk of explosion \((L_0)\)  
  [Table L.6.7.9]

• No reduction for provisions taken to reduce the consequences of fire 
  [Table L.6.7.12]

• Risk of fire = 1 
  [Table L.6.7.12]

• Does not consider any risks outside the structure
Recommended Revisions – $L / P$ Factors

• Revise Loss Factor Table L.6.7.9 to reflect $L_F$ and Note 2 from IEC 62305-2 Edition 2
  • NOTE 2 In case of a structure with risk of explosion, the values for $L_F$ and $L_O$ may need a more detailed evaluation, considering the type of structure, the risk of explosion, the zone concept of hazardous areas and the measures to meet the risk.

• Introduce Loss $L_E$ to address damage to structure that effects surrounding structures or the environment
  • Rousseau and Kern (2014) provide considerations for additional loss factors that should be considered

• Introduce zone concept of IEC 62305-2 to address areas containing hazardous (classified) locations and/or energetic materials

• Introduction of $P_{TWS}$ to account for reliability of Lightning Warning Systems
Factors relating to Thunderstorm Warning

• Thunderstorm Warning Systems (TWS) allowed by services as factor in waiving requirement for LPS

• Probability $P_{TWS}$ that a thunderstorm warning system does not detect a lightning related event in the target area must be considered
  • Value given in IEC 62793 as failure to warn ratio (FTWR)
  • Generally available from the manufacturer’s product data sheet

• $P_{TWS}$ is reduction factor in applicable probability calculations

• $P_{TWS} = 1$ if FTWR not declared by manufacturer
Example of Environmental Risk Consideration

• Evaluation of R1 – Loss of life or permanent injury
• Ground flash density - 4 flashes / km² / year
• Structure has coordinated SPDs on power and data lines
  • Case 1 – SPD Level I
  • Case 2 – SPD Level I++
• Thunderstorm warning system in use at the site
• Lightning protection system meets NFPA 780, Chapter 8 (LPL II)
Additional (Future) Considerations

• Consideration of Loss of Life or Injury due to thermal effect, overpressure, or fragmentation in vicinity of explosion

• Consider Quantity-Distance data in probability of physical damage or injury?

• Build on Strike-QRA concepts?
Summary

• NFPA 780 Annex L cited as a method to assess lightning risk for explosives applications

• Revision of existing assessment method is proposed to reflect state of knowledge for explosives applications

• Items for consideration available in IEC 62305-2 Edition 2 and peer reviewed publications

• Future considerations are identified that can provide more accurate assessments when justified and probability and loss data is available