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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_O) *[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

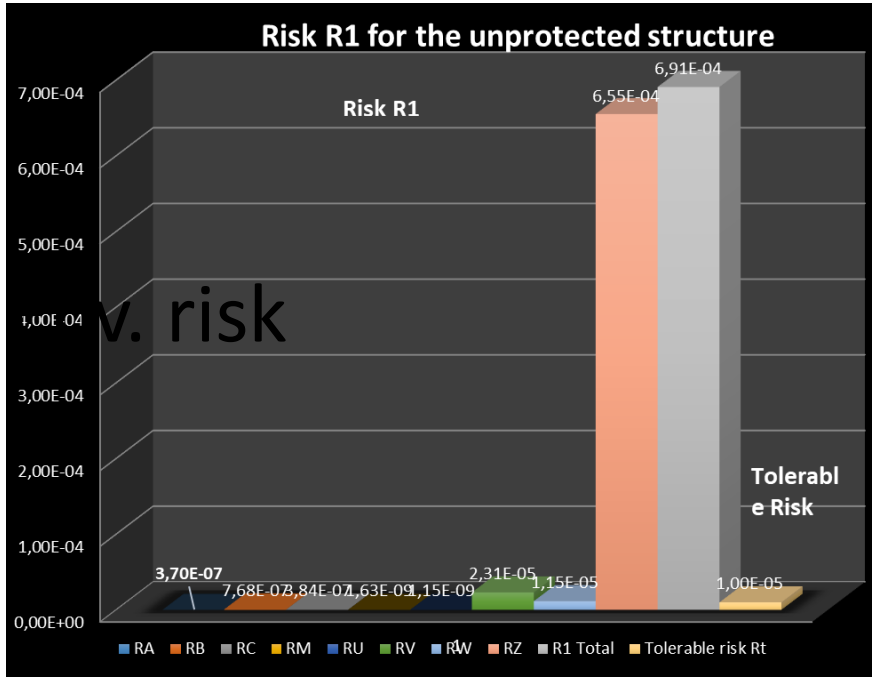
Factors relating to Thunderstorm Warning

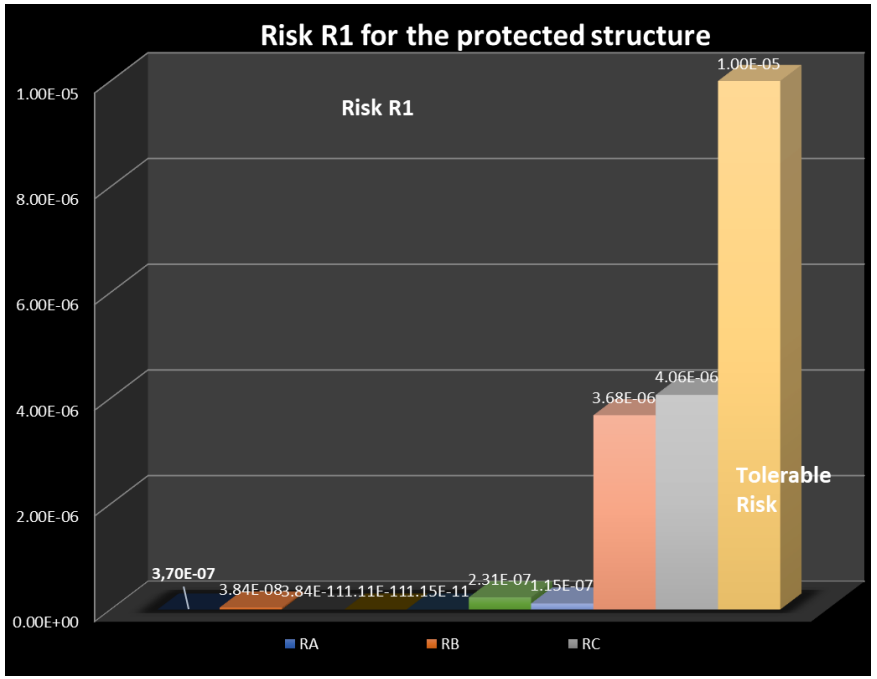
- Thunderstorm Warning Systems (TWS) allowed by services as factor in waiving requirement for LPS
- Probability P_{TWS} that a thunderstorm warning system does not detect a lightning related event in the target area must be considered
  - Value given in IEC 62793 as failure to warn ratio (FTWR)
  - Generally 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

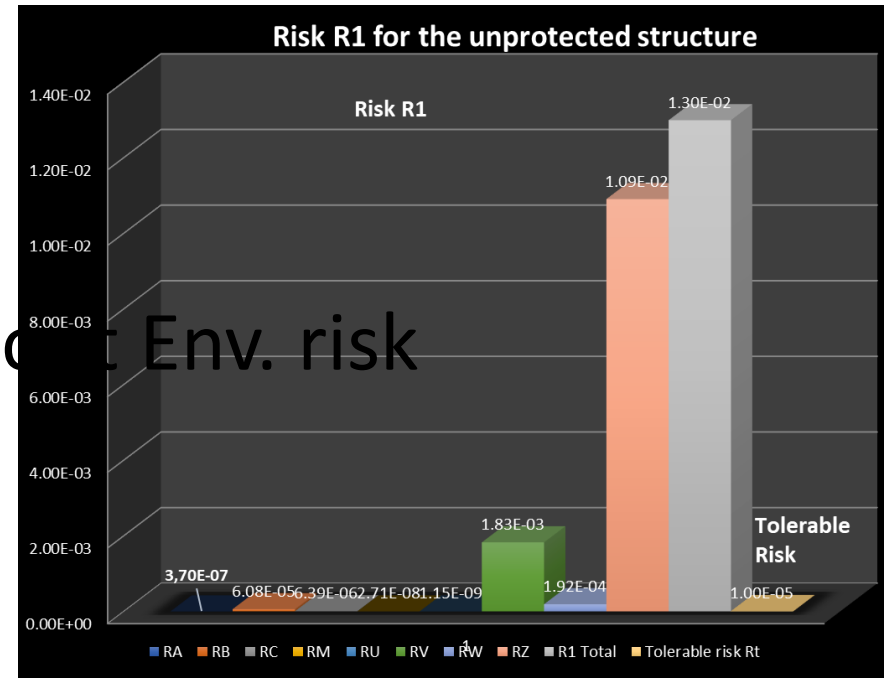
- Evaluation of R1 – Loss of life or permanent injury
- Ground flash density - 4 flashes / km^2 / year
- Structure has coordinated SPDs on power and data lines
  - Case 1 – SPD Level I
  - Case 2 – SPD Level I++
- Thunderstorm warning system in use at the site
- Lightning protection system meets NFPA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

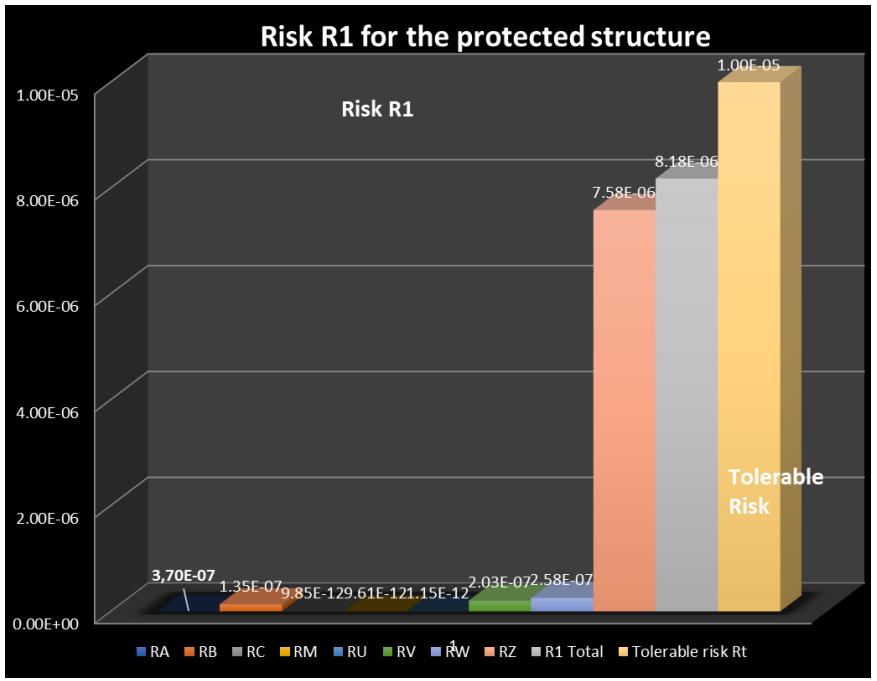
With v. risk





Without Env. risk





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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