ADDRESSING FIRE SAFETY “The Right Way”

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Fire is considered a dominant contributor to the total risk of core damage for most plants.
Fire at Browns Ferry in the U.S. in 1975
The fire protection programs in the U.S. today, are a direct result of this fire and its lessons learned
Prior to Browns Ferry Fire, not much regulation

General Design Criteria (GDC) is broad with no specific details

After the Browns Ferry Fire, regulations were developed to make fire protection measures more robust
First comprehensive fire protection regulation provided guidelines for:
- implementing fire protection criterion for nuclear power plants
- provided detail design methods and requirements for various plant areas
- Provided very general requirements for separation of plant safety related systems
U.S. REGULATIONS (Cont’d)

- All U.S. plants implemented the requirements of new regulation
- A new rule "Fire Protection Program for Nuclear Power Facilities" was issued on February 1981
  - Deterministic
  - Strict compliance for all plant areas
  - Ensure one train remains free of fire damage
ACHTING COMPLIANCE WITH DETERMINISTIC REGULATION

- Performance of Fire Safe Shutdown Analysis (FSSA)
  - Determination of Performance Goals;
  - Selection of systems and components;
  - Identification of required cables for selected components;
  - Identification of physical location of required cables and selected components;
  - Evaluate potential impact to selected components and cables based on complete area fire damage;
  - Identify equipment and cable interactions’
  - Document resolutions for each fire area analysis
CHALLENGES WITH DETERMINISTIC REGULATION

- Relatively straight forward, although costly
- Literal compliance “one train of equipment free of fire damage” not possible
- Other issues related to safe shutdown capability during a fire not fully resolved
In the late 1990s, new issues were identified:
- Inconsistencies identified with circuit analysis
- Electrical Raceway Fire Barrier issue

Re-analysis and Modifications

Operator manual actions
Developed by the NFPA in the mid-1990s
- Allows the use of performance based analysis
  - fire modeling tools
  - probabilistic risk assessment
- Provided an alternative to deterministic fire protection regulation

NFPA 805 has been adopted by approximately half of the operating U.S. plants
RISK INFORMED PERFORMANCE BASED APPROACH (Cont’d)

- Complex transition process
  - Pilot new approach at two sites
  - Not completely vetted before other plants started transition
  - Extensive revalidation of the existing licensing basis mandated by the new rule
  - Full Fire Probabilistic Safety Analysis (PSA) mandated
RISK INFORMED PERFORMANCE BASED APPROACH (Cont’d)

- Fire Safe Shutdown Analysis provides an assessment of plant’s capability to safely shut down the plant during a postulated fire.
- It does not provide an indication of plant risk.
- Performance of fire PSA provides insights to plant risk, i.e., Core Damage Frequency (CDF), due to fire.

EPM
In the end, utilities that performed a RIPB analysis recognized significant safety benefits.

Plants that performed the analysis properly saved millions of dollars.

Fire PSA was a major cost contributor on this project.
A REASONABLE APPROACH

- Deterministic compliance is not practical, nor does it improve plant safety in all plant areas.
- Performance based method, with realistic qualitative and/or qualitative engineering evaluation provides the best tool/results.
- Separate or protect the redundant system adequately.
- Similar performance based techniques were utilized to address fire safety in all Canadian plants (CSA 293-95/07/12).
A REASONABLE APPROACH (Cont’d)

- A performance based analysis
  - Not less onerous
  - Requires more effort to collect and analyze the data to support fire modeling efforts
  - Based on real fire hazards and realistic fires
  - Focused on plant areas that are vulnerable to fire damage to critical safety systems
Eliminates plant modifications that provide little or no safety benefit
A REASONABLE APPROACH (Cont’d)

- Performance based analysis and screening process
  - Screen 1, no credited safe shutdown equipment and/or cables in the fire zone
  - Screen 2, all performance goals can be met, even with loss of all credited equipment and/or cables in the fire zone
  - Screen 3, one or more performance goals cannot be met due to loss of all credited equipment and/or cables in the fire zone
A REASONABLE APPROACH (Cont’d)

- Typical methods for resolving fire impact on safe shutdown systems
  - Removing fire hazards from the area, if feasible
  - Reducing impact of the hazards (i.e., installing dikes and/or heat shields)
  - Installing or upgrading detection and/or suppression system
  - Provide additional barrier protection
  - Operator manual action, if feasible and practical
  - Cable protection (wrapping raceways should be considered as a last resort)
RESOURCES AND MANPOWER

- Complex and time consuming process
- Requires many engineering disciplines
- Use of analytical software tool recommended
- 15,000 - 25,000 man hours, sometimes more
CONCLUSION

- Fire is a major risk contributor to every nuclear power plant
- All countries operating nuclear power plants must take this challenge seriously
- Take into account lessons learned
- Performance based fire safe shutdown analysis that focuses on real fire hazards and realistic fire scenarios will provide
  - an accurate and realistic analysis
  - will be cost effective
  - will make plants safer
THANK YOU
QUESTIONS?