U.S. Regulatory Information Conference

EPRI Fire PRA Research Plan

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TH30-Improving Realism in Fire PRA
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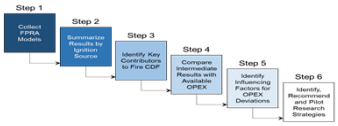
Process to Develop Near-Term EPRI Fire Research Plan

- Collected FPRA results from nearly 30 plants
  - BWR and PWR
  - NFPA 805 and non NFPA 805 plants
  - Plants that have implemented revised HRRs and fire frequencies and plants that have not yet implemented
- Sorted risk by fire ignition source to generate “skyline” of results and identify top Fire PRA contributors
- Follow on investigation identified:
  - Analytical drivers to calculated risk
  - Departures from operational experience
  - Research to close gaps (to achieve realism)

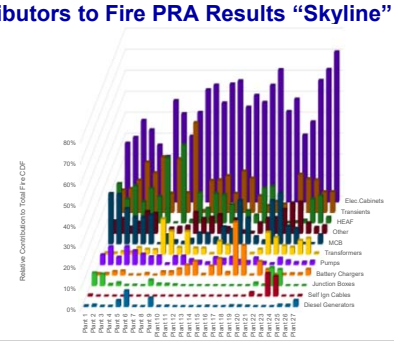
Near-Term Fire PRA Research Plan

- Structured approach followed to set plan priorities

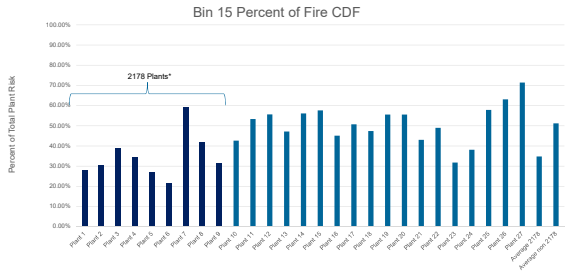


- Plan attributes:
  - Accomplish impactful improvement to fire PRA realism and provide results within 2 years (i.e. technical work by 2019) to support risk-informed applications (50.69, 4b, 5b, etc.)
  - Data or technical bases can be obtained in the near term from established sources without the need for new large scale experimental tests which may or may not produce conclusive results
  - Priority was given to tasks which can be completed in accordance with the above principals and that have the highest probability of providing statistically significant improvement in realism
  - Stakeholder input welcomed at all points in the integrated schedule which is designed to support completion by 2019.

Key Contributors to Fire PRA Results "Skyline"



Impact of Recent Research

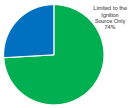


* 2178 plants have implemented the revised HRRs and fire ignition frequencies approved in recent years. There was an average reduction/improvement (shown at the far right of the graph, "Average 2178") obtained by implementing these updates, although some individual plants saw net increases in overall fire risk due to the increase in electrical cabinet and main control board fire frequencies implemented in conjunction with the new heat release rates. Even with these improvements, electrical cabinet fires continue to dominate fire PRA risk.

Task 1: Fire Progression Groupings

- FPRA results calculate the rate of severe electrical cabinet fires as:
  - 2.5 fires per year for the industry
  - Over a 10 year period, 25 fires
- Delta: OPEX suggests that a majority of fires do not generate damage outside the ignition source

FPRA Results: rate of severe / non-severe fires



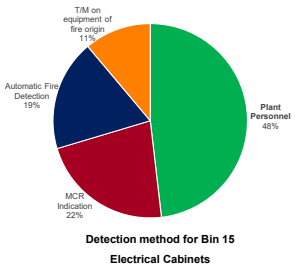
Electrical Cabinets: Damage primarily limited to the ignition source

Task 1: Fire Progression Groupings

- Gaps:
  - Methodology does not acknowledge the different fire growth progressions
  - The current treatment of characterizing each fire parameter independently coupled with aggressive fire growth results in a large percentage of severe fires (use of stylized tests in combination with operating experience)
- Research to address gaps:
  - Develop fire progression grouping (and technical basis) to support fire quantification based on the characteristics and attributes of different ignition sources
  - Started with electrical cabinets (based on skyline insights) but framework applicable to variety of sources

Task 2: Plant Personnel Suppression

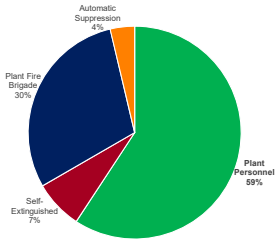
- Delta: OPEX suggest that plant personnel routinely **detect** and suppress fires before growth or propagation
- Only 1 in 5 fires detected by automatic fire detection
  - Remaining fires are of low energy or early fire progression
    - Should not be treated with the same 12 minute growth



Detection method for Bin 15 Electrical Cabinets

Task 2: Plant Personnel Suppression

- Delta: OPEX suggest that plant personnel routinely detect and **suppress** fires before growth or propagation
- Most fires suppressed by initial attack through simple suppression measures
  - Removal of power supply
  - Single portable extinguisher



Suppression method for Bin 15 Electrical Cabinets

Task 2: Plant Personnel Suppression

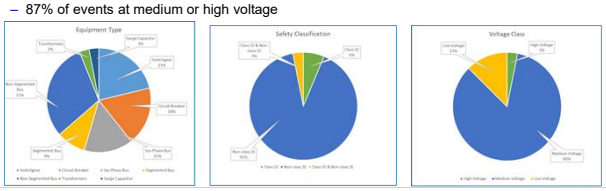
- Gap:
  - Personnel suppression credit only applied for continuously occupied rooms (MCR) and continuous fire watch (hot work)
  - OPEX suggest that personnel detection and suppression is present in a wide range of ignition sources
- Research to address gap:
  - Develop methods and data to credit *plant personnel suppression* more realistically in the fire scenario progression

Task 3: Fire Resulting in Plant Trip

- Delta:
  - Fire PRAs assume every fire leads to a plant trip, when in actuality it is dependent on the ignition source and severity of fire
  - For all ignition sources, approximately 1 in 8 fires resulted in a plant trip
- Gap:
  - Fire PRA analyses make an implicit assumption that every fire leads to a plant trip
- Research to address gap:
  - Develop guidance for applying a conditional probability of plant trip following a fire event

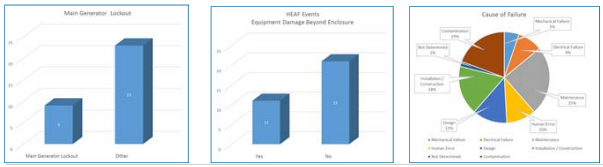
Task 4: High Energy Arcing Faults

- Contrary to conventional wisdom, no one equipment type is a dominant source of HEAF events
- HEAF events are primarily a concern for non-safety class medium-voltage equipment
  - >90% of documented HEAFs occurred on non-safety related equipment
  - 87% of events at medium or high voltage



Task 4: High Energy Arcing Faults

- Nearly 1/3 of HEAF events were associated with “Unit Connected” designs
- 2/3 of HEAF events did not impact equipment beyond enclosure
- 65% of HEAFs involved preventable shortcomings (human error, maintenance, design, installation/construction)



Task 4: High Energy Arcing Faults

- Gap: Current guidance treat all HEAF similarly (e.g., same frequency, scenario progression, and damage profile)
- Research to close gap:
  - Accurately reflect HEAF ignition trends and properly account for the plant impact due to HEAF
    - Update frequencies to reflect split between safety and non-safety equipment
    - Update consequence model to account for the circuit protection effectiveness and other factors that may affect the duration of a HEAF event

Task 5: Transient Fires

- Delta:
  - OPEX suggests that majority of transient fire events are:
    - Small transient ignition sources that do not propagate through transient combustibles
    - Not capable of significant growth or propagation

Requires large ignition source to achieve sustained flaming combustion
Unlikely to be located near a large ignition source

Small ignition source needed
Reasonable likelihood to have shop rags located with power tools + power supplies

Task 5: Transient Fires

- Gap: Most general transient fires are treated with the same fire scenario progression
  - No consideration between transient ignition source and transient combustibles
  - No consideration of different types of transients ignition source or combustibles in different plant locations
    - Disconnect between likely fire scenarios given OPEX and experimental testing of every possible combustible material found in NPPs
    - EPRI 3002005303 – Probability of Propagation for Transient Fires
- Research to close gap:
  - Use OPEX on a plant area basis to develop a more detailed characterization of transient fires
  - Perform heat release rate testing on common NPP transients seen in OPEX to better characterize heat release rate distribution

Task 6: Main Control Board

- Delta: OPEX suggests that main control board fires have not propagated outside the sub-component level ignition source given rapid intervention by operators
- Gap: Damage profile is conservative given difficulty of identifying targets within the main control board.
- Research to close gap:
  - Revise fire growth/spread model for the main control board (MCB) to better align with OPEX

Key Takeaways

- Skyline exercise in early 2017 provided a "reset" used to re-calibrate the path forward for fire PRA research
- Skyline results and comparison with OPEX provides motivation to continue working to refine fire PRA methodology
- EPRI Fire PRA research plan focused on most impactful research in near term (now through 2019)
  - Top research tasks to improve the realism in the fire PRA models
  - Not intended to be exhaustive list of low hanging fruit or listing of every task or data set to be improved

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