

EPRI/NRC-RES FIRE PRA METHODOLOGY

Integration, Lessons Learned and Insights

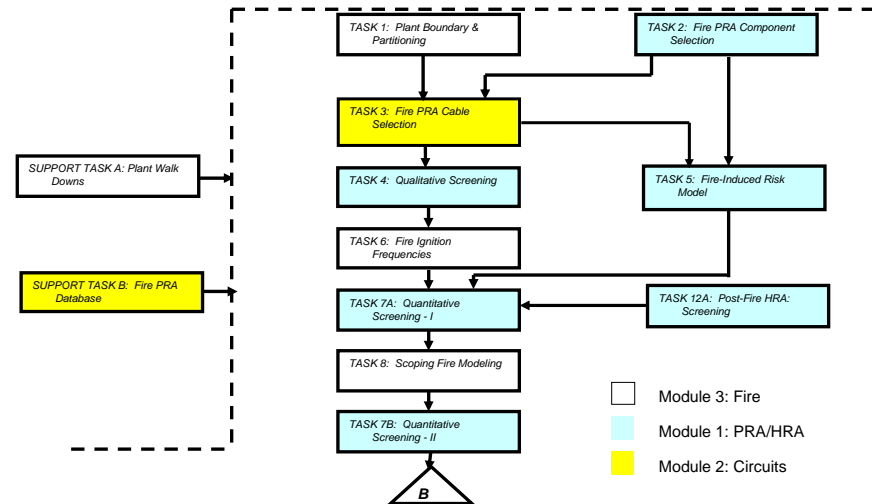
Bijan Najafi, SAIC
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Joint EPRI/RES Fire PRA Course
June 22-26, 2009, Palo Alto, CA and
October 12-16, 2009, Richmond, VA

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PART I

Integration

Remember the Fire PRA Process and Module Structure flow chart we showed the first day...

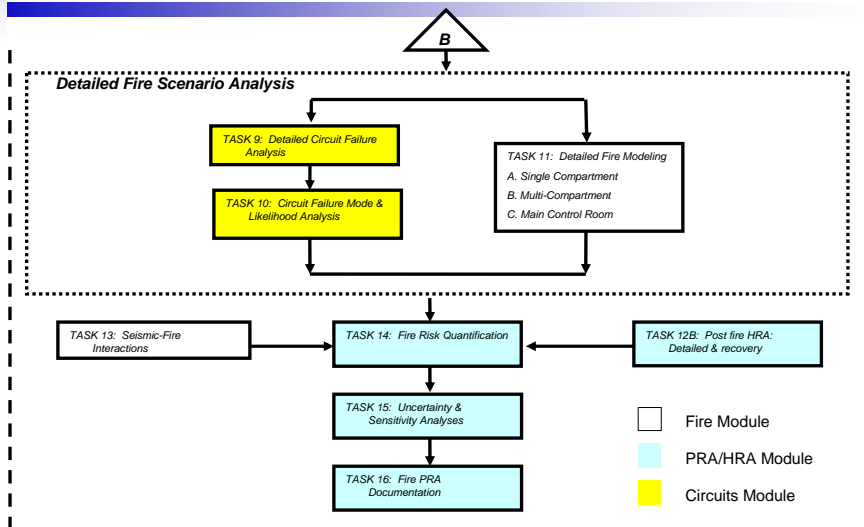


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Fire PRA Process and Module Structure (2)

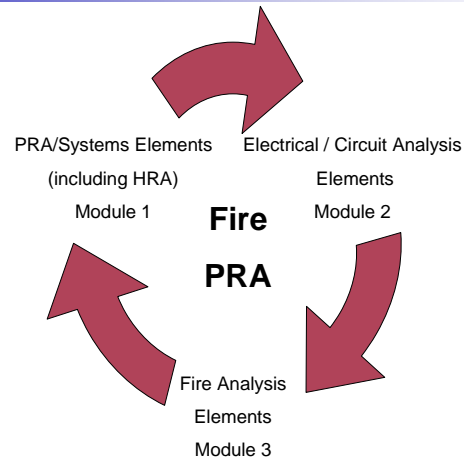


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We also look at the fire PRA as comprised of three major parts (hence, the 3 training modules)



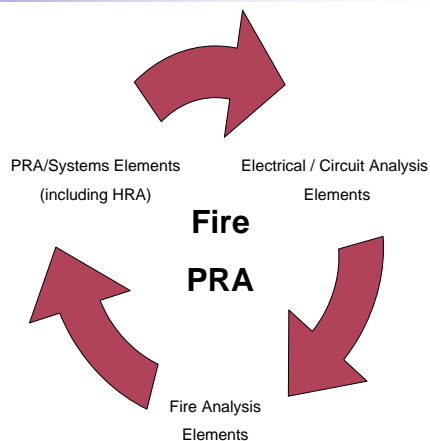
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Conducting the fire PRA involves an iterative process that progressively refines these elements

- Objective of refinement process is to:
 - Identify (screen) unimportant contributors
 - Obtain more realistic results for important contributors



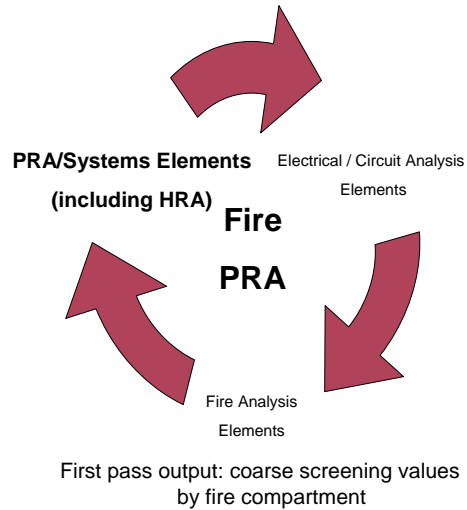
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The first pass through the analysis generally focuses on the PRA/Systems elements

- Building the plant response model is a major focus of the first pass
- A good, solid plant response model is a necessary element of the fire PRA:
 - System/equipment selection (i.e., what will be credited in the fire PRA)
 - Adoption/modification of internal events PRA models e.g.,
 - Incorporating unique fire-induced equipment failure modes
 - Incorporating fire-specific human actions / human failure events



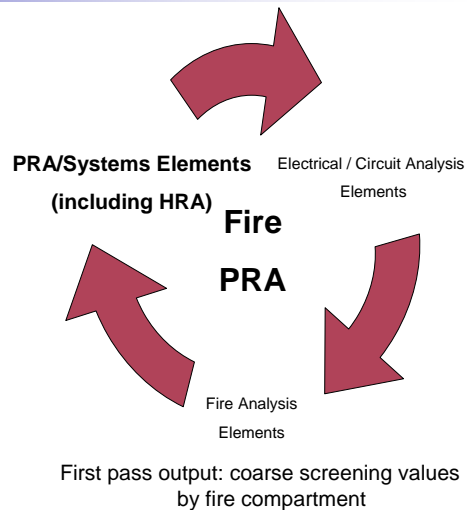
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The first pass through the analysis generally focuses on the PRA/Systems elements (cont.)

- Fire and Electrical tend to be treated at a pretty coarse level during the first pass
 - Fire: focus is generally on fire compartments
 - define fire compartments
 - raw fire frequency work
 - map targets to compartments
 - Electrical: utilize existing information as much as possible
 - identify and trace cables
 - identify potential component failure modes using conservative approaches



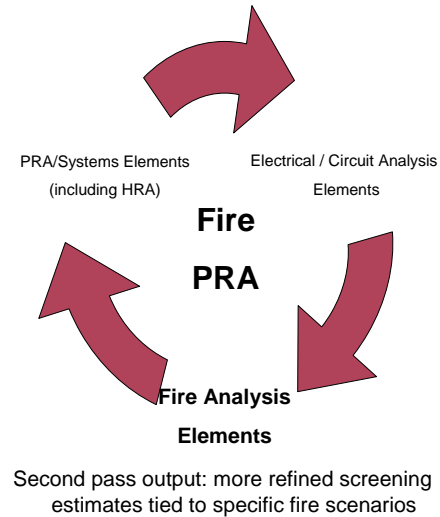
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The second pass will likely focus on first level refinement of the fire analysis elements

- Develop more specific and localized fire scenarios
 - Screen out non-threatening fire sources (no spread or damage potential)
 - Get past the room-wide damage scenarios for important compartments
 - Wide-spread damage scenarios may be plausible, but are generally low-likelihood events
 - Scenario focus shifts towards more representative fire source – target set combinations
 - Localized damage scenarios represent higher-likelihood events for most compartments and will likely dominate final risk estimates



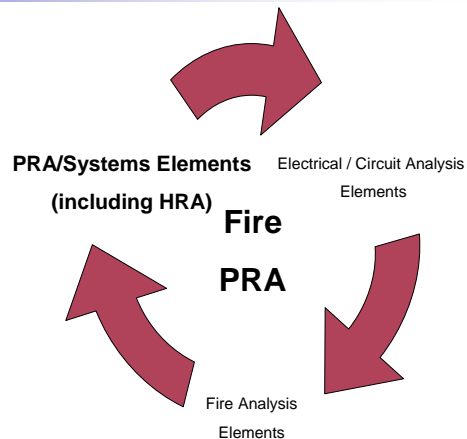
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Beyond this point, the analyst must choose where to allocate resources, where to seek further refinement

- One key to success: resource allocation
 - What element should you refine?
 - Where can you get the most “bang for the buck”?
 - Is there something that is easy to do that will improve the answer?
 - “easy” being a relative term here...



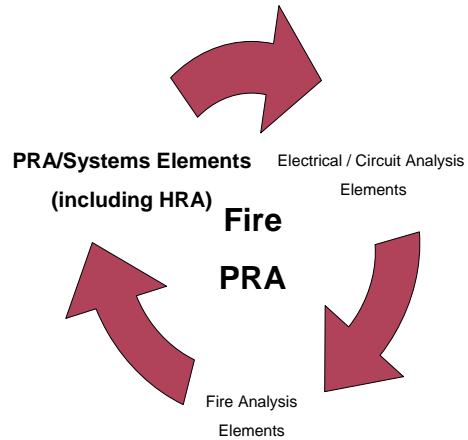
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Possible PRA/Systems refinements

- Take credit for additional systems or equipment and add these to the plant response model
- Take credit for additional operator actions
- Refine estimates of existing HEP values
- Refine mitigation/recovery models to reflect changes in your understanding of fire-induced equipment failure modes (requires support from the electrical/circuit element)



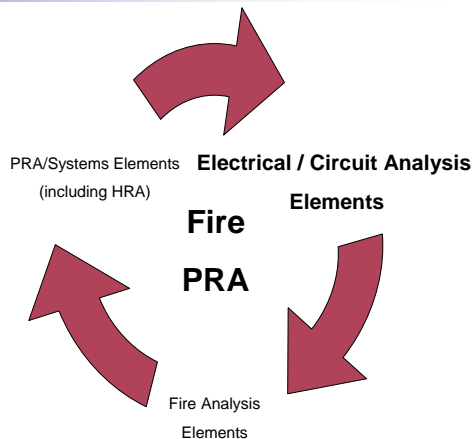
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Possible electrical / circuit analysis element refinements

- Refine estimates of the cable/component failure mode likelihoods (e.g., spurious actuation)
- Refine circuit analyses to eliminate cable-to-component failure mode relationships originally assumed but not really plausible (requires input from the PRA/Systems element)
- Refine cable routing/tracing information



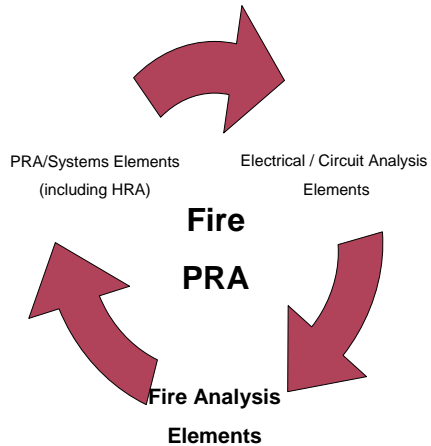
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Possible fire analysis element refinements

- Refine fire frequencies
- Refine fire scenarios
 - Break into sub-scenarios to reflect progression of fire damage with time
 - Refine credit given to fire protection systems and features
 - Take credit for fire protection systems and features not previously credited
- Apply fire modeling tools to refine scenario timing (time to target damage)
 - e.g., take advantage of the severity factor approach and distribution on fire peak HRR
- Refine your target sets
 - e.g., incorporate new cable routing/tracing information

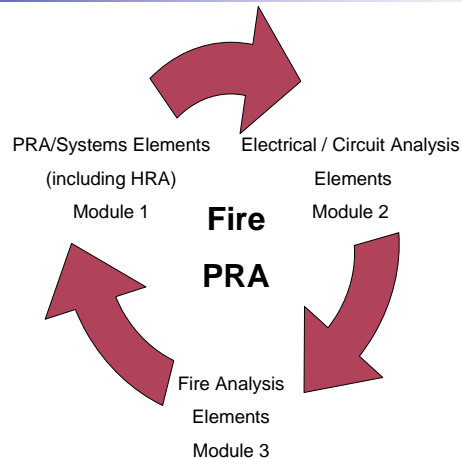


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Bottom line: you have the option to refine any element of the fire PRA at any time – Choose Wisely!



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PART II

Lessons Learned and Insights to-date on Use of EPRI 1011989, NUREG/CR-6850

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Use of the Fire PRA Method Since its Publication

- Completed
 - First application by the 805 pilot plants at Harris and Oconee
 - Both PWRs
 - These Fire PRAs reported early conservative results
 - Initiated a number of technical improvements and clarification to the method
 - FAQs
 - Long term (beyond 09) efforts
- Second wave of result will likely be coming out when next LARs are due early 2010
 - As many as 19 Fire PRAs will need to be completed ~end of 09 to support this schedule (including 4 BWRs)
 - These may use the results of the on-going improvement projects by the industry and the NRC

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General

- Planning and schedule
 - Get the electrical analysis going ASAP
 - This can become critical path quickly
 - Identify and populate cable and raceway database blank fields
- Automation
 - Plan for an integrated Fire PRA by specifying proper tools and plant data that eventually will communicate with each other
- Fire PRA Standard
 - Self-assessment is easier to do as each task is completed
 - Traceable documentation
- FAQs and evolution of method
 - Stay informed and get involved

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Fire Analysis

- Develop a clear consistent process to be followed by the analysis team focused on integrated approach for quantification and simplify documentation process
- Compare the Fire PRA and the cable/raceway database partitioning and reconcile the differences.
 - Ideally one partitioning or a correlation between partitioning schemes
- Walkdowns
 - Keep them targeted: Identify the information needed throughout the Fire PRA and schedule them appropriately
 - Avoid collecting unnecessary information
 - Avoid duplicate walkdown efforts
- Data quality
 - Ignition sources and targets should be identified with the proper ID's
- Tasks 1, 6, 8, and Appendix P will set you up to perform detailed quantification when properly structured

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Electrical Analysis

- Develop a clear consistent process to be followed by the analysis team focused on integrated approach for quantification and simplify documentation process
- Plant specific decisions on where to store/maintain the circuit analysis information
 - Separate database, expanded capability for the cable and raceway database, etc.
- Cable selection and detailed circuit analysis may/should be combined in one task
 - Many cables can be selected and analyzed at the same time
 - Need a well structured database to store and maintain all the information

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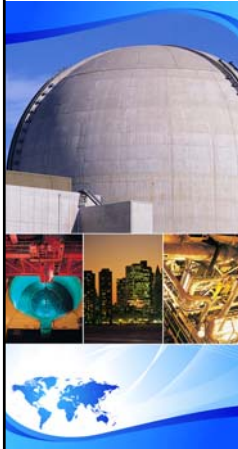
PRA/System Analysis

- Fire PRA component selection
 - Each component in the list needs a story
 - Where it comes from (Internal events, Appendix R, MSO expert panel, HFE cues/indication review, etc.)
 - How should it be reflected in the model
 - Single most important input to electrical analysis
- Plan for the MSO expert panel
 - Input for the Fire PRA equipment list and the logic model
 - Recognize the application, probabilistic vs. deterministic
- Fire PRA Model
 - There is significant link that begins early on between component selection, fire-risk model and fire HRA.
 - Identification and modeling of operator actions; fire response actions and spurious actions (those in response to erroneous alarms/instruments)
 - Identification and modeling of alarms and instruments
 - Proper reflection of fire procedures in the fire-risk model can become both cumbersome and critical

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Module III-2: Perspective

R.P. Kassawara - EPRI

J.S. Hyslop - RES

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June 12 – 26, and October 12 - 16, 2009

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On The Requantification Project

- A consensus methodology for Fire PRA that is facilitating implementation of risk-informed fire protection
- Best available method to estimate fire risk & obtain insights
- High activity ongoing in NFPA 805 FAQ program due to fire PRAs being performed during transition

Continued Cooperation

- We established a framework for future research cooperation
- The cooperation under the MOU is continuing
 - Fire Model User's Guide
 - Fire Human Reliability Analysis (HRA)
 - D. C. Circuits Testing
 - Fire Events Database Improvement
 - Future Projects....