

Tab 5:

Closing Session

Tab 5.1:

Lessons Learned and Application Insights



EPRI/NRC-RES FIRE PRA METHODOLOGY

Integration, Lessons Learned and Insights

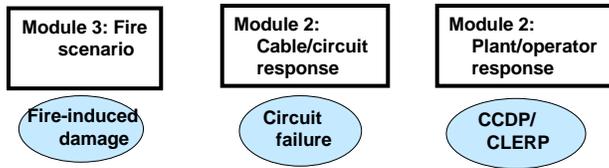
Bijan Najafi, SAIC
Steve Nowlen, SNL
Joint RES/EPRI Fire PRA Course
Sept. 29 – Oct. 2, and Nov. 17-20, 2008
Bethesda, MD

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PART I

Integration

Integration Modules



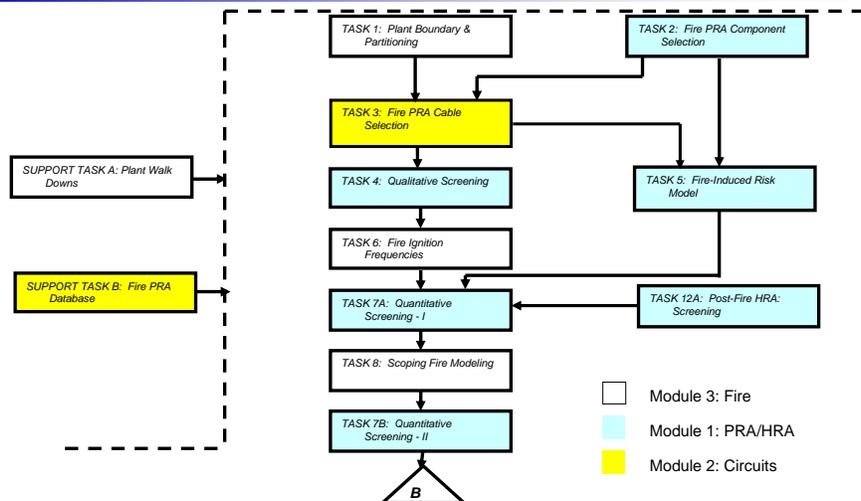
- **Module 1: PRA/HRA**
 - Post-fire plant response model, including systems, components and operator manual actions (CCDP, CLERP)
- **Module 2: Cable selection, circuit failure mode analysis**
 - Electrical response, embedded in the Post-fire plant response model (P_{cf})
- **Module 3: Fire analysis**
 - Fire hazard; ignition frequency, fire severity, fire growth, detection/suppression ($IF * SF * P_{ns}$)

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Overview Of Fire PRA Process and Module Structure

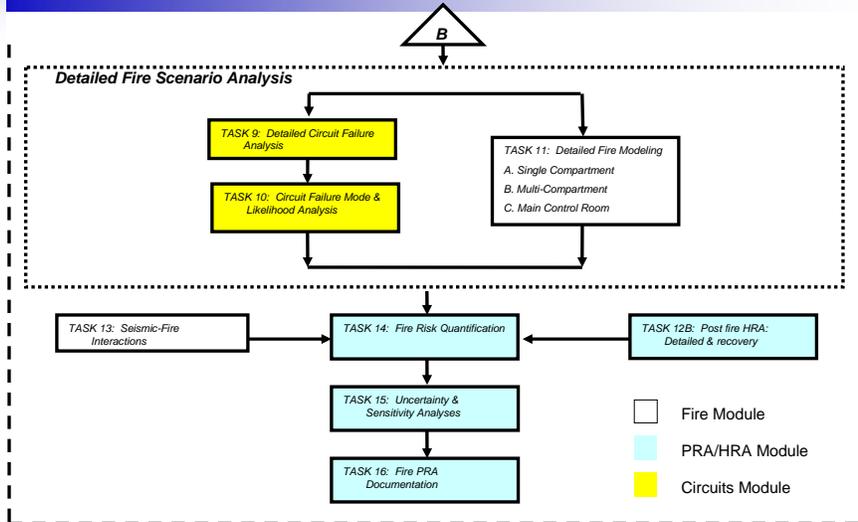


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Overview Of Fire PRA Process and Module Structure (2)



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PART II

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

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Lessons Learned and Insights

Scope of this Module

- Demonstration studies / Pilots
 - *Focus today is on NFPA-805 pilot plants and other “early adopters”*
- FAQ process and methods-related topics
- General insights; Programmatic & Technical
- Path forward with EPRI 1011989 , NUREG/CR-6850

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Lessons Learned and Insights

Demonstration /Pilot Studies

- The procedures were individually tested during development
- All the procedures worked, and seemed to be of reasonable depth, scope, and clarity to make implementation practical
- First top-to-bottom testing as a full, consolidated, and complete set ongoing by 805 pilots and other early adopters

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Lessons Learned and Insights

Demonstration /Pilot Studies (continued)

- Numerical results are being developed, but remain preliminary
- The potential for “hidden surprises” was acknowledged from the outset, and there have been some...
 - Others likely remain to be discovered, and **you** may find them
- *The NFPA-805 FAQ process is the primary mechanism currently available to address application issues*
 - As a user, you should monitor the FAQ process
 - FAQ resolutions may resolve your questions as well
- We continue to seek user feedback and experience – the procedures are intended to be “living documents” to at least some extent

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Lessons Learned and Insights

Pilot Studies – Our Early Experience Showed and Pilots Confirm that...

- It's Easy to get distracted, e.g.:
 - If you want to re-baseline Appendix R, do that first, then do your fire PRA – the objectives are *NOT* the same although the Fire PRA would benefit
 - Work together with the Appendix R re-baseline to ensure the final product is useful for Fire PRA purposes
- Get a team of the right people with the right knowledge to do the job, e.g.:
 - The PRA gurus may think they know circuits, but you really need those with true electrical expertise
 - You *NEED* your team to include expertise in fire, systems, PRA, plant operations, HRA, and electrical circuits/analysis

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Lessons Learned and Insights Frequently Asked Questions (FAQ)

- The NPFA-805 FAQ process is the primary vehicle for feedback to EPRI TR 1011989, NUREG/CR-6850
 - Managed by the NEI/NRC NFPA-805 task force and NRC/NRR NFPA-805 team
- FAQs cover a range of topics and not all are related to the fire PRA methodology
- FAQs come from various sources including the RES/EPRI team, the 805 pilot plants, and other early adopters

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Lessons Learned and Insights Frequently Asked Questions (FAQ) (continued)

- To date 52 FAQs have been initiated
- Of these 52, 16 are related to implementation of EPRI TR-1011989, NUREG/CR-6850
- Of these 16:
 - 4 are closed (i.e., resolution complete and docketed)
 - 12 are pending (i.e., resolution is not yet final)
 - Various stages from near complete to in the initial “problem statement” stage
- **Caveat:**
 - Although a resolution may be complete and docketed, a FAQ still remains “unofficial” until endorsed in a revision of Regulatory Guide 1.205 (either directly, or by endorsing a NEI-04-02 revision that incorporates the FAQ)

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Lessons Learned and Insights Frequently Asked Questions (FAQ) (cont)

- Fire PRA “Methodology” FAQs include
 - Clarifications to existing guidance
 - Filling in methodology “gaps”
 - Refinements to existing approaches
 - Revised guidance for specific aspects of the analysis
- 14 of the 16 methodology FAQs are “fire” questions
 - These FAQs cover a range of topics
- The other two are “electrical” questions
 - Spurious actuation dependency given multiple cables with HS potential impacted by the same fire
 - Hot short duration

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Lessons Learned and Insights Closed FAQs

- FAQ 06-0016: Electrical cabinet counting guidance
 - Provides clarifying examples of “vertical section” counting guidance
- FAQ 06-0017: High Energy Arc Faults in electrical cabinets
 - Provides clarifying guidance for counting cabinets in the context of HEAF ignition frequency
 - Provides a frequency split between low and medium voltage cabinets
 - Clarifies treatment of HEAF in MCCs
- FAQ 06-018: Main control board (MCB) fires
 - Clarifies definition of MCB (what to include, what to exclude)
 - Clarifies direct link between model in Appendix L and the as-defined MCB

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Closed FAQs (continued)

- FAQ 06-0031: Ignition source counting guidance clarifications and extensions
 - **Bin 14 – Electric motors:** clarifies guidance, provides for excluding small motors of 5hp or less and totally enclosed motors.
 - **Bin 21 – Pumps:** provides for excluding small sampling pumps, and other pumps of 5hp or less
 - **Bin 23 – Transformers:** provides for excluding dry transformers of 45KVA or less
 - **Bin 26 – Ventilation subsystems:** clarifies that intent is to exclude small subsystems powered by motors of 5hp or less (consistent with electric motors bin 14)

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Lessons Learned and Insights

In-process FAQs

- FAQ 07-0035: High energy arc faults in bus ducts
 - Issue:
 - Guidance document is silent on topic
 - General approach to resolution:
 - Acknowledge potential for such events (e.g., Diablo Canyon 5/2000)
 - Provide plant wide frequency and counting/partitioning guidance
 - Provide zone of influence and scenario development guidance
 - Status:
 - FAQ resolution has been drafted and reviewed
 - Final revisions in process

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Lessons Learned and Insights

In-process FAQs (continued)

- FAQ 08-0042
 - Issue:
 - Guidance provides conflicting language regarding propagation of fire from cabinets (Chapter 6 versus Appendix G)
 - General approach to resolution:
 - Clarify and expand definition of “well-sealed and robustly secured cabinets” (which will not propagate fires)
 - Status:
 - FAQ resolution has been drafted and reviewed by RES/EPRI team
 - Industry and NRC staff reviews pending

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Lessons Learned and Insights

In-process FAQs (continued)

- FAQ 08-0043
 - Issue:
 - Guidance for placement of a cabinet fire (the source location) suggests inspecting cabinet contents and placing fire at fuel location
 - Applicants would prefer a “one size” approach less conservative than placing on top of cabinet that would not require internal inspection
 - General approach to resolution:
 - RES/EPRI teams are debating merits of general application of fire protection SDP approach – place fire 1 foot below cabinet top (unless top is unsealed or vented)
 - Status:
 - Team position has been drafted and is under review
 - Staff final review pending

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0044
 - Issue:
 - Guidance for large oil spill and fire is generating conservative results especially in the case of MFW pump fires (high frequency of large release compared to experience base)
 - General approach to resolution:
 - Provide an alternative approach and revised fire frequencies for leaks and spills from higher volume circulating oil/lubrication systems
 - Status:
 - General consensus that a revised treatment is appropriate and needed
 - RES/EPRI team discussion of the specific resolution approach continues, reviews ongoing
 - NRC 805 team and industry 805 task force reviews pending

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0045
 - Issue:
 - Fire growth recommendations for electrical cabinets does not include consideration of an incipient stage (e.g., pre-ignition heating and generation of un-burned pyrolysates which might be detected)
 - General approach to resolution:
 - No clear resolution approach has yet been developed
 - Status:
 - A problem statement has been generated
 - **FAQ may be withdrawn - not amenable to short-term solution**

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0046
 - Issue:
 - Methodology provides no approach for crediting incipient fire detection systems
 - General approach to resolution:
 - Develop an approach that would credit these systems
 - Status:
 - Initial drafts of a proposed approach are under discussion within the RES/EPRI teams
 - Work continues to try to establish a firm technical basis
 - NRC staff and industry review pending

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0047
 - Issue:
 - Guidance states that when more than one cable can cause the same spurious actuation you combine probabilities using “exclusive or”
 - This assumes faults/effects are independent
 - General approach to resolution:
 - Consensus reached that “exclusive or” is not appropriate if faults are dependent (e.g., a common power supply for both cables)
 - Clarify treatment to determine and address dependency
 - Status:
 - Team draft has been completed
 - Staff and final industry review pending

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0048
 - Issue:
 - Fire frequency analysis may not reflect industry trends (i.e., towards reduced fire frequencies)
 - General approach to resolution:
 - Work is under way within EPRI team to determine if statistically significant fire frequency trends can be demonstrated
 - Fire frequencies for one or more ignition source bins may be modified (up or down depending on trends)
 - Status:
 - Work to date remains largely within the EPRI team
 - Review/input by RES team pending

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0049
 - Issue:
 - The cable fire empirical spread model (tray-to-tray, stack-to-stack) has been misapplied in pilot applications
 - Reviewers concluded that misapplication resulted in very conservative fire growth and risk results
 - General approach to resolution:
 - Clarify the bounds of the empirical model to avoid misapplication
 - Status:
 - Proposed resolution has recently completed final review within the RES and EPRI teams
 - Staff and industry final review pending
 - Final revision, as needed, pending
 - Note: as a follow-on, team plans to generate a new FAQ to address broader needs relative to cable fire growth modeling

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0050
 - Issue:
 - The fire non-suppression curves as cited as reflecting suppression performance *after* fire brigade response time but a significant fraction of the duration data used in curves includes brigade response time
 - Fire brigade may not be getting adequate credit for suppressing fires prior to damage
 - General approach to resolution:
 - EPRI team has reviewed data and proposed an alternative set of non-suppression curves that would include fire brigade response time
 - Status:
 - Work to date has largely been confined to EPRI team
 - NRC team is currently reviewing proposed resolution
 - Staff and industry reviews pending

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Lessons Learned and Insights *In-process FAQs (continued)*

- FAQ 08-0051
 - Issue:
 - The guidance does not provide a method for estimating the duration of a hot short once formed
 - This could be a significant factor for certain types of plant equipment that will return to a “fail safe” position if the hot short is removed
 - General approach to resolution:
 - Analyze the existing cable failure modes and effects test data to determine if an adequate basis exists to establish hot short duration distributions
 - Status:
 - Initial data analysis has been completed and results are under team review
 - NRC staff and industry review pending

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Lessons Learned and Insights

In-process FAQs (continued)

- FAQ 08-0052
 - Issue:
 - No guidance on fire growth times for transient fires
 - Guidance not clear as to which non-suppression curve would apply to transient fires in the MCR (i.e., transient curve or MCR curve)
 - General approach to resolution:
 - Review existing test data and develop guidance for transient fire growth times
 - Clarify non-suppression curve application for this case
 - Status:
 - Initial team position drafted and undergoing review within the teams
 - Staff and industry reviews pending

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Lessons Learned and Insights

Component Selection

- Resource intensive and critical, for the most part due to consideration of multiple spurious operation (MSO)
 - ANS Fire PRA Standard is identifying requirements on MSOs
- Defines the scope of the Fire PRA as it relates to post-fire plant (system and operator) response
 - Ongoing discussions re: instrumentation in NFPA 805 pilot program
- Fire PRA component list will be larger than your Appendix R and PRA component list
 - New components whose omission will be non-conservative
 - For MSO considerations
 - For fire-specific operator manual actions (OMAs)
 - Expect that you *will* want/need to consider others to get a realistic risk result
- NMP-1 pilot follows the EPRI/NRC-RES method on MSO consideration

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Lessons Learned and Insights

Cable Selection

- Cable selection is probably the single biggest factor that will drive your resource requirements
 - The burden comes largely with the need to trace selected cables
 - You also need an *accessible* cable database, and constructing such a database from your existing system may not be so easy
 - This is going to depend a lot on the depth of your cable tracing and the nature of your current tracking system
- Exercise judgment
 - You may initially want to trace *all* your cables, but that may not be the best choice – you are taking on quite a job at most plants
 - Take advantage of the iterative approaches to cable tracing

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Lessons Learned and Insights

Circuit Analysis

- Circuit analysis need not be a huge burden
- Compared to cable tracing, circuit analysis should be far less resource intensive – although it does require participation of key personnel (the electrical guru)
- The procedure provides various approaches that have been drawn from past practice and experience
 - Make use of those options!
 - Go after the “bang for the buck” circuits and “take the hit” when it is not risk important

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Lessons Learned and Insights

Fire Ignition Frequency and Fire Modeling

- Understand the scope of work of Tasks 1, 6, 8 and 11
 - One walkdown effort for collecting information for all the tasks
 - Use of a relational database for organizing and analyzing data is recommended
 - It is recommended that Task 8, Scoping Fire Modeling be conducted with Task 6, Fire Ignition Frequencies or Task 11, Detailed Fire Modeling
- Fire modeling in single compartments
 - Hand calculations will suffice for many cases, but more sophisticated modeling (e.g., compartment fire models) also has a place
 - Create fire modeling drawing packages. These are room layout drawings with ignition sources and Fire PRA targets highlighted.
- Fire modeling in the main control room
 - Fire zone or field models are necessary
 - Will require detailed system analysis and HRA
 - Smoke removal system can significantly impact abandonment and risk

Tab 5.2:

RES & EPRI Closing Perspectives



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module III-2: Perspective

Ken Canavan - EPRI

J.S. Hyslop - RES

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On The Requantification Project

- A consensus methodology for Fire PRA that is facilitating implementation of risk-informed fire protection
- Remains the best available method to estimate fire risk & obtain insights
- Guidance is producing greater agreement among technical experts
- Much activity ongoing in NFPA 805 FAQ program due to fire PRAs being performed during transition

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Module III-2: Perspective*

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Continued Cooperation

- We established a framework for future research cooperation
 - Quality of work and positive technical reviews pave the way for continued cooperation
- The cooperation under the MOU is continuing
 - Fire Model User's Guide
 - Fire Human Reliability Analysis (HRA)
 - Fire Low Power and Shutdown
 - Others....