

MOVING FORWARD WITH DEVELOPED FIRE PRA MODELS – A MODEL OWNER'S PERSPECTIVE

Young G. Jo

Southern Nuclear Operating Company

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I. INTRODUCTION

- US utilities had Challenges in developing fire PRA to support for NFPA 805 transitions:
 - Lack of matured methodologies and clear guidance,
 - Difficulties in retrieving/obtaining plant data,
 - Insufficient time and resources, and
 - Lack of in-house technical expertise.
- Many US utilities had to heavily rely on more experienced external contractors to complete fire PRA models as soon as practically possible for a timely support for NFPA 805 transition
- **Developing in-house technical capabilities for fire PRA modeling was not the first priority.**
- **As a consequence, when their NFPA 805 transitions were completed, the utilities (“Fire PRA Model Owners”) encountered new challenges**



II.A New Challenges after NFPA 805 Transition

- **For, a Fire PRA model owner without having a chance for developing sufficient in house technical capabilities,**
 - **Even using the delivered fire PRA model(s) for post NFPA 805 plant change evaluation for fire risk impact is challenging**
 - **This is true even when a fire PRA model owner acquired partial technical capabilities, because the fire PRA model owner is lack of full understanding of the interfaces among and integration of various fire PRA tasks inputs and outputs to form a fire PRA model**



II.A New Challenges after NFPA 805 Transition

- **Similar challenges may exist where a fire model owner has acquired certain level of expertise for all aspects of fire PRAs if only one or two engineers in the organization have such technical capabilities and there are multiple requests from multiple plants for plant change evaluations within a short time.**
- **More challenges come from the requirements to update fire PRA models periodically to represent as-built as-operated plant and to upgrade fire PRA models to implement newly accepted methods and data.**
- **For a utility which owns fire PRA models for its several multi units nuclear plant sites, these challenges become more difficult to overcome.**



II.B Path Forward

- **In order to overcome the new challenges and move forward as a fire PRA model owner, a plan is needed.**
- **The followings should be considered in developing a plan:**
 - Developing/updating a fire PRA model requires multidisciplinary technical expertise
 - It is complex to integrate all inputs and outputs from various fire PRA tasks into a fire PRA model
 - Acquiring technical skills and expertise in all fire PRA technical tasks may not be achieved in a short time period
 - While a utility is struggling to acquire the necessary in-house technical skills/expertise, there, in parallel, will be continuous demands for applying the fire PRA model for plant change evaluations and for other risk informed applications and demands for updating/upgrading the fire PRA model.



II.B.1 Three Tier Goals

- **It is proposed to set three tier goals in order to meet the most urgent needs first and less urgent needs later:**
 - **Tier 1 (short term) goal: To acquire in-house technical capabilities for fully understanding the current version of the fire PRA model and handling the fire PRA model in order to support the immediate needs for plant change evaluations for NFPA 805**
 - **Tier 2 (mid-term) goal: To acquire in-house technical capabilities for updating the fire PRA model to represent as-built as-operated plant**
 - **Tier 3 (long term) goal: To acquire in-house technical capabilities for upgrading the fire PRA model to enhance realism or to replace existing methods with newly accepted methods**



II.B.2 Required Technical Skills/Expertise to Achieve Tier Goals

- **Before trying to achieve the three tier goals, the following fundamental PRA technical expertise may be required as prerequisites:**
 - Familiarity of fundamentals of the PRA methodologies
 - Familiarity of systems designs and controls and interfaces, drawings, operations, and procedures of the specific plant for which the fire PRA was developed
 - Familiarity the specific plant's internal PRA model which was used as the bases for the fire PRA model. Especially, it is required to have good understanding of accident sequences and event trees, system fault tree modeling and linked fault tree, human reliability analysis, and quantification and recovery analysis
 - Familiarity with computer programs used for the internal PRA model which are be used also for fire PRA model
 - Familiarity with data base software and spread sheet software



Required Technical Skills/Expertise to Achieve Tier 1 Goal

- **The Tier 1 goal aims at acquiring technical capabilities for mastering the use of a plant specific PRA model for NFPA 805 plant change evaluations.**
- **The technical skills/expertise for achieving the Tier 1 goal include, but not limited to, the followings:**
 - **Fundamentals:**
 - Basic understanding of fire PRA development process
 - Basic understanding of each fire PRA task and its interfaces with other fire PRA tasks



Required Technical Skills/Expertise to Achieve Tier 1 Goal

- **The technical skills/expertise for achieving the Tier 1 goal include, but not limited to, the followings (continued):**
 - **For a plant specific fire PRA model:**
 - **Knowledge of what are included** in the plant specific fire PRA material package. The plant specific fire PRA package may include task reports, data bases, model files, modeling computer tools, and supporting analyses
 - **Knowledge/understanding of the methods and data chosen** for developing the plant specific fire PRA
 - **Ability to locate information**, which is needed for plant change evaluations, from the plant fire PRA materials
 - **Ability to figure out, given a plant change, how and where it will impact the plant specific fire PRA.** In order to able to do this, an analyst should be familiar with the details of the plant specific fire PRA model



Required Technical Skills/Expertise to Achieve Tier 1 Goal

- **Also, during Tier 1, it is desirable to**
 - Integrate fire PRA data bases into a software platform which facilitates management of various fire PRA data bases -> FRANX and
 - Establish extended configuration control program to include data bases and models which provided inputs to the fire PRA model but may be modified by other engineering groups:
 - Internal PRA logic model or backbone logic model
 - Cable and raceway data,
 - Circuit Analysis packages, and
 - Fire Protection and etc.



Required Technical Skills/Expertise to Achieve Tier 2 Goal

- **To achieve Tier 2 goal, or to update the fire PRA model to represent as-built as-operated plant, the technical skills/expertise which should be acquired for the Tier 2 goal include, but not limited to, the followings:**
 - Ability to perform an update of the plant specific internal events PRA model or a backbone logic model which was used as the basis for existing plant specific fire PRA model
 - For each fire PRA task, full understanding of the methods applied and how the methods were applied in developing the existing plant specific fire PRA model
 - **Ability to perform each fire PRA task again using the same/similar methods in order to reflect the changes in inputs to the fire PRA model due to plant changes, internal PRA model changes, or data changes.**



Required Technical Skills/Expertise to Achieve Tier 2 Goal

- To achieve Tier 2 goal, or to update the fire PRA model to represent as-built as-operated plant, the technical skills/expertise which should be acquired for the Tier 2 goal include, but not limited to, the followings (continued):
 - Ability to integrate inputs and outputs from each task into a fire PRA model in a fire PRA software platform such as FRANX
 - Ability to validate and refine the updated fire PRA model to make the model realistic and error free as much as practically possible.
 - **Ability to provide technical oversight on the fire PRA model update**



Required Technical Skills/Expertise to Achieve Tier 3 Goal

- **To achieve the tier 3 goal, acquiring subject matter expert level technical skills/expertise is required for major fire PRA tasks.**
- Since upgrading a fire PRA model means to update the fire PRA model using more advanced methods, to achieve the tier 3 goal a focus may be made on acquiring in-depth technical skills/expertise **for the following fire PRA tasks whose methodologies have not been fully matured:**
 - Fire modeling
 - Circuit failures and circuit failure mode likelihood analysis
 - Modeling scenarios after main control room (MCR) abandonment
 - Fire Human Reliability Analysis, especially, for the operator recovery actions after MCR abandonment



II.B.3 Training

- **Training programs should be developed to acquire the technical skills/expertise to achieve the tier goals.**
- **In developing the training programs, the followings should be considered:**
 - The urgency in achieving goals is in order of Tier 1 goal, Tier 2 goal, and Tier 3.
 - Sometimes in order to perform a plant change evaluation for NFPA 805, technical capabilities for meeting Tier 2 and Tier 3 goals may also be required.
 - Also, sooner or later the fire PRA model needs to be updated. Furthermore, if any existing method is replaced with a newly approved method, the fire PRA model should be upgraded.
 - **Therefore, it is desirable to initiate the efforts for acquiring technical skills/expertise to achieve Tier 2 goal and Tier 3 goal at the same time as or shortly after the initiation of achieving Tier 1 goal.**



II.B.3 Training

- In developing the training programs, the followings should be considered (continued):
 - **Engineers with the plant specific internal PRA experience/knowledge and some fire PRA experiences may need to be trained first in order to meet tier 1 training goals as soon as possible.**
 - **Considering the expected large demands for plant change evaluations during the transition to and after full implementation of NFPA 805, It is desirable to train as many engineers as practically possible to acquire the technical skills/expertise for meeting Tier 1 goals.**
 - **For tier 1 training, a plant specific fire PRA model and materials should be used as much as practically possible so that trainees can use the plant specific fire PRA immediately after the training for plant change evaluations for NFPA 805**



II.B.3 Training

- **In developing the training programs, the followings should be considered (continued):**
 - **The following fire PRA tasks may be easily performed by experienced internal PRA analysts with some task guidance/instruction:**
 - Component selection,
 - Fire PRA logic modeling including modeling of multiple spurious operation scenarios and instruments for operator action cues, and
 - Ignition source counting and the estimation of ignition frequencies



II.B.3 Training

- **In developing the training programs, the followings should be considered (continued):**
 - **It may be more practical to acquire Tier 2 technical capabilities at the team level.**
 - **To acquire the technical skills/expertise for meeting Tier 3 goals, it is desirable to let selected in-house subject matter experts involve in industry efforts to develop advanced fire PRA methodologies and data.**

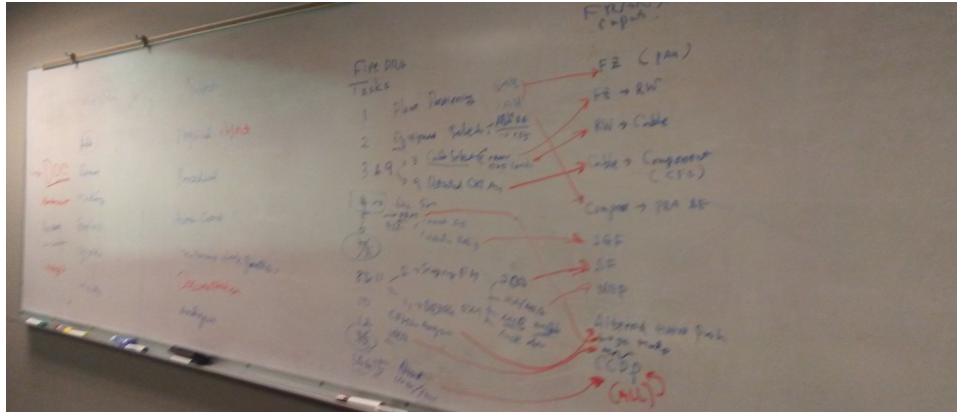


II.B.3 Training

- **In developing the training programs, the followings should be considered (continued):**
 - **In addition to the above technical capabilities, it is essential to develop a capability to provide technical oversight for using, updating and upgrading fire PRA model.**
 - **Diverse training methods should be considered:**
 - Use of existing department and company training/qualification programs.
 - In-house training may be offered by:
 - A series of fire PRA training sessions offered by in-house subject matter experts or invited outside fire PRA experts
 - On the job training by mentors
 - Self-study
 - Utilizing NRC/EPRI fire PRA trainings



II.B.3 Training



- **Training for Design Change Fire Risk Impact Review Qualification**
 - Implemented through 4 Sessions (July - August 2017)
 - Used a plant fire PRA specific model and materials
 - Graduate school seminar style classes
 - Two (one with 30 yrs of internal PRA experience and another with 3 years of internal PRA experience + 5 years of circuit analysis experience) survived training and were qualified
- **Fire modeling training (by an invited industry fire modeling expert): Use fire correlations and CFAST program as well as basics of fire behaviors and modeling: ~ 8 trainees**



III. CONCLUSIONS

- **After transition to NFPA 805, US utilities encounter new challenges in using, updating, and upgrading their fire PRA models for continuously supporting NFPA 805 implementation and other risk informed applications.**
- **To overcome such challenges, it was proposed to set up three tier goals, identify technical skills/expertise to achieve each tier goal, and develop training programs to acquire the required technical skills/expertise.**
- **The proposed approach will help US utilities in acquiring technical capabilities for dealing with the most urgent needs, or plant change evaluations for NFPA 805, as soon as practically possible and for gradually developing in-house technical capabilities for updating and upgrading their fire PRA models.**

