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Observations on Status of Risk Technology

Stuart Lewis
Program Manager

Rick Wachowiak
Sr. Project Manager

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Background

- EPRI continues to engage in research into methods relevant to risk assessment and risk-informed applications
- Many of the research areas are pursued jointly with NRC
- Examples of ongoing research areas
  - Treatment of uncertainties
  - Modeling of supporting-system initiating events
  - Methods for fire PRA
  - Methods for assessment of seismic hazards
  - Methods for PRA for low-power/shutdown conditions

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Experience in fire PRA

- Methods for fire PRA developed jointly by NRC and EPRI, and reported in NUREG/CR-6850 (EPRI 1011989)
- Fire PRA methodology put into use with limited experience and incomplete trial
- Observations from experiences in using NUREG/CR-6850:
  - Significant conservatisms identified across the industry; e.g.,
    - Manner in which fires are characterized in does not appear to conform with operating experience
    - Level of quantified risk appears to be overstated, as compared to operating experience
  - Attempts to augment methods via FAQ process has had limited success in providing more realistic guidance

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Experience in fire PRA (continued)

- Areas of need for additional methodology improvements have been identified by both industry and NRC staff to achieve more realistic fire PRAs
- Uneven level of conservatism may obscure key risk insights; biased results can
  - Mask important events and components
  - Drive plant changes that do not improve safety
- Realistic methods important for applications
  - NFPA 805
  - Other risk-informed activities (e.g., Maintenance Rule a(4), risk-informed tech specs, NOEDs, Significance Determination Process)

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Focus of additional research activities

- Increase level of realism in fire PRA
  - Support risk-informed applications
  - Reduce large uncertainties where possible
  - Achieve compatibility with internal events PRA
- Fire PRA Action Matrix developed to outline and track research activities needed to increase realism; areas of research:
  - Fire initiation, detection, and suppression
  - Fire damage assessment
  - Plant impact, fire PRA scenarios, and quantification
  - Other ongoing fire PRA activities

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Fire initiation, detection, and suppression

- Experience indicates that currently used frequencies are too high
- Activities to improve the estimation of fire event frequencies:
  - Revision of the Fire Events Database (FEDB)
  - Update of fire ignition frequencies
  - Evaluation of detection and termination prior to an actual fire event
  - Investigation (with NRC) of credit for incipient detection
  - PWROG working on oil fires
  - BWROG working on fire suppression probabilities

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Update to Fire Events Database

- Interim report issued that describes structure for the data base—NRC has reviewed and is in agreement
- Currently collecting data from industry
  - Owners groups performing initial screen of records
  - Data entry expected to be completed in 2011
  - Report of the data to be publicly released
- Working with INPO to transition to single entity for ongoing data collection

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Fire damage assessment

- Reassessment of assumptions on rate of fire growth (ramp-up stage to fully developed fire is inconsistent with operating experience)
- Reanalysis of peak heat release rates
  - Report on electrical cabinet fires undergoing industry peer review
  - Transient fires and hot work identified for refinement
- Revision to fire modeling guidance
  - Fire modeling users guide is about to undergo review
  - Joint effort with NRC Research

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Plant impact, fire PRA scenarios, and quantification

- Treatment of hot shorts
  - Update of AC circuit failure probability and duration
  - DC circuit testing complete
- Human reliability methods (revised report expected early 2011)
- Modeling of control room fires
- PRA model refinement to address unrealistic assumptions currently used
  - For example: assumption that every fire results in a plant trip and challenge to safety systems

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Other ongoing fire PRA activities

- Update of Fire PRA section of PRA standard
- Refinement of guidance for peer reviews
- Comparison of risk results
- Fire PRA training (joint EPRI/NRC activity)
- Peer review of new methods
  - Initiated by industry as needed
  - Methods intended to be
    - Transparent and well documented
    - Reproducible

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Seismic PRA pilot recently completed

- Pilot PRA conducted for reference US PWR
- Objectives
  - Investigate state of the art in SPRA relative to requirements of ASME/ANS PRA Standard
  - Identify changes or additions needed for Standard
- Conduct of pilot offers insight into gaps in seismic risk technology (still being evaluated)

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Further seismic PRA research needed

Areas under review or further development include

- Resolution of issues associated with seismic hazard characterization
- Seismic response scaling for soil sites
- Ability to use generic fragility estimates vs. need for detailed analyses
- Apparent need for better coordination/optimization of hazard/fragility parameters
- Ability to model correlations among seismic failures
- Methods to adapt HRA to seismic situation
- Quantification and uncertainty analysis tools

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Issues related to LPSD PRA

- LPSD PRA Standard available in draft form:
  - Includes new concepts
  - Intended for large LPSD PRA models
  - Complex
- Further technical development needed in certain areas
- Comprehensive piloting needed to
  - Evaluate methods relative to LPSD standard
  - Identify additional gaps in technology that need to be addressed

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Potential research areas

- Limited experience in applying definitions of CDF and plant operating states (definition of “average” outage, etc.)
- Appropriate calculation for initiating event frequencies (mixes of time-related failures and conditional failures on demand)
- Adaptation/extension of human reliability analysis
  - Ability to identify relevant human interactions/human failure events
  - Treatment of dependence among post-initiator HFEs

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Examples of research areas

- Use of Demand-Based Initiators to Develop IEs
  - CDF and LERF are calculated using contributions from both time-based and demand-based initiators
    - Example – loss of DHR based on frequency of pump failures (time-based) and based on human error during draindown (demand-based)
  - *It is not clear that the demand-based IEs are distinctive contributors or if they are precursors to a loss of DHR event.*

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Summary

Experience with fire PRA has provided evidence that

- Areas for which methods are not fully developed should be explored further
- Effective piloting should be performed to investigate
  - Adequacy and maturity of methods
  - Practical use of standards
  - Degree to which methods allow standard requirements to be met

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