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Protecting People and the Environment

Perspectives on the NRC's Standardized Plant Analysis Risk (SPAR) Models

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Outline

- SPAR Uses & Capabilities
- SPAR Modeling Philosophy
- Quality Activities & Processes
  - SPAR QA Program Activities
  - SDP Process Controls
- Comparison with Licensee PRAs
- Key Messages

SPAR Model Uses

- Reactor Oversight
  - Significance Determination Process (SDP)
  - Notices of Enforcement Discretion (NOEDs)
  - Management Directive MD 8.3 Incident Investigation Assessments
  - Accident Sequence Precursor Program
- System & Component Studies
- Generic Issue Screening
- Special Studies

SPAR Model Capabilities

- Operating Reactors
  - 79 full-power, internal events models representing all operating plants
  - 17 IPEEE-based external hazard models
  - 3 All Hazard Models
  - 8 Shutdown template models
  - 3 Level 2 feasibility models
  - 1 Integrated Capability Model
- New Reactors
  - ABWR – GE & Toshiba (SD)
  - APWR
  - AP1000 (seismic, flooding, fire)
  - US EPR

SPAR Philosophy

- Provide independent, plant-specific PRA models for use by agency risk analysts
  - "[I]ndependent oversight of licensee performance is critical for effective NRC oversight and is an important aspect of upholding public confidence in the [SDP] process" (letter from EDO to NEI, October 2007, ML072490566)
- Use standardized modeling conventions
  - Standardization approach supports plant-specific modeling
  - Ease of use for agency analysts
  - Efficient model maintenance and updating

SPAR Philosophy

- Support event and condition assessment (ECA) activities
  - SAPHIRE user “workspaces” structured to support ROP
  - SPAR models designed to efficiently address typical ECA activities (e.g., CCF, LOOP modeling)
- Apply agency resources in a cost-effective manner
  - SPAR models generally not as detailed as licensee models (with some exceptions)
  - SPAR generally relies on licensee PRA modeling assumptions (supported with some independent analysis)
  - Models developed with the best available information provided by licensees

SPAR QA Program

- SPAR Quality Assurance Plan
- SPAR Project Manager Handbook
- RASP Handbook
  - Volume 3 provides detailed guidance on performing SPAR model modifications and reviews to ensure that the models are of adequate quality and reflect the as-built, as-operated plant for the problem being analyzed
- Model Maker Guidelines (MMGs)
  - All Hazard Models
  - Shutdown
  - Integrated Capability Modeling

SPAR & SAPHIRE QA Programs

- Onsite verification reviews
  - Onsite reviews conducted during MSPI benchmarking activities
  - Onsite reviews conducted for new modeling elements (e.g., shutdown, fire, external hazards)
- SPAR Configuration/Version Control
- SAPHIRE Quality Assurance Plan
  - Independent Verification and Validation for SAPHIRE 8
  - NUREG/BR-0167, “Software Quality Assurance Program and Guidelines” compliant QA program, including annual audits

SPAR QA - Process

- SPAR model Maintenance Program
  - Major updates are performed on approximately 8-12 SPAR models per year based on feedback from model users and licensees
  - Less significant model changes are performed on an additional ~20 models per year to support risk assessments for specific regulatory applications
  - Approximately a third of the plant-specific SPAR models are typically updated in a given year

SPAR QA Program

- Licensees are provided their SPAR models upon request
  - Consistent with SECY 2004-0191, SPAR models are non-public and licensees are expected to protect the models against inadvertent release (using controls consistent with RIS 2005-026)
  - With each distribution, NRC requests feedback on unresolved differences between the models
  - Ideally, differences between SPAR and licensee models could be reconciled before an SDP, but this is difficult in practice

SPAR QA Program

- 2009 ASME PRA Standard Peer Reviews
  - BWROG and PWROG led peer reviews of a typical BWR and PWR SPAR model
  - Peer review team consisted of industry experts and experienced agency risk analysts (HQ and SRAs)
  - The Peer Review noted the following SPAR model strengths:
    - Model structure is robust and well developed.
    - Fault trees are streamlined with an appropriate level of detail for its intended uses.
    - Model structure and the SAPHIRE computer software are at the state of the technology.
    - Models are an efficient method to develop qualitative and quantitative insights for applications, SDP evaluations, inspections, event assessments, and model evaluations.

SDP Process Controls

- Qualified Analysts - SRAs complete a rigorous training and qualification program (described in Inspection Manual Chapter 1245, Appendix C-9) to ensure that they can proficiently apply risk tools
- Internal SERP reviews are held for all “greater than green” findings to ensure appropriate risk assessment methods are applied with consistency in the ROP
- Licensees afforded an opportunity to either attend a Regulatory Conference or provide a written response for all performance issues of “Greater than Green” significance

Comparisons to Licensee PRAs

- SPAR models are benchmarked to licensee PRA information after major SPAR updates
  - Comparisons rely on the best available information provided by the licensee
- Benchmarking includes the following baseline model checks:
  - SPAR core damage frequency (CDF) less than 1E-4/yr
  - Difference between SPAR and PRA CDF less than a factor of 3
  - Difference between initiator specific CCDPs less than factor of 10
  - Difference in CDF of top 25 cut sets less than a factor of 5
  - Qualitative review of top cut sets
- Identified differences are described in the SPAR model documentation

Comparisons to Licensee PRAs

- The NRC has not observed significant divergence in analysis results due to modeling differences between licensee and SPAR models
  - While divergence between licensee and NRC SDP assessments is sometimes noted, the reasons generally involve analysis-specific assumptions and boundary conditions (e.g., human reliability analysis, recovery credit) rather than baseline modeling differences
- Exchange of technical PRA information between the NRC and licensees is an expected part of the SDP
  - Focused discussion on a specific operational event is often more efficient than attempting to make more generic changes to the base model

Comparisons to Licensee PRAs

- In general, SPAR models do not credit equipment repair & recovery
  - SPAR equipment recovery is generally limited to EDGs and offsite power
  - Generic approach to recovery is not practical
- The lack of recovery modeling is not an "error", but a consequence of the SPAR modeling philosophy
  - NRC analysts can adjust SPAR models when there is sufficient technical justification
  - However, even appropriate changes for a specific event or condition may not be appropriate for the base model

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Key Messages

- No PRA (SPAR or licensee) can accurately capture every nuance of an operational event
  - Experienced risk analysts must make modeling decisions for each specific event
  - Process controls include peer reviews of model results
- NRC maintains an active Quality Assurance Programs for SPAR and SAPHIRE
  - Process controls include issue reporting and resolution
  - Actively seek feedback on models to ensure they represent the as-built, as-operated plant

Key Messages

- Exchange of technical information between the NRC and licensees is an expected part of the significance determination process
- SPAR models provide an independent and effective risk assessment tool and are fully capable of supporting ROP activities.