Application of Seismic PRA in the United States since the Tokyo Workshop

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Presenting for
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Outline of the Presentation

- Background
- PRA Quality Developments at the NRC
- Status of US Consensus PRA Standards
- Status of Guidance Documents
- Examples of Application of PRA
  - Transition Break Size
  - SPAR Models – External Events
- Additional Discussion of Topics
  - Development of US Seismic Siting & Design Guidance
  - Development of US National Standard on External Event PRA

NRC PRA Policy Statement

- Increase use in all regulatory matters to the extent supported by the state-of-the-art
- Reduce unnecessary conservatism and to support proposal for additional regulatory requirements
- Perform PRA evaluations as realistic as practicable
- Use Safety Goals and subsidiary objectives with appropriate consideration of uncertainties

Risk-Informed Regulatory Activities (examples)

- Rulemakings
  - 50.69 – Special treatment requirements
  - 50.44 – Combustible gas control
  - 50.48(c) – Fire Protection (National Fire Protection Association Standard 805)
  - 50.46a – Emergency Core Cooling
- Licensing Actions
  - Risk-informed licensing actions using Regulatory Guide 1.174
  - Risk-informed technical specification initiatives (e.g., flexible completion times)
- Reactor Oversight Process
  - Risk-Informed Baseline Inspections
  - Significance Determination Process
  - Performance Indicators
  - Mitigating Systems Performance Index (MSPI)

Overall Issue: PRA Quality

- Need to understand what is meant by "PRA Quality" with regard to its relationship to risk-informed decision-making
- Regulatory Guide 1.174: the PRA only needs to be as good as necessary to support the decision being made
- Fundamental issue is how to judge the elements relating to the baseline PRA
- Establishing the quality of the baseline PRA is needed

PRA Quality (cont'd)

- Two sets of elements characterizing "PRA Quality"
- PRA baseline elements: address the accuracy of the baseline risk; e.g., core damage frequency and large early release frequency
  - These elements include such items as: PRA scope, level of detail, data, realism, treatment of uncertainties
- Risk-informed decision-making elements: are used to assess the effects of a change to the facility
  - Elements more difficult to define: safety significance of proposed changes vary widely

Phased Approach to PRA Quality

- "A phased approach to PRA quality allows the continued practical use of risk-informed methods and continued progress towards adoption of state-of-the-art methodologies."
- Phase 1- Current situation: regulatory guidance and/or PRA standards not comprehensive for current and anticipated applications
- Phase 2 - regulatory guidance available for specific applications and PRA standards available for risk-significant contributors
- Phase 3 - PRA standards and regulatory guidance available for all current and anticipated applications
- Phase 4 - PRAs fully developed to the state-of-the-art

Standards

- ASME has issued PRA standard on Level 1 and LERF addressing full-power operation and internal events (excluding internal fire)
- US NRC is issuing Revision 1 to Regulatory Guide 1.200
  - Describes an approach to determine if quality of PRA is sufficient to support the regulatory decision-making
  - Endorses standards and industry related guidance
  - Obviates the need for an in-depth review of the PRA by the staff
- ASME "integrated standard" will integrate the Level 1- LERF, external events, internal fire and low power shutdown standards into one standard

Technical Guidance

- Standards provide requirements on what is needed
  - Supporting technical guidance needed for the "how to"
- Additional guidance documents being issued and under development; examples include:
  - <u>US NRC</u>: Data Analysis Handbook, HRA Good Practices, Treatment of Uncertainties and Use of Alternate Methods
  - <u>NRC/EPRI</u>: Fire PRA Methodology, Verification and Validation of Fire Models

Table 1: Status of Consensus PRA Standards

ITEM	SCOPE	RESPONSIBILITY	STATUS
Risk Characterization	Level 1	ASME	available and endorsed in RG 1.200
	Level 2 (LERF)	ASME	available and endorsed in RG 1.200
	Level 2 (full)	ANS	under development
	Level 3	ANS	under development
Operating Modes	full power	ASME	available for Level 1 and LERF
	low power and shutdown	ANS	under development (projected draft in 2005)
Initiating Events	internal (transients, LOCAs, floods)	ASME	addressed for Level 1 and LERF in ASME standard
	internal (fires)	ANS	under development
	external (seismic, winds, floods, other)	ANS	available

Table 2: Status of Guidance Documents

APPLICATION	DOCUMENT	ORIGINATOR	STATUS
License amendment	RG 1.174	NRC	Rev. 1
In-service testing (ST)	RG 1.175	NRC	Rev. 0
Graded QA	RG 1.176	NRC	Rev. 0
Technical specifications	RG 1.177	NRC	Rev. 0
In-service inspection (ISI) of piping	RG 1.178	NRC	Rev. 1
Technical adequacy of PRA	RG 1.200	NRC	Rev 0 issued for trial use, Rev 1 for use to be issued Dec 2006
Endorsement of NEI-00-04	RG 1.201	NRC	Rev. 0
Guidance for categorization of structures, systems and components (SSCs) by risk- significance	NEI-00-04	NEI	Rev. D
Guidance for PRA Peer Review Process and self-Assessment Process	NEI-00-02	NES	Rev. 1
Endorsement of NEI-00-02	RG 1.200	NRC	Appendix B of RG 1.200

Background -Proposed Transition Break Size (TBS)

- *The proposed rule would divide the current spectrum of LOCA break sizes into two regions. The division between the two regions is determined by a "transition break size" (TBS). The first region includes small breaks up to and including the TBS. The second region includes breaks larger than the TBS up to and including the double-ended guillotine break (DEGB) of the largest reactor coolant system pipe. The term, "break," in the TBS does not mean a double-ended guillotine break; rather it refers to an equivalent opening in the reactor coolant system boundary*

Background - Proposed TBS

- Starting with frequency of 1E-5/yr from the expert elicitation results, TBS was adjusted based on the following factors:
  - Uncertainties in elicitation process
  - Factors not considered in the elicitation process: seismic; heavy drop loads; etc..
  - Consideration of largest connected piping and other considerations

- Proposed TBS is largest connected line

- Proposed rule published for 5-month public comment period starting in November 7, 2005

Objectives and Approach of Seismic Evaluation

- Objectives
  - To examine likelihood and conditions that would result in seismically-induced breaks incompatible with the proposed TBS.
  - Provide key considerations to facilitate the public review and comments
- Approach
  - Use of hybrid deterministic and probabilistic approaches
  - Instead of directly estimating probabilities of pipe failures at various earthquake levels, the question raised was how large a flaw or degradation will have to lead to failures of piping under a low probability earthquake of interest.

Key Findings – Flawed Piping

- Critical flaws associated with the stresses induced by seismic events of annual probability of exceedances of 1E-6 and 1E-5 are large (crack depths are larger than 30% to 40% of pipe wall thickness) and the probabilities of pipe breaks larger than the TBS are likely to be less than 1E-5/year

General Insights

- Incorporation of passive component failures into PRAs still remain a significant challenge
- Passive failures may have to be considered as initiating events as well as consequential failures
- Common cause effects could have significant impact on PRAs
- Fragility data is sparse
- Innovative approaches are needed

Standardized Plant Analysis Risk (SPAR) Model Development Program

- To Provide the NRC Staff with Readily Available and Easy-to-Use Analytical Tools for use in Performing Risk-Informed Regulatory Activities, such as:
  - To Evaluate Risk Significance of Inspection Findings,
  - To Evaluate Risk Associated with Operational Events,
  - To Improve the Quality of PRAs,
  - To of PRAs,
  - To Perform Analyses in Support of Generic/Safety Issue Resolution, and
  - To Perform Analyses in Support of Risk-Informed Review of License Submittals

SPAR Model Development Program Activities

- Internal Events
  - Full Power
  - Low Power/Shutdown
  - Large Early Release Frequency
- External Events
  - Seismic Events,
  - Fires, and
  - Floods

Additional Topics for Discussion at Workshop

- Dr. Yong Li – *Development of a Risk-Informed Approach to Seismic Siting and Design* Monday am
- Dr. R.M. Ravindra – *Development of American National Standard on External Event PRA Methodology* Wednesday am