RISK-INFORMED REGULATION: MOVE TOWARD REALISM

Ashok C. Thadani

Director, International R&D Projects

U.S. Nuclear Regulatory Commission

International Conference on Probabilistic Safety Assessment and Management

June 18, 2004

OUTLINE

- **Implementation of Risk-Informed Regulation**

- **The Move to Realism**

- **Summary and Conclusions**

IMPLEMENTATION OF RISK-INFORMED REGULATION

- **Risk-informed approach applied in several areas in parallel**
  - Day-to-day regulatory issues, e.g., license amendments, technical specifications, QA, ISI/IST
  - New Reactor Oversight Program (ROP), using objective performance indicators and risk-informed significance determination process (SDP) for inspection findings
  - Modification of existing rules, to allow risk-informed approach, e.g., Combustible Gas rule, PTS, ECCS acceptance criteria

IMPLEMENTATION OF RISK-INFORMED REGULATION (con’t)

- **Risk-informed approach applied in several areas in parallel**
  - **Risk-informed treatment of systems, structures and components (SSCs) according to safety significance**
  - **Development of integrated, technology-neutral framework for advanced reactors**
  - **Development of consensus standards for PRA quality**

THE MOVE TO REALISM

- "Realistic conservatism" first defined in 2002:
  - Realism: Regulatory decisions are informed by "real world" science, technology, experience
  - Conservatism: Preserve appropriate and prudent safety margins
  - Regulate in a manner that corresponds to real risk and not "worst-case" assumptions

THE MOVE TO REALISM (Con't)

- **"Realistic conservatism" first defined in 2002:**
  - **Maintain properly balanced approach that provides protection of public health and safety while ensuring that licensee resources are focused on safety-significant issues**
  - **Gain better understanding of real safety margins that exist in nuclear facilities**

ADDING NEW DIMENSIONS TO REALISM

Risk-Informed ↑

Applying Traditional Safety Margins to PRA success paths and failure paths; weigh with path frequency	Applying safety-indices (detailed Safety Margins) to PRA success paths and failure paths; weigh with path frequency
Traditional Safety Margins (e.g., DBAs using Appendix K or 10 CFR 50.46)	Applying safety-indices (detailed Safety Margins) to Traditional Safety Margins

Additional margins →

EVOLUTION OF REALISTICALLY CONSERVATIVE APPROACH

- **Severe Accident Research Program established after TMI accident**
  - **Recognized need to support PRA techniques with improved phenomenological models for severe accidents**
- **NUREG-1150 “update” of WASH-1400 study**
  - **Significant improvement in PRA application, but substantial conservatisms still incorporated, e.g., “alpha-mode” containment failure, later shown not to be credible**

EVOLUTION OF REALISTICALLY CONSERVATIVE APPROACH
(Con’t)

- **Spent fuel pool safety analyses also initially characterized by conservative and/or bounding assumptions, producing overly pessimistic results**

SPENT FUEL POOL SAFETY

- **Previous NRC Studies based on more conservative assumptions and analytical models than current analysis**
  - **Limited to "early phase" heat-up calculations**
    - **Bounding pool configurations**
  - **No integrated severe accident analysis**
  - **Potential For Zircaloy fire using "ignition temperature" criterion**
  - **Up to 100% of Cesium released to atmosphere**
  - **No credit for likely intervention by operators to prevent uncovering fuel, although very long time for operator action is available for loss-of-cooling event**

SPENT FUEL POOL SAFETY (Con't)

- These assumptions are neither realistic nor appropriate for assessment of security issues where realism is needed

SPENT FUEL POOL SAFETY (Con't)

- Current analyses use more sophisticated models and techniques (MELCOR Severe Accident Code + Detailed Computational Fluid Dynamics--Thermal Hydraulic Calculation)
- MELCOR has mechanistic melt progression models
  - Damage propagation
  - Oxidant depletion
  - Fission product release and transport
  - Heat transfer
  - Flow mixing

SPENT FUEL POOL SAFETY (Con't)

- Builds on more than 20 years of research and experience
  - Thermal-hydraulics, severe accidents, and PRAs

FUTURE PLANS

- Continuing severe accident research to improve models, e.g., fission product release, transport, deposition
- Continued development/improvement of PRA methodology
- Better understanding/characterization of uncertainties
- Learn from experience and apply to new problems

SUMMARY AND CONCLUSIONS

- **NRC has made substantial progress in improving PRA technology and phenomenological understanding of reactor accidents**
- **Better understanding of expected plant responses and real safety margins**
- **Further research will build on previous achievements and support realistically conservative approach to regulation**