U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Risk Aggregation Issues

February 9th, 2016

Jeff Mitman

Senior Reliability and Risk Analyst

Division of Risk Assessment

Office of Nuclear Reactor Regulation

Overview

- Issue description
- Staff's understanding
- Next steps

- Industry and NRC have been aggregating quantitative results since the 1970s

- Problem is: How do we combine quantitative risk results with deterministic criteria to facilitate risk informed decision making (RIDM)?

- Specific concern is when quantitative risk results are near or exceed regulatory thresholds

Staff's Understanding of Issue

- RG 1.174 supplies guidance:
  - Combining results to be compared against thresholds to make decisions
  - Consideration of deterministic (e.g., defense in depth and safety margin) aspects
- EPRI "An Approach to Risk Aggregation for Risk-Informed Decision-Making" 3002003116
  - Staff has studied but has not been requested to review
  - Redefines aggregation to consider deterministic aspects

EPRI Report Strengths

- Appears to be consistent with RG 1.174
- Discusses three scenarios where results are near regulatory threshold
  - Mean is less than quantitative guideline
  - Mean is greater than acceptance guideline
  - Decision is indeterminate e.g., conservatisms are known to exist, but current methods do not support case for meeting acceptance guidelines
- Report supplies some guidance for considering probabilistic results using deterministic criteria
  - Redundancy/diversity
  - Common cause
  - Human failures
  - Barrier integrity
  - Safety margin
  - Uncertainty
- Characterizing PRA input as robust, needing review or not robust

EPRI Report Weakness

- New definition of aggregation can lead to confusion
- Report characterizes external hazards as extreme, rare and with large uncertainties
  - True in most cases for BDBEE but not all cases, examples:
  - Frequency of design basis flood at TMI is about 1.3E-4 per year
  - EPRI 3002005292 supplies flood hazard curve for unidentified site. Frequency of above grade flood disabling ECCS and containment is ~2E-5 per year
  - Problem is not that hazards are rare, extreme or uncertain
  - Problem is that CDF from these events sometimes approach or exceed regulatory thresholds
- Acknowledges possibility of non-conservatisms: errors of commission; missing hazards, e.g., LP/SD; inter-system common cause failures
  - But does not supply guidance on how to factor non-conservatisms into decisions
- Emphasizes concerns of conservatisms and uncertainty masking question at hand – how to make decisions

Unanswered Concerns

- Need for better guidance on how to evaluate deterministic criteria

- When risk results are below threshold and deterministic criteria <u>are not adequately met</u> – when should deterministic criteria be used to find that change is unacceptable?

- When risk results are above threshold and deterministic criteria <u>are met</u> – What is maximum credit?

  – Example: Threshold 1E-6 and quantification exceeds threshold by factor of 0.1 (1.1E-6), 2 (2E-6) or 10 (1E-5)?

  – Example: Threshold 1E-4 and quantification exceeds threshold by factor of 0.1 (1.1E-4), 2 (2E-4) or 10 (1E-3)?

Next Steps

- NRC to hold workshop with industry to further develop concepts and decision making criteria

- Industry to revise proposed process to address NRC concerns