

# **Severe Accident Mitigation Alternatives and Severe Accident Mitigation Design Alternatives for New Reactor Applications**

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# Definitions and Key Concepts

- SAMA: Severe Accident Mitigation Alternative – design alternatives and procedural or training modifications that reduce the radiological risk from a severe accident by preventing substantial core damage or by limiting releases from containment in the event that substantial core damage occurs.
- SAMDA: Severe Accident Mitigation Design Alternatives – Same as SAMA but only considers design alternatives.

# Definitions and Key Concepts (cont.)

- Commission Policy Statement (June 13, 1980):  
Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act (NEPA) of 1969 (45 FR 40101):

*It is the position of the Commission that its Environmental Impact Statements, pursuant to Section 102(c)(1) of the National Environmental Policy Act of 1969, shall include a reasoned consideration of the environmental risks (impacts) attributable to accidents at the particular facility or facilities within the scope of each such statement.*

# Introduction and Background

- The U.S. Court of Appeals decision, in Limerick Ecology Action v. NRC, 869 F.2d 719 (3rd Cir.1989), requires the NRC to consider severe accident mitigation design alternatives (SAMDA) in the environmental impact review performed under Section 102(2)(c) of NEPA.
- All applications for license renewal must consider SAMAs if not previously analyzed.
- For new reactor designs, the NRC requires evaluations of SAMDAs to address issues raised in SECY-93-087 and SECY-90-016 and their associated SRMs.

# Introduction and Background (cont.)

- The requirements have led the DC applicants to evaluate design features that would prevent or mitigate severe accidents. Some of these are included in the plant designs submitted for approval. COL applicants tier their SAMDAs from the DC.
- As a matter of discretion, the Commission has determined that considering SAMDAs is consistent with the intent of 10 CFR Part 52 for early resolution of issues, finality of design issues resolution, and achieving the benefits of standardization.
- In effect, the Staff considers the set of SAMDAs analyzed under NEPA the same as those considered to satisfy the Commission's severe accident requirements and policies.

# Regulations Pertaining to Part 52 Applications

- 10 CFR 52.47(a)(23) and 10 CFR 52.79(a)(38), require the inclusion of a description and analysis of design features for preventing and mitigating severe accidents in DC and COL FSARs, respectively.
- 10 CFR 52.47(b)(2) requires that the DC application include an environmental report (ER) as described in 10 CFR 51.55

# Regulations Pertaining to Part 52 Applications (cont.)

- 10 CFR 51.55(a): A DC applicant shall submit an ER that addresses the costs and benefits of severe accident mitigation design alternatives, and the bases for not incorporating them in the design to be certified.
- 10 CFR 51.30(d) describes the scope of the NRC's Environmental Assessment for a certified design.
- 10 CFR 51.50(c) states that an ER shall be submitted by an applicant for an ESP or a COL that contains information specified in 10 CFR 51.45, including cost/benefit assessments relevant to mitigation features.



# SAMA Guidance

- Staff's environmental review guidance found in NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants* (ESRP) and Regulatory Guide 4.2, *Preparation of Environmental Reports for Nuclear Power Stations* (RG 4.2)
  - ESRP Section 7.2, Severe Accidents, and Section 7.3, Severe Accident Mitigation Alternatives
  - Note: While the methodology not appropriate, the current RG 4.2 provides guidance for the Environmental Report, such as referencing documents.
- Cost/Benefit analysis guidance current in:
  - NUREG/BR-0058, Revision 4, *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission*
  - NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook*.
- NRC is in the process of updating and revising all of the above guidance documents.

# Other Guidance Considerations

- NEI 05-01A, *Severe Accident Mitigation Alternatives (SAMA) Analysis*
  - NRC-approved guidance for license renewal SAMAs
  - Not approved for new reactor applications; however, useful if properly applied
- Level 1 and Level 2 PRA technical information
  - Docketed information
  - Chapter 19 of Final Safety Analysis Report (FSAR) for DCs and COLs
  - Docketed FSAR-supporting Level 1 and Level 2 PRA technical reports
- Off-site consequence (Level 3 PRA) guidance
  - NUREG/BR-0184, Appendix B.4.2, MACCS Input Parameter Assumptions
  - MACCS Users Guides
  - NUREG-1150 and technical support documents (e.g., NUREG/CR-4551 V2 R1 Pt7)
  - NUREG-1935 and other SOARCA supporting documentation
  - Site-specific information

# Major Steps in a SAMA Evaluation

1. Identify leading contributors to risk
  - Use plant-specific risk study or equivalent
  - External events considered to the extent practicable
2. Identify candidate SAMAs
  - Identify SAMAs, including low-cost ways of achieving functional objective
  - Use of PRA importance measures to identify important basic events
  - Utilize relevant past SAMA evaluations

# Major Steps in a SAMA Evaluation (cont.)

3. Risk reduction / implementation cost estimates
  - Calculate maximum attainable benefit (MAB)
    - MACCS used to estimate averted off-site consequences for population dose and economic costs
  - Perform benefit assessment and cost assessment
  - Screen out SAMAs that can't be cost-beneficial
4. Potentially cost-beneficial SAMAs
  - Estimate net value of SAMA (averted costs – cost of enhancement)

# Major Steps in a SAMA Evaluation (cont.)

5. More detailed analysis for remaining SAMAs
  - More realistic evaluation of benefits
    - MACCS used to estimate averted off-site consequences
  - More detailed implementation cost development
  - Assess effects of uncertainties
- Analyst Aid: Chapter 4 of NEI 05-01A provides a good presentation of the cost formulas from NUREG/BR-0184 as applied for SAMAs/SAMDAs

# Maximum Attainable Benefit: The Total Cost Impact of a Severe Accident

- The severe accident cost impact is determined by summing the occupational exposure cost, on-site clean-up cost, public exposure cost, off-site property damage cost, and replacement power cost.
- All severe accident initiators must be accounted for, including both internal and external events for at-power and low power/ shutdown scenarios, in keeping with new reactor PRA requirements.
- Sensitivity studies are also carried out as appropriate for certain parameters. Examples include the 3% discount rate, dose uncertainties, cleanup costs, and evacuation cohorts.

# Closing Remarks

- The requirements for SAMA and SAMDA were a result from the U.S. Court of Appeals decision, in Limerick Ecology Action v. NRC, 869 F.2d 719 (3rd Cir.1989).
- For new reactor applications, the overall severe accident risk is already significantly low and it can be difficult to identify additional cost-effective design features.
  - The new reactor designs include severe accident prevention and mitigation features not found in first-generation plants.
  - Level 1 and Level 2 PRAs are more complete and are used as design tools
- Guidance documents are being revised.