Proposed Methodology and Criteria for Establishing the Technical Basis for SMR Emergency Planning Zone Sizing

Presented to NRC

Nuclear Energy Institute

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Presentation Outline

- Background
- Objectives
- Methodology Overview
- Path Forward
- Discussion

Background

SECY-11-0152 on EP Framework for SMRs

SECY-11-0152[1] notes the NRC staff's intent to develop a technology-neutral, dose-based, consequence-oriented emergency preparedness framework for SMR sites that takes into account the various designs, modularity and co-location, as well as the size of the emergency planning zone (EPZ), with the expectation that an applicant will provide a well-justified technical basis for NRC's review and consideration.

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1. U.S. NRC, SECY-11-0152, "Development of an Emergency Planning and Preparedness Framework for Small Modular Reactors," October 28, 2011

Background, cont.

- December 2013 NEI white paper responds to SECY-11-0152
- Approach based on the SECY-11-0152 concept that EP requirements could be scaled to be commensurate with the accident source term, fission product release, and associated dose characteristics for SMR designs

Benefits of Scalable EPZ Approach

- NRC identified these benefits in SECY-11-0152 for a scalable EPZ approach:
  - Regulatory predictability for SMR applicants and for State and local officials
  - Consistent application of NRC regulations and requirements in the review of emergency preparedness plans prepared for SMRs
  - Consistency with current emergency preparedness requirements and no reduction in the protection of public health and safety

Many Stakeholders

- NRC
- Industry
- Federal Emergency Management Agency
- Environmental Protection Agency
- Department of Energy
- State & Local Emergency Response Organizations
- Public

Meeting Objectives

- Discuss the proposed methodology and criteria for establishing the technical basis for SMR EPZ sizing in NEI White Paper
  - submitted for NRC staff review in December, 2013
  - responds to SECY-11-0152
  - incorporates NRC feedback from December, 2012 public meeting
  - addresses light-water SMRs only
  - addresses plume exposure pathway
  - SMR ingestion pathway EPZ and EP program standards to be addressed later
- Obtain NRC staff comment and feedback
- Discuss path forward

Key Aspects of the Proposed Methodology

- Industry approach is rooted in enhanced SMR safety (smaller cores; passive safety systems; smaller, slower fission product release)
- Application of SECY-11-0152 concepts:
  - maintain NUREG-0396 approach and dose savings objectives
  - apply significant body of risk information now available to inform EPZ
  - account for uncertainties
- Incorporate experience and lessons from risk-informed decision-making in regulatory applications
  - use risk-informed judgment in which insights from the PRA required for new plants are considered together with insights from a more deterministic, defense-in-depth approach
  - balance risk considerations and defense-in-depth
  - use a deliberative, decision-making process

Generic Risk-Informed Framework

Risk-Informed Framework

Traditional "Deterministic" Approach

- Unquantified probabilities
- Design-basis accidents
- Defense in depth and safety margins
- Can impose unnecessary regulatory burden
- Incomplete

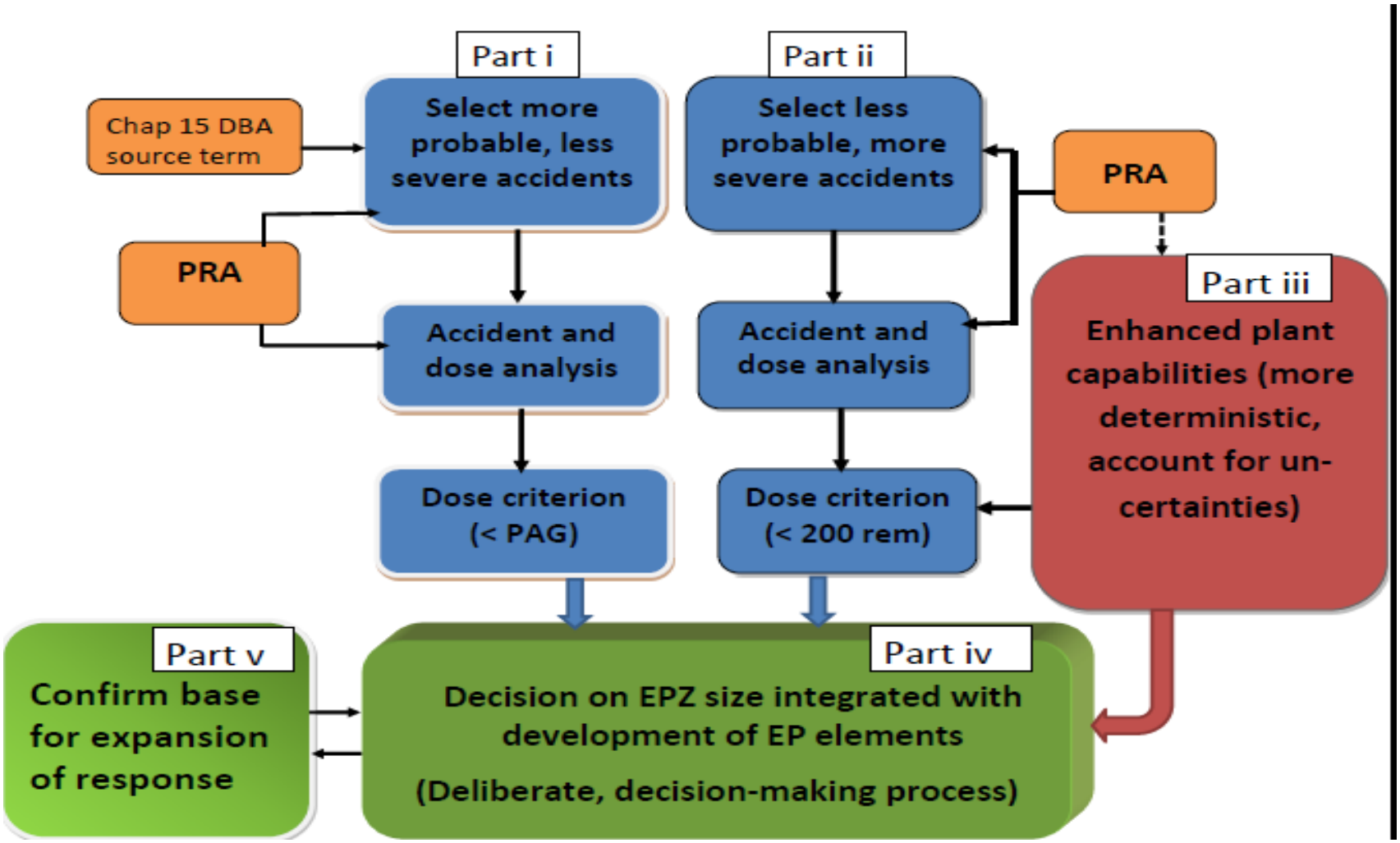
Risk-Informed Approach

- Combination of traditional and risk-based approaches through a deliberative process

Risk-Based Approach

- Quantified probabilities
- Thousands of accident sequences
- Realistic
- Incomplete

SMR EP Risk-Informed Framework



Using the PRA to Inform EPZ*

- Technical criteria from EP regulatory basis in NUREG-0396 (1978) as restated in SECY-97-020:
  a. The EPZ should encompass those areas in which projected dose from design basis accidents (DBAs) could exceed the protective action guides (PAGs)
  b. The EPZ should encompass those areas in which consequences of less severe core melt accidents could exceed the PAGs
  c. The EPZ should be of sufficient size to provide for substantial reduction in early severe health effects in the event of more severe core melt accidents

**EP Framework Parts i and ii (blue boxes)*

Criteria a. and b. – Evaluate DBA and More Probable, Less Severe Scenarios against PAGs (EP Framework Part i)

- Criterion a: Extract DBA source term from Chapter 15 (time dependent fission product accident release to environment)
- Criterion b: Address S/A scenarios with mean CDF > 1E-6 per year (similar to SOARCA* but include additional considerations to adapt to SMRs and be more complete):
- Dose calculation should use PRA methodology (e.g., MACCS code) and evaluate dose against PAGs (1 – 5 rem TEDE)

* SOARCA – State-of-the-Art Reactor Consequence Analysis

Criterion c. – Less Probable, More Severe Scenarios against Early Health Effect Risk (EP Framework Part ii)

- Address accident scenarios with mean CDF > 1E-7 per year (again similar to SOARCA but include two additional considerations):
  1. Address impact of shared or common systems among modules
  2. Address extreme external hazards
- Perform EPZ boundary consequence evaluation – relevant parameter is probability of dose exceedance vs. distance (early health effect risk)
- EPZ applicant will need to establish that the technical adequacy of the PRA is sufficient to justify the results and insights that support the EPZ decision

Enhanced Plant Capabilities to Account for Uncertainties and Assure Defense-in-Depth*

- A complement to PRA-based effort (deterministic, defense-in-depth approach; not numerically-driven; more qualitative)
- Four steps to be implemented by applicants to address:
  1. Completeness uncertainty
     - Develop diverse, operationally-focused accident mitigation strategy (not based on probabilities)
     - Provide base for expansion of response
  2. Potential risks that are not fully addressed in the PRA
     - Perform engineering assessment, qualitative or quantitative, to confirm features in design and operation to address these risks
     - Example features: margin beyond design basis, plant simulator, operationally-focused accident mitigation strategy

**EP Framework Part iii (large red box)*

Enhanced Plant Capabilities to Account for Uncertainties and Assure Defense-in-Depth

3. Risk impact of lower frequency accidents (cliff edge effects)
   - Look for low frequency, higher consequence scenarios with increased risk (e.g., sensitivity studies, truncation limits, historically important scenarios)
   - Accidents should be credible (physically plausible)
   - Use best-estimate evaluations (consider margin, intrinsic passive safety, and operationally-focused mitigation strategies)
   - For extreme external events, evaluate general societal impact to provide perspective on incremental risk from nuclear plant operation
4. Balance accident prevention, accident mitigation, and protective actions
   - Provide both onsite and offsite emergency plan with appropriate EPZ
   - Deliberative decision process on planning elements and EPZ size
   - Emergency plan consistent with providing base for expansion of response

Path Forward

- For Plume Exposure Pathway EPZ:
  - NRC staff comments and feedback on proposed methodology
  - continued dialogue towards a mutually agreeable methodology
  - more substantive, design-specific analytical reports to follow
- For ingestion pathway EPZ:
  - a generic approach to be developed and proposed
- For EP program standards:
  - a generic template approach to be developed and proposed
- A site-specific emergency plan for an SMR will be developed and submitted by an applicant

NRC Feedback & Discussion