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ESTABLISHING RIGHT-SIZED SMR-SPECIFIC EMERGENCY PLANNING ZONES
THE 4TH INTERNATIONAL TOPICAL MEETING ON SMALL REACTORS (ITMSR-4)

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ABSTRACT – This study supports the nuclear industry's approach to secure US Nuclear Regulatory Commission (USNRC) approval of a scalable Emergency Planning Zone (EPZ) specific to light-water cooled Small Modular Reactors (SMR). The study describes the approach to achieve regulatory approval, whichrequires demonstrating a reduced SMR risk profile, by establishing SMR-specific Probabilistic Risk Assessments(PRA) through the description of methodological and technological advancements that reduce likelihood of accidents and potential dose.

Introduction

Current United States Nuclear Regulatory Commission (NRC) Emergency Planning Zone (EPZ) sizing for large LWR plants provides a 10-mile radius for inhalation pathways and a 50-mile radius for ingestion pathways. These parameters were conservatively determined based on dose-release data provided for 70 plants (129 separate reactors) in an analysis referenced in the Nuclear Regulatory Commission's EPZ guideline(U.S. NRC, 1978). The report provides results for a range of postulated dose releases with the median plant (50th percentile of the distribution) as the lower limit and 60th percentile as the upper bound.

The fact that the SMR is a smaller size and hence provides a lower dose risk profile has been cited as a justification for a smaller EPZ. Additional justification beyond size is required because approximately 50% of the current plants in operation have a lower dose profile than the representative median plant which was used to establish the current standard. Hence to support the argument of a different approach for SMR EPZ size determination, additional justification must be provided. This abstract describes research that has recently been concluded, which provides the technical basis for a Scalable SMR-Specific EPZ.

The research addressed the following issues:

- Advances in Modelling Techniques since 1978 Assessment:
  - Significant advances in analytical techniques including computational fluid dynamics and stochastic methods (e.g. Monte Carlo sampling with software)
  - Overly conservative assumption of plume straight line trajectory can now be more accurately evaluated
  - Pseudo-quantitative Approach used in 1978 Assessment: The lack of a quantitatively determined basis for the 10-mile radius makes it challenging to draw inferences for the SMR.
- Improved and Updated Meteorological Data since 1978 Assessment
- Conservative approach for current plants shows that up to 30 percent of the plants in the sample exceed the EPA's Protective Action Guide limits:

- By improving the analysis and reducing the overly conservative assumptions, the level of confidence associated with the risk of exceedance for large plants would be improved beyond 70 percent as documented in USNRC NUREG 0396.

1. Overall Summary of Studies Performed

The approach to achieve regulatory approval for a Scalable EPZ may be summarized in two major steps - 1) Establishing a regulatory position, which includes the NRC indicating an interest in a regulatory change, and 2) Demonstrating SMR reduced risk profile, by establishing SMR-specific PRA through the description of methodological and technological advancements that reduce likelihood of accidents and potential dose. Table 1 shows an alignment of the objectives of the two-step process along with the technical scope of work done to support each effort. The activities associated with the second step, provide assumptions and methodology that may be used in performance of SMR-specific PRAs.

Table 1 Alignment of Research Studies with Process to Support Rulemaking

<table>
<tr><th rowspan="2">Step 1: Establishing a regulatory position</th><th colspan="3">Step 2: Demonstrate SMR reduced risk profile by establishing SMR-specific PRAs through the description of methodological and technological advancements that reduce likelihood of accidents and potential dose</th></tr>
<tr><th>Alignment with Level 1 PRA</th><th>Alignment with Level 2 PRA</th><th>Alignment with level 3 PRA</th></tr>
<tr><td>1. Gap Assessment of Technical Requirements for SMR Emergency Preparedness</td><td rowspan="2">3.Quantifying Evacuation Time Reduction to Support Scalable EPZ Using IAS and IPAWS</td><td>4.Assessment of Nuclear Accident-Related Atmospheric Dispersion Methods and Models to Support Establishment of a Scalable SMR EPZ</td><td>3.Quantifying Evacuation Time Reduction to Support Scalable EPZ Using IAS and IPAWS</td></tr>
<tr><td>2.SMR Emergency Planning Technical Support Roadmap</td><td colspan="2">5.Dose Calculation Methodology and Technical Acceptance Criteria Update to Support Technical Basis for SMR-Specific EPZ</td></tr>
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The five stated studies are further summarized as follows:

I. **Gap Assessment of Technical Requirements for SMR Emergency Preparedness Framework:** This report provides a record of technical items that requiredfor NRC rulemaking regarding a consequence-based approach for SMR emergency preparedness.

II. **SMR Emergency Planning Technical Support Roadmap:**Figure 1 provides a technical scope and stakeholder association map, which lists the work scopes that are completed, in progress, or planned in support of SMR EP planning.

III. **Assessment of Nuclear AccidentAtmospheric Dispersion Methods and Models:** Figure 2 summarizes the technical, regulatory, design, and methodological advancements related to atmospheric modeling, which have occurred since the EPZ technical basis was established.

IV. Quantifying Evacuation Time Reduction to Support Scalable EPZ: Development of a quantification method fortime savings due to advanced communication systems, which allows their use in demonstrating reduced evacuation times.

V. Dose Calculation Methodology and Technical Acceptance Criteria Update to Support Technical Basis for SMR-Specific EPZ: Identification of references for more appropriate dose calculation methodology and critical dose calculation input-variables.

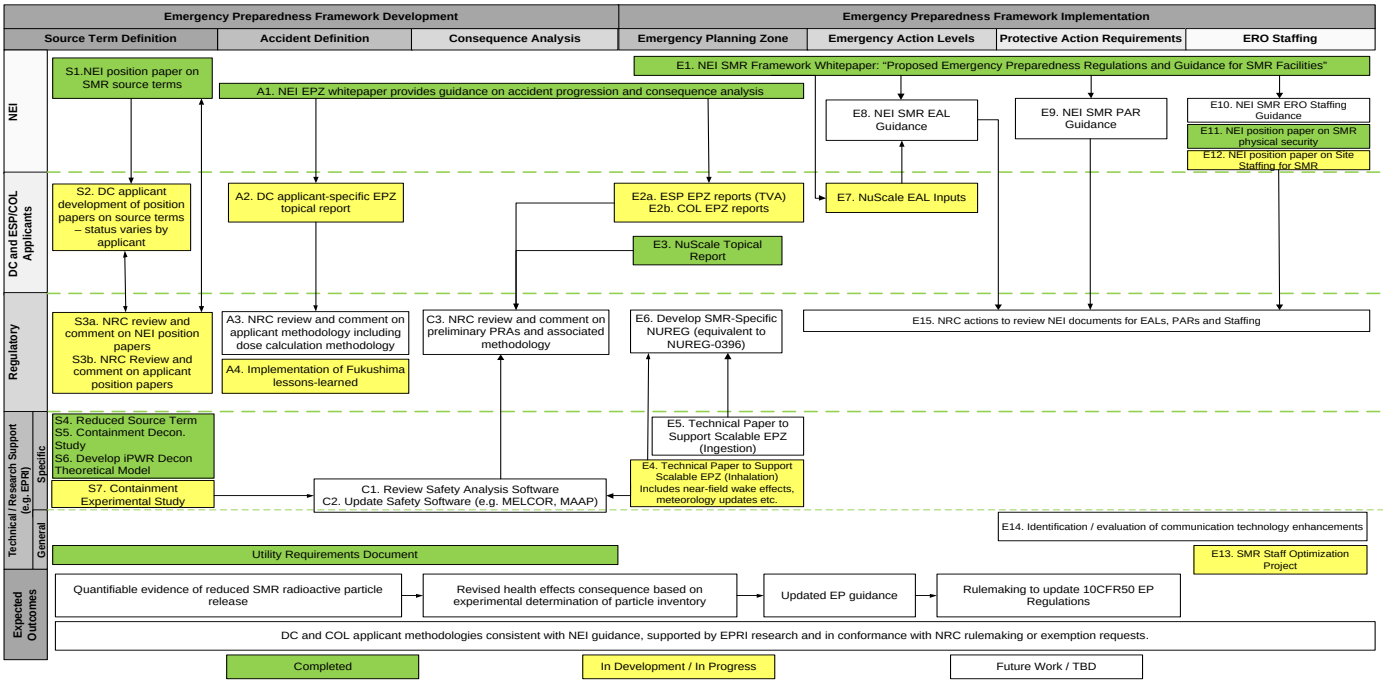


Figure 1SMR Emergency Planning Technical Roadmap Elements

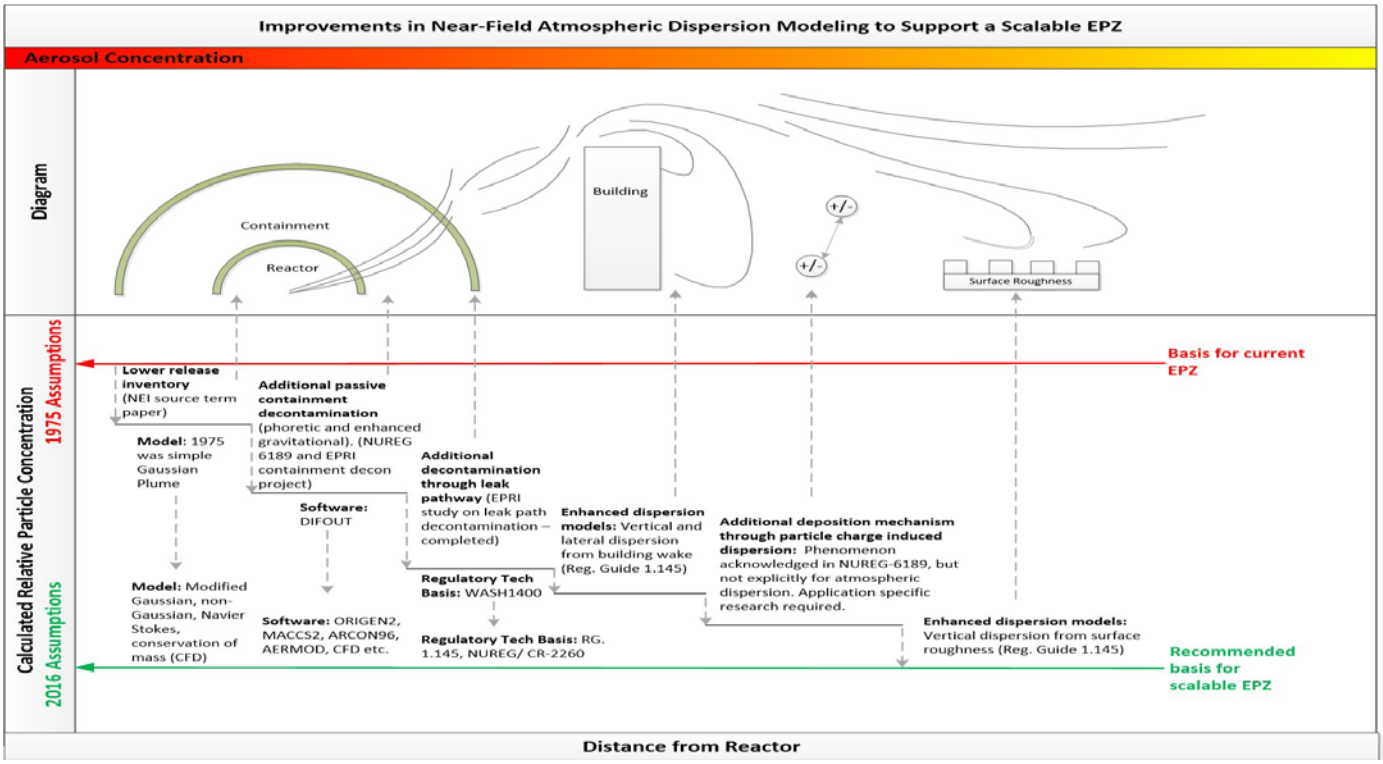


Figure 2: Improvements in Atmospheric Dispersion Modeling

2. Conclusions

The research showed that there is a substantial lag in regulatorory response to technology and knowledge advancement in the technical basis for EPZ determination. There is an opportunity to develop a risk informed approach to emergency planning zones, which will provide a standard industry approach to EPZ determination based on the specific and customized risk profile of a plant. There is currently no consistent approach to EPZ size determination. There are currently three categories of plants that will benefit; these are current plants in operation, plants that are undergoing decommissioning and advanced plants for future deployment such as Small Modular Reactors (SMR). The need for a risk-informed method as applied to each of these types of plants is described as follows:

Current plants under the LLWR category have different risk profiles: The 10-mile EPZ is based on a 50th percentile profile as a lower bound; hence half of the current plants sampled have a lower risk-profile than the lower bound; however, these plants are still required to conform to the 10 mile EPZ. Hence, these plants are operating with a significant uncharacterized EPZ safety margin. This is an imposition that can be modified with a risk informed approach that allows each plant to base its EPZ on its own actual risk profile, rather than the “one size fits all” approach.

Plants undergoing decommissioning have to make special requests for exemptions: Due to the absence of a set of EPZ requirements for plants undergoing decommissioning, by default they are required to maintain the EPZ requirements of an operating plant.his is an added and potentially unnecessary burden that can be alleviated by a standard risk-informed guideline, which would allow the decommissioned plant to simply demonstrate that it is at a reduced risk profile, and adjust its EPZ accordingly.

Advanced plant design and site applicants have to make special requests for exemptions: Similarly, the availability of a risk-informed methodology would allow smaller plants to determine their EPZ size based on the reduced risk profile of the plants.

3. References

[1]. U.S. NRC.,Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Spport of LWR Nuclear Power Plants, NUREG-0396, 1978.