Rulemaking for Emergency Planning and Physical Security for Advanced Reactors

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Outline

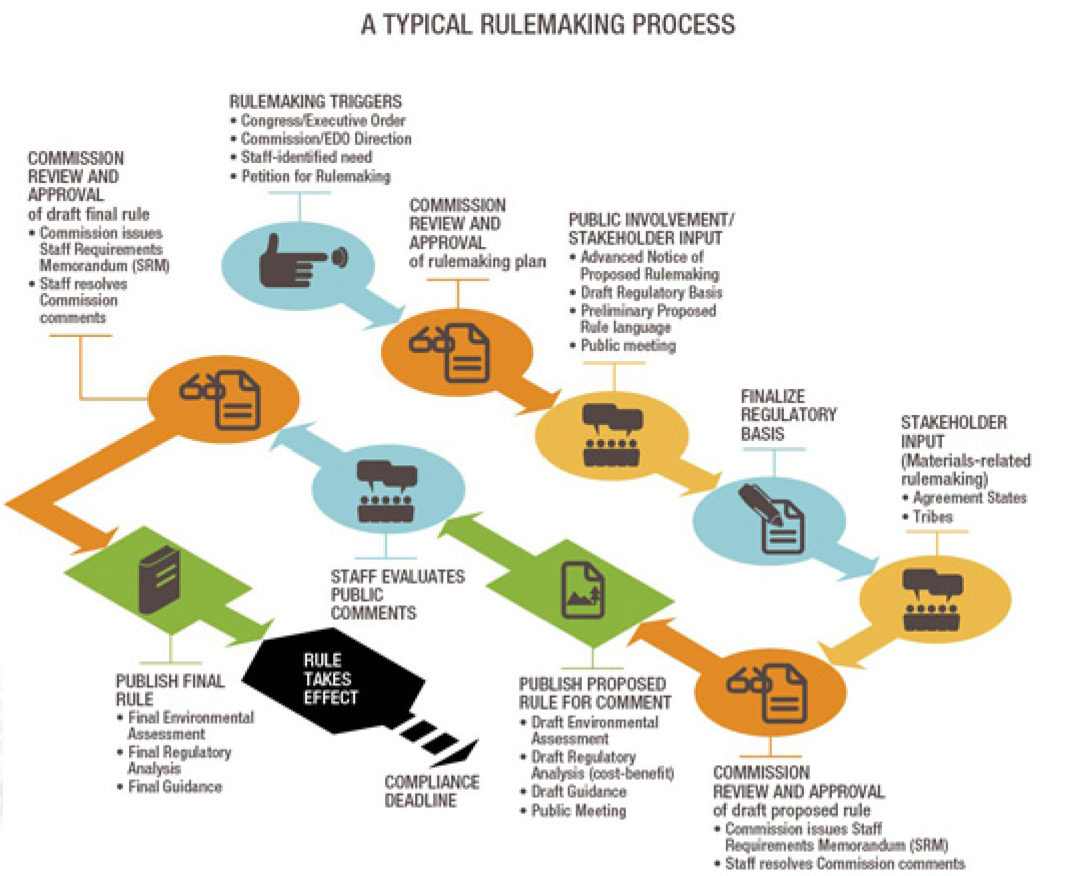
- Background on rulemaking for advanced reactors
- Emergency preparedness for SMRs and other new technologies (ONT)
- Physical security for advanced reactors

Examples of ONT are non-light-water reactors (non-LWRs) and medical isotope facilities.

Advanced reactors refer to non-LWRs and light-water SMRs (thermal power rating of up to 1,000 MWt (approximately 300 MWe) per module.

Background

- United States Nuclear Regulatory Commission (U.S.NRC or NRC) uses rulemaking as a process to develop and amend regulations (rules).



Source: NRC

Motivations for Rulemaking

- facilitate public engagement on technical and policy issues.
- eliminate the need for future applicants to propose alternatives or request exemptions.
- promote regulatory stability, predictability, and clarity.
- replace prescriptive regulations with risk-informed, performance-based requirements.
- recognize technology advancements and design features and attributes of advanced reactors.
- promotes consideration of safety and security in the early stages of design.

USNRC Open Policy Issues Related to Advanced Reactors

- Technical and policy issues related to SMRs and non-LWRs were originally listed in SECY-10-0034.
- Most but five of the issues have been resolved.
- Open Policy Issues:

I. Appropriate Source Term, Dose Calculations, and Siting for SMRs

II. Offsite Emergency Planning (EP) Requirements for SMRs and other new technology

III. Insurance and Liability for SMRs

IV. Security and Safeguards Requirements for SMRs

V. Functional Containment Performance

POTENTIAL POLICY, LICENSING, AND KEY TECHNICAL ISSUES FOR SMALL MODULAR NUCLEAR REACTOR DESIGNS, SECY-10-0034, March 28, 2010.
https://www.nrc.gov/reading-rm/doc-collections/commission/secys/2010/secy2010-0034/2010-0034scy.pdf

Key Differences between SMRs and Large LWRs

Design aspects that impact accident frequency, progression, and consequences:

- Smaller reactor core size
- Lower power density
- Employing inherent passive safety features
- Below grade or in-ground construction
- Lower probability of severe accidents
- Slower accident progression
- Smaller offsite accident consequences per module

Regulatory Issues Impacted by Inherent Characters of SMRs, 1/2

1. Size of the Emergency Planning Zone (EPZ) and Other Offsite Emergency Preparedness (EP) Requirements
   - Appropriate size of the EPZs (e.g. 10 miles of plume exposure pathway EPZ and 50 miles of ingestion exposure pathway EPZ)
   - Public alert and notification requirements
   - Extent of onsite and offsite emergency planning (e.g. need for emergency evacuation plan)
   - Number of response staff
   - Appropriate protective actions (e.g. shelter versus evacuation)

2. Source Term, Dose Calculations, and Siting
   - Multi-modules share structures, systems, and components (SSCs)
   - Design-specific and event-specific mechanistic source terms versus assuming prompt response to a wide spectrum of accidents
   - Risk-informed approach to selecting licensing basis events

Regulatory Issues Impacted by Intrinsic Characters of SMRs, 2/2

3. Operator Staffing
    - Multi-modules sharing a single, centralized control room
    - NRC regulation 10CFR50.54(m) sets forth the minimum licensed operator staffing requirements

4. Collocation of Facilities
    - Interaction with collocated facilities: proximate hazards, EPZ, staffing, training, etc.

5. Multi-Module Facilities
    - Shift staffing changes and impact on common or shared systems
    - Use of probabilistic risk assessment (PRA) or bounding analysis to define EP requirements with a maximum number of reactors

6. Performance-Based Approach to EP
    - In contrast to current largely prescriptive planning standards for EP requirements, licensee has the flexibility to determine how to meet the established performance criteria for an effective EP program

Proposed Rule for Emergency Preparedness for SMRs

- Using a technology-neutral, performance-based, risk –informed, consequence-oriented EP framework that accounts for SMR design features.
- Considering a scalable method for determining EPZ size rather than the fixed 10-mile (16-km) and 50-mile (80-km) EPZs established for large LWRs.
- Implementing EP requirements that could be scaled to be commensurate with the fission product release, accident source term, EPZ size and dose characteristics of the SMR design.

EPZ Determination

- Reduced EPZ sizes are predicated on the expectation that SMRs are designed to have a reduced potential for offsite releases from radiological emergencies.
- Motivated by guidance for offsite areas in which the 1 rem (10 mSv) EPA PAG (Environmental Protection Agency Protective Action Guides) is not exceeded, a pre-planned FEMA Radiological Emergency Preparedness Program would not be needed.
- Need to demonstrate that projected dose from a range of accidents, including design basis accidents (DBA) and severe accidents would not exceed the EPA PAG limits outside the EPZ.
- Require to show a substantial reduction in risk to public health and safety at the chosen plume exposure pathway EPZ outer boundary for very severe accidents, similar to the evaluation in NUREG-0396.
- In case the plume exposure pathway EPZ is bounded by the site boundary, no ingestion exposure pathway EPZ would be necessary, otherwise it would be appropriately sized to a fixed distance beyond the site boundary.

An Approach for Analyzing Plume Exposure Pathway EPZ Size

This rigorous site- and design-specific approach, is analogous to the methodology discussed in NUREG-0396.

(1) Calculate the probability of exceeding PAGs as a function of distance from the site boundary for a spectrum of accidents.

(2) Establish criteria for determining the point at which the probability of exceeding the PAGs is acceptably low, and/or,

(3) Conclude that the proposed EPZ size is supported by an acceptable spectrum of consequences.

References for EP Rulemaking

- Proposed Rule: Emergency Preparedness for Small Modular Reactors and Other New Technologies, SECY-18-0103, October 12, 2018. https://www.nrc.gov/docs/ML1813/ML18134A086.html
- Rulemaking for Emergency Preparedness for Small Modular Reactors and Other New Technologies – Regulatory Basis, RIN: 3150-AJ68, September 2017. https://www.nrc.gov/docs/ML1720/ML17206A265.pdf
- PROPOSED METHODOLOGY AND CRITERIA FOR ESTABLISHING THE TECHNICAL BASIS FOR SMALL MODULAR REACTOR EMERGENCY PLANNING ZONE, NEI White Paper, December 23, 2013. https://www.nrc.gov/docs/ML1336/ML13364A345.pdf
- DG-1350, "Emergency Preparedness for Small Modular Reactors and Other New Technologies." Draft regulatory guide to be released by the USNRC for public comment.

Rulemaking for Physical Security for Advanced Reactors

Background

- Policy Statement on the Regulation of Advanced Reactors (USNRC, 2008)
  - address security issues early in the design stage
  - resolve security issues through facility design and engineered security features, and formulation of mitigation measures, with reduced reliance on human actions
- SECY-11-0184 evaluated applicability of existing security regulatory framework for SMRs
  - current framework is adequate for SMRs and non-LWRs
  - potential for applicant to propose alternative methods and approaches that are equivalent in performance and meet intended functions and requirements.
- NEI White Paper (2016) suggested high-level criteria for determining when an advanced reactor design would be a candidate for alternative security requirements
  - existing security requirements impose unnecessary regulatory burden on licensees
  - compliance with existing requirements will diminish the cost competitiveness of advanced reactors.
- SECY-18-0076 provided options and a recommendation to the Commission on possible changes to regulations and guidance related to physical security for advanced reactors
- SRM-SECY-18-0076 directed the staff to proceed with the staff's recommended limited-scope rulemaking
  - evaluate an alternative to the prescribed minimum number of armed responders
  - evaluate prescriptive requirements for onsite secondary alarm stations

Current Physical Security Framework for Large LWRs

- Title 10 of the *Code of Federal Regulations* (10 CFR) Part 73, "Physical Protection of Plants and Materials," includes requirements for the physical security of power reactors.
- Regulations are designed to protect the plant features needed to provide fundamental safety functions.
- 10 CFR 73.55 organizes the regulatory requirements for physical protection of nuclear power reactors against radiological sabotage in eighteen (18) paragraphs or subsection.
- The NRC establishes the specifics of how certain engineered systems must be designed or configured (or both), along with program, process, and organization requirements, in subsections of 10 CFR 73.55.
- The physical protection program must ensure that there are capabilities to detect, assess, interdict, and neutralize threats up to and including the Design Basis Threat (DBT) of radiological sabotage.
- The DBT for radiological sabotage describes the adversary force the nuclear power plant licensee must defend against. It is based on realistic assessments of the tactics, techniques, and procedures used by international and domestic terrorist groups and organizations, as well as cyber criminals.

Regulatory Issues 1/2

Focus on attributes of advanced reactors that potentially impact,

- Size of onsite armed responders
- Requirements for onsite secondary alarm stations

- Target Sets
  - defined as a minimum combination of equipment or operator actions which, if all are prevented from performing their intended safety function or prevented from being accomplished, would likely result in significant core damage or spent fuel sabotage barring extraordinary actions by plant operators.
  - SMRs may have fewer target sets due to smaller reactor core sizes, lower power densities, lower probability of severe accidents, slower accident progression, and smaller accident offsite consequences per module.

Regulatory Issues 2/2

- Passive safety features will influence the accident frequency, progression, and potential consequences, impacting the number and the timeliness requirement for armed responders to a radiological sabotage.
- Mechanistic Source Term
  - A mechanistic source term is the result of using best-estimate phenomenological models of the transport of the fission products from the fuel through the reactor coolant system, through all holdup volumes and barriers, taking into account mitigation features, and finally, into the environs.
  - The analysis can demonstrate the ability of the enhanced safety features of plant designs to mitigate accident releases.

Technical Basis for Establishing Reduced PS Requirements

NEI White Paper proposed three performance-based criteria for determining the applicability of alternative security requirements for a specific design or facility.

1) Uses a reactor technology that is not susceptible to significant core damage and spent fuel sabotage, or
2) Does not have an achievable target set, or
3) Has engineered safety and security features that allow for implementation of mitigation strategies to prevent significant core damage and spent fuel sabotage if a target set is compromised, destroyed, or rendered nonfunctional.

Limited Scope Rulemaking

- Focus on establishing a performance-based approach and associated criteria to assess attributes of advanced reactors in determining alternatives to the prescribed minimum number of armed responders and the prescriptive requirements for onsite secondary alarm stations.
- The performance-based approach has the flexibility of implementing an effective physical protection system by incorporating many combinations of physical protection measures while recognizing that each reactor facility and its operational circumstances may be different.

References for PS Rulemaking

- OPTIONS AND RECOMMENDATION FOR PHYSICAL SECURITY FOR ADVANCED REACTORS, SECY-18-0076, August 1, 2018. https://www.nrc.gov/docs/ML1817/ML18170A051.html
- PROPOSED PHYSICAL SECURITY REQUIREMENTS FOR ADVANCED REACTOR TECHNOLOGIES, NEI White Paper, December 14, 2016. https://www.nrc.gov/docs/ML1702/ML17026A474.pdf
- SECURITY REGULATORY FRAMEWORK FOR CERTIFYING, APPROVING, AND LICENSING SMALL MODULAR NUCLEAR REACTORS, SECY-11-0184, December 29, 2011. https://www.nrc.gov/docs/ML1129/ML112991113.pdf