U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Thoughts on NRC Regulatory Approach for Fusion

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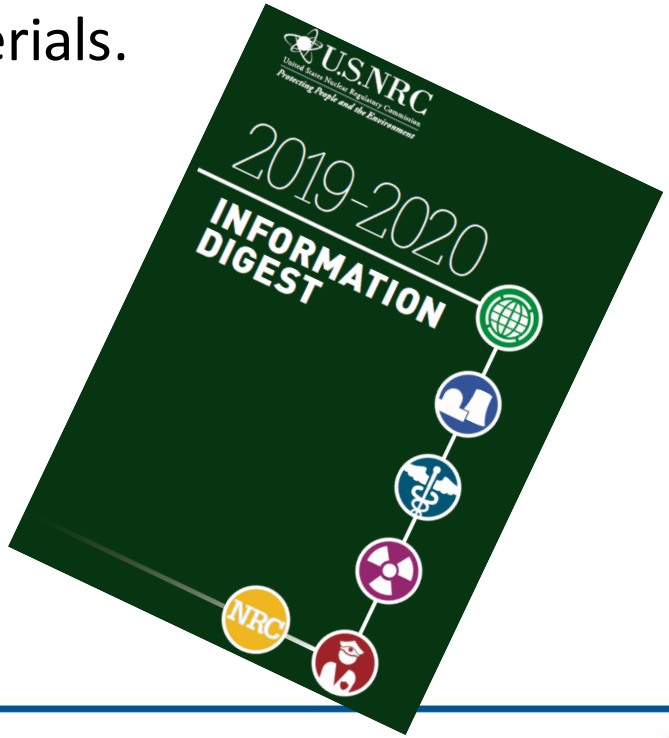
Nuclear Regulatory Commission

- The U.S. Nuclear Regulatory Commission (NRC) is an independent agency created by Congress. The NRC regulates the Nation's civilian commercial, industrial, academic, and medical uses of nuclear materials.
- Major Programs
  - Nuclear Reactors
    - Commercial
    - Research & Test
  - Materials & Waste
    - Materials
    - Nuclear Fuel Cycle



NRC & Fusion

- Topic was initially visited in 2009
  - SECY-09-0064, "Regulation of Fusion-Based Power Generation Devices"
  - Commission Direction:
    - … the Commission asserts, as a general matter, that the NRC has regulatory jurisdiction over commercial fusion energy devices whenever such devices are of significance to the common defense and security, or could affect the health and safety of the public
    - … The staff, however, should wait until commercial deployment of fusion technology is more predictable, by way of successful testing of a fusion technology, before expending significant resources to develop a regulatory framework for fusion technology.

Nuclear Energy Innovation and Modernization Act (NEIMA)

- NEIMA Section 103 requires that the NRC "complete a rulemaking to establish a **technology-inclusive, regulatory framework** for optional use by commercial advanced nuclear reactor applicants for new reactor license applications" by December 31, 2027
- NEIMA defines "advanced nuclear reactor" as "**a nuclear fission or fusion reactor**, including a prototype plant . . . with significant improvements compared to commercial nuclear reactors under construction" as of January 14, 2019."

Regulatory Approaches

- Preliminary assessment left open the regulatory approach for commercial fusion reactors
- Possible approaches include treatment similar to
  - Nuclear (fission) power plants

  - Materials (e.g., accelerator)

  - Hybrid or new approach

Regulation of Radioactive Materials

- Application needs to address areas such as:
  - Radionuclides, including maximum possession limits
  - Information on Radiation Safety Program (personnel, monitoring, etc.)
  - Occupational and public doses
  - Procedures for safe use of radionuclides, security of materials, and emergencies (emergency plans, if required)
  - Waste management
  - Decommissioning (including financial assurance, if required)
  - Environmental protection regulations
  - Some usages of "byproduct material" have additional requirements due to the unique purpose of these materials. Examples include:
    - 10 CFR Part 35 (Medical)
    - 10 CFR Part 36 (Irradiators)

Regulation of Radioactive Materials

- Another item to note is that pre-commercial demonstration of fusion may be able to be conducted under DOE oversight and requirements if the private sector fusion company performs pre-commercial demonstration activities at a DOE facility. The company would not be subject to NRC licensing or NRC specific regulations.
- As a general matter, the NRC has not regulated fusion-related activities beyond the possible possession of byproduct materials by companies, universities or other research institutions
  - Phoenix Neutron Generators (Wisc)
  - Laboratory for Laser Energetics (NY)
  - Planned approach for Commonwealth Fusion Systems SPARC facility (Mass)

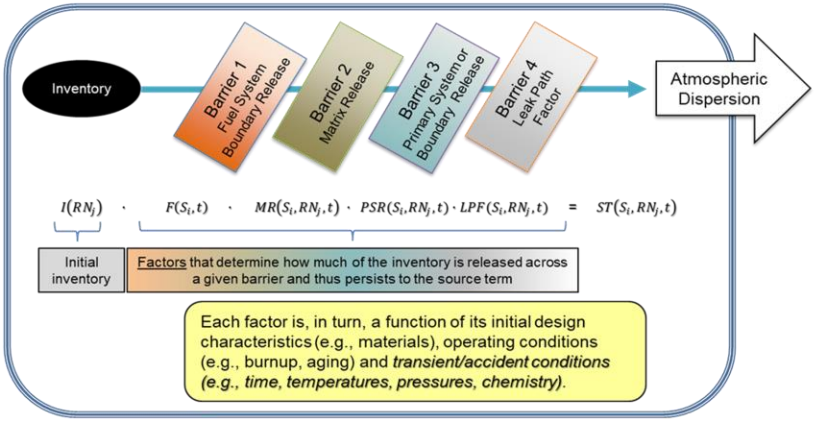
Regulation of Reactor Facilities

- Legal and technical framework defined in Atomic Energy Act and NRC regulations for utilization facilities (currently those using special nuclear material (SNM))
  - SNM is plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235
- NRC historical focus on large light-water reactors
- Technical requirements on design, construction, operation and decommissioning
- Extensive licensing reviews
- Environmental Impact Statements
- Mandatory hearings

Regulation of Reactor Facilities

- Developing regulations for advanced (fission) reactors involves return to first principles and different approaches to achieving key safety functions:
  - Control power
  - Remove heat
  - Retain radionuclides

Recent NRC activities related to advanced reactors (e.g., functional containment performance criteria, possible changes to emergency planning & security, and DG-1353) recognize the limitations of existing LWR-related guidance, which requires a return to first principles such as fundamental safety functions supporting the retention of radionuclides



See SECY-18-0096, "Functional Containment Performance Criteria"

See also DOE-HDBK-3010-94, "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities"

Other Regulatory Requirements

- Coordination with other regulatory agencies
  - EPA
  - FEMA
  - OSHA
  - Agreement States
- Electric Supply and Rates (FERC, PUCs)
- Land and Water Use (EPA, ACE, State/Local)

Path Forward

- NRC Developing Technology-Inclusive Regulatory Framework
  - 10 CFR Part 53, “Licensing and Regulation of Advanced Nuclear Reactors”
  - Decide on how to address fusion either within Part 53, within existing regulations, developing new regulations within materials realm, or combination
  - Scope to also include fusion/fission hybrid designs
- Process to include extensive interaction with public stakeholders