

Perspectives on Regulation of Fusion from a Former NRC Commissioner

Peter B. Lyons

A BIT OF PERSONAL HISTORY

- University of Arizona, B.S. Math-Physics
- California Institute of Technology, Ph.D. Nuclear Physics
- Los Alamos National Laboratory: 34 years
 - Wide range of technical and management roles
- Science Advisor to Senator Domenici and Senate ENR* : 8 years
- Commissioner: U.S. NRC 2005–2009
- Assistant DOE Secretary for Nuclear Energy: 2010–2015
- After retirement: advise labs and companies (including CFS)

* Energy and Natural Resources Committee

MISSION OF THE NUCLEAR REGULATORY COMMISSION

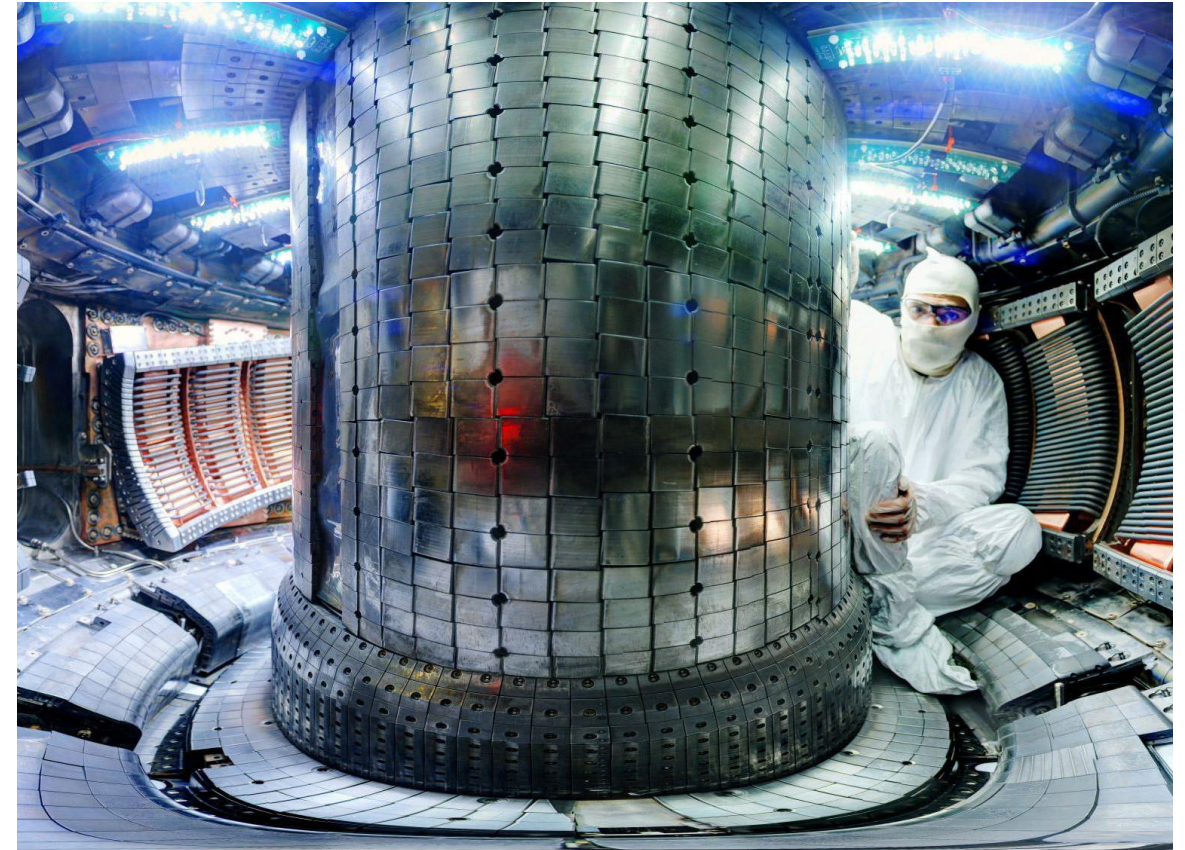
The NRC licenses and regulates the Nation's civilian use of **radioactive materials** to provide reasonable assurance of adequate protection of public health and safety and to promote the common defense and security and to protect the environment.

FUSION NEEDS A DIFFERENT REGULATORY APPROACH THAN FISSION

- **Fusion is fundamentally different from fission.**
- Commercial approaches to fusion energy:
 - Do not use any special nuclear or source material and produce no long-lived or high-level waste,
 - Fusion power presents a much lower risk profile than fission power.
 - Criticality accidents and meltdowns are physically impossible.
 - Use abundant fuels that do not require mining or fabrication,
 - Have low proliferation risk for weapons,
 - Require no enrichment nor reprocessing, thus avoiding those avenues to production of weapons-grade materials.
 - In principle, fusion neutrons could be used to produce weapons materials.
 - The use of fusion neutrons for such a mission defies logic, it would be a very difficult approach.
 - Conclusion of Princeton study, which included fission-fusion hybrids: “If designed to accommodate appropriate safeguards, fusion power plants would present low proliferation risk compared to fission.”
- With appropriate controls (Parts 20 and 30) on tritium (for approaches using the d-t fusion reaction) and disposal of activated low-level rad waste:
 - Present minimal public safety risk.
 - All other safety risks can be managed like other industrial facilities.

FUSION IN THE 1954 ATOMIC ENERGY ACT CONTEXT

- Amendments to the Atomic Energy Act (AEA) in 1954 permitted commercial atomic energy.
- “Atomic energy” refers to energy released from “nuclear fission or nuclear transformation” – which includes fusion reactions.
- Pursuant to this AEA authority, NRC decided in 2009* to exercise its jurisdiction over commercial fusion.
 - But NRC staff were directed not to proceed further until commercial fusion is more predictable based on successful testing of the technology.



Alcator C-Mod Tokamak at MIT. Source: <https://qz.com/1402282/in-search-of-clean-energy-investments-in-nuclear-fusion-startups-are-heating-up/>

* I left Commission before this vote

DEVELOPING A REGULATORY APPROACH FOR FUSION

- NRC and Agreement States already have precedent for regulating devices that use fusion reactions.
- The States of Wisconsin and New York already regulate devices that use fusion reactions.
 - Phoenix, LLC (Wisconsin)
 - Omega - U. Rochester (New York)
- DOE already has taken important steps to support the commercial fusion energy industry.
 - Safety standards for fusion devices
 - INFUSE
 - ARPA-E's ALPHA, BETHE and GAMOW
 - Potential Public-Private Cost Share



Phoenix Neutron Generator. Source: <https://phoenixwi.com/>

RECOMMENDED SPECIFIC ACTIONS FOR FUSION DEVELOPMENT IN THE U.S. TO REMAIN COMPETITIVE

- The NRC, working closely with the fusion industry, should set a fusion-focused regulatory direction.
- NRC's Part 50 and 52 regulations for fission plants address risks different from most of those posed by fusion energy facilities.
 - Fusion energy facilities **should not** be "utilization facilities" under the AEA.
 - NRC's rules for fission are not appropriate for the risk profile of a fusion energy facility.
 - Hazards associated with fusion energy plants, primarily use of tritium, can be managed using practices and procedures developed over decades to protect the health and safety of the public, onsite workforce, and the environment.
- NRC's Part 20 regulations for general radiation protection and Part 30 rules for handling byproduct material are appropriate for fusion energy systems.
 - Agreement States enforce Parts 20 and 30.
- DOE has framework and standards for safe construction, operation, and decommissioning of experimental fusion energy devices in DOE facilities.

NRC DEFINITION OF A **UTILIZATION FACILITY**

- “(1) Any **nuclear reactor** other than one designed or used primarily for the formation of plutonium or U–233; or
(2) An accelerator-driven subcritical operating assembly used for the irradiation of materials containing special nuclear material described in the application assigned docket number 50–608.”
 - Part (2) of definition added in 2014 to include Shine as a utilization facility.
- NRC definition of a “**nuclear reactor** :”
 - “*Nuclear reactor* means an apparatus, other than an atomic weapon, designed or used to sustain nuclear fission in a self-supporting chain reaction.”

Fusion energy systems are NOT Utilization Facilities.

NRC STAFF HAS SIGNALLED OPENNESS TO THE AGREEMENT STATE APPROACH

- In SECY-20-0032, NRC Staff proposes a new Part 53 for “advanced nuclear reactors.”
- NRC Staff makes clear its intention to separate the newly proposed Part 53 from the prescriptive or programmatic criteria in Parts 50 and 52, reducing the regulatory burden for developers of advanced reactors.
- Staff noted that NRC could approach regulation for fusion like it regulates accelerators (i.e., under 10 CFR Parts 20 and 30).
 - Staff notes that it will “consult with Agreement States” if NRC adopts this approach.
 - This statement suggests that NRC Staff believe that fusion devices could fall within the existing Agreement State program.
- Regulating fusion devices pursuant to Parts 20 and 30 would comply with NEIMA.*

* Nuclear Energy Innovation and Modernization Act

RECOMMENDED NRC APPROACH

- NRC should use only Parts 20 and 30 to regulate the fusion industry.
- States, operating within the context and oversight of the NRC's Agreement State Program, should have a significant role in regulation of fusion energy plants.
 - NRC retains licensing role for fusion facilities in non-Agreement States
- Federal agencies should take a coordinating role to develop risk- and performance-based regulations, allowing states and industry to innovate new technologies to improve fusion.