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Comment On: NRC-2019-0062-0159
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Submitter Information

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General Comment

See attached file(s) Comments of Clean Air Task Force (CATF) on Fusion Energy Systems in Part 53 Rulemaking.

Attachments

CATF Comment Fusion in Part 53 Jan. 7 2022

January 7, 2022

Submitted via regulations.gov

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CATF Comments on the Role of Fusion in the Part 53 "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors," 85 Fed. Reg. 71,002 (Nov. 6, 2020), Docket ID No. NRC-2019-0062

Introduction

Clean Air Task Force ("CATF") respectfully submits the following comments regarding fusion energy technologies in the Nuclear Regulatory Commission ("NRC") proceeding on establishing a Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors, Docket ID NRC-2019-0062.[1] CATF is a non-profit environmental organization whose mission includes working to decarbonize the global energy system to address climate change through regulatory and legal advocacy to promote policies that encourage technological innovation.

In CATF's view, crafting U.S. regulations governing fusion energy technologies at this point is premature. Emerging fusion technologies are further from commercialization than many advanced fission technologies, and it is difficult at this juncture to fully characterize their risks. Many different fusion-to-energy pathways are currently under study and can be expected to vary widely in their risks, the regulatory issues they present, and their applications. For example, aneutronic fuel pathways[2] present substantially different risks than conventional, deuterium-tritium (D-T) based pathways.

Although fusion is included in the definition of "advanced reactors" under the Nuclear Energy Innovation and Modernization Act ("NEIMA")[3], the NRC retains flexibility in how to implement the Act's mandate by 2027. For these reasons, and as explained further below, NRC should not include fusion energy facilities in its current Part 53 rulemaking.

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[1] CATF has today also submitted a separate comment letter directed to NRC's ongoing Part 53 rulemaking effort undertaken for advanced fission reactors.

[2] As used here, "aneutronic" fuel cycles are those that do not produce neutrons in the primary reaction, although they may produce some level of neutron flux (below that for D-T processes) in secondary reactions.

[3] Pub. L. No. 115-439, 132 Stat. 5565 (2019)(codified as amended at 42 U.S.C. §§ 2134, 2215).

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Risks of potential fusion energy technologies vary widely and differ categorically from those of fission.

Fusion energy technologies are expected to present significantly lower and categorically different waste, proliferation, and safety concerns compared to fission-based reactors used for energy production.

There are also many variations among fusion technologies. Research has focused on D-T fusion in tokamaks historically, but—as NRC staff have acknowledged[4]—a wide variety of concepts are now being pursued. Many magnetic confinement approaches—e.g., tokamaks, spheromak, or stellarator designs—are likely to have similar risk profiles. Other designs relying on inertial confinement differ in their radiological risks, especially as these approaches appear to enable the use of alternative, aneutronic fusion pathways using deuterium-helium (D-^{3}He) or proton-boron (p-^{11}B) reactions. Figure 1 illustrates the variety of fusion technologies under consideration for energy production.

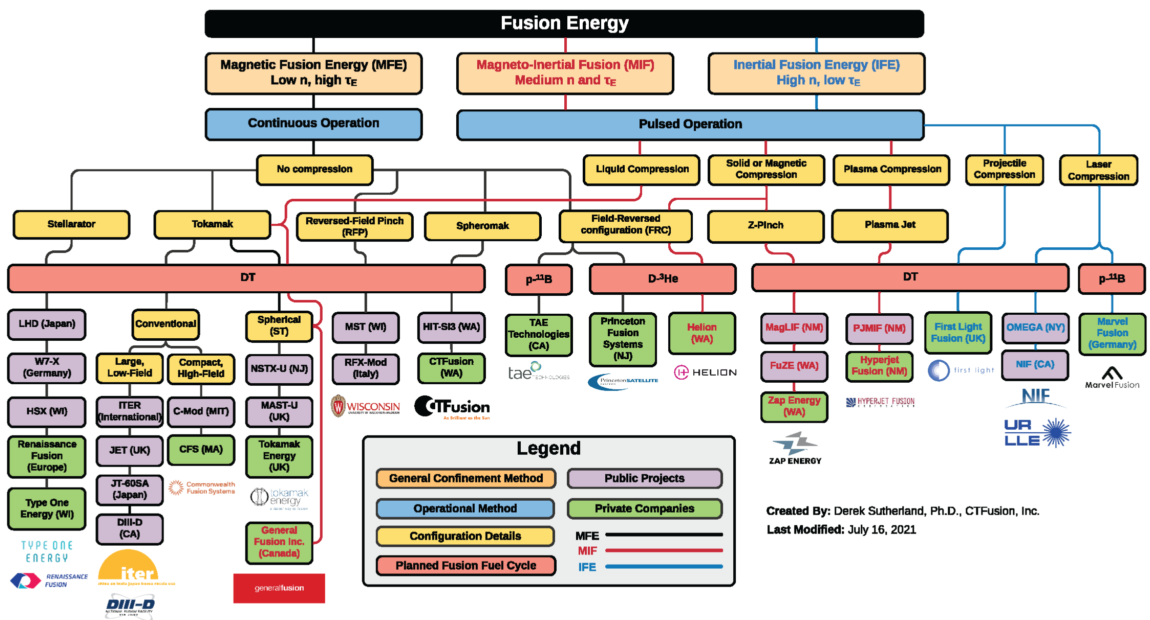

Figure 1. Private and public fusion approaches vary significantly by confinement method and include at least four companies pursuing aneutronic fuel pathways. *Via Derek Sutherland, CTFusion.*

Potential fusion energy technologies can be expected to vary widely in their risk profiles concerning waste, proliferation, and radiological safety:

- **Waste**: Fusion systems will not produce high-level waste. However, the D-T fuel cycle has the potential to generate significant volumes of low-level waste (and could generate some intermediate-level waste)

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[4] Nuclear Regulatory Commission, White Paper - Preliminary Options for a Regulatory Framework for Fusion Energy Systems (May 6, 2021), ML21118A081.

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due to neutron-activated materials in the blanket and vacuum vessel structures. On the other hand, fuel cycles that produce fewer or no high-energy neutrons can be expected to produce less activated waste. While some amount of waste from fusion processes may be inevitable, its quantity and longevity will depend on the design and materials chosen for the facility.

- **Proliferation**: Fusion technologies pose significantly less proliferation concern as compared to nuclear fission reactors, although depending on the fusion technology in question, the equipment for a fusion plant could still pose non-negligible proliferation concerns.[5] For example, high-energy neutrons provided by some fusion technologies could be used to produce weapons-usable materials from bombarding natural uranium to produce plutonium, or from bombarding thorium to produce uranium-233. [6] Other materials used at the fusion facility or inputs to the fusion process could be used as components for weapons: for example, the covert diversion of tritium from a fusion facility (for a process using it as an input) could enable production of enhanced weapons in nation-states already in possession of fission weapons ("vertical proliferation").[7] These potential proliferation concerns may in some areas be well understood, but they still vary with the fuel cycle as well as the design and materials used in the fusion plant.

- **Radiological Safety**: With no risk of a meltdown, radiological risks from accidents at fusion facilities are expected to be contained to the site boundary.[8] Public and operator safety risks may also differ between fusion technologies. Facilities using the D-T reaction must manage the risk of tritium release, while facilities using aneutronic fuel cycles will require different materials management regimes—for

[5] A. Glaser, R.J. Goldston, Proliferation risks of magnetic fusion energy: clandestine production, covert production and breakout, 52 Nucl. Fusion 43004 (2012).

[6] R.J. Goldston et al., Proliferation Risks of Fusion Energy: Clandestine Production, Covert Production, and Breakout (2009), https://www.osti.gov/servlets/purl/962921; C.B. Chou et al., The Fusion Energy Distillate at 22 (2016), available at http://www.firefusionpower.org/ACEE-Fusion-Distillate_request.pdf.

[7] R.J. Goldston, A. Glaser, Safeguard Requirements for Fusion Power Plants (2012), PPPL-4794, https://www.osti.gov/biblio/1056803.

[8] *See* Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, *Review of the safety concept for fusion reactor concepts and transferability of the nuclear fission regulation to potential fusion power plants* (2016) (analysis finding expected offsite radiological risks for fusion to be several orders of magnitude lower for fission plants), https://www.grs.de/en/node/2676.

example, in a p-^{11}B reaction, none of the reactants or products of the fusion reaction are radioactive.[9]

A technology-inclusive regulatory framework for fusion energy facilities must be sensitive to the likely variation in fusion technologies that are in development now or may be developed in the future. Due to these differences, it is likely to be difficult to craft one set of regulations that can apply appropriately to both fission and fusion reactors.

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NEIMA's mandate is flexible and can appropriately accommodate the range of fusion technologies and their differences from fission.

NEIMA requires the NRC to promulgate a risk-informed, technology-inclusive regulatory framework for advanced reactors by 2027, and fusion facilities are including in NEIMA's definitions as a type of "advanced reactor."[10] However, establishing a "framework" for both advanced fission and fusion by 2027 does not compel the NRC to develop detailed regulations for fission reactors and fusion energy facilities within a single rule, or to apply the same regulatory language in the licensing process for each. Indeed, due to the differences between fission and fusion systems, it is likely to be inappropriate for a single set of regulations to apply to both fission and fusion reactors.

Current draft language, written with advanced fission reactors in mind, is unlikely to apply appropriately to fusion reactors. As NRC has noted with respect to microreactors, reactor technologies with low potential consequences and/or different (passive) systems for power and heat control may be more appropriately regulated under a different approach that is informed by insights gained from the regulation of nonpower reactors.[11] The same is true of fusion. Fusion systems may be inherently safe with respect to certain types of accidents due to the precise conditions needed to maintain the plasma. For example, a D-T fusion system may be inherently safe with respect to a loss of coolant accident because, in such a scenario, the impurity influx to the plasma from increased reactor wall temperature would cause the plasma to cease.[12] This may render certain requirements with respect to these accident types—for example, the preliminary language requirement for defense in depth (§ 53.250)—unnecessary.

Including fusion facilities in the current rulemaking may have the unintended effect of stifling emerging technologies. If NRC constructs its regulatory

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[9] Although the three helium nuclei resulting from this reaction are not radioactive, some level of activated materials may still result from the process.

[10] Nuclear Energy Innovation and Modernization Act, 115 S. 512, § 3.

[11] NRC, SECY-20-0093, *Policy and Licensing Considerations Related to Micro-Reactors* (2020).

[12] *See* J.C. Rivas et al., *Revisiting the Analysis of Passive Plasma Shutdown During an Ex-Vessel Loss of Coolant Accident in ITER Blanket*, 98 Fusion Eng. & Design 2206 (2015).

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framework assuming the facility will use the D-T reaction in a tokamak, and the regulations are written solely from that perspective, it would likely discourage investment and advances in other fusion technology choices.

Because fusion for energy production has not yet been commercially demonstrated, and because it presents distinct and complex regulatory issues, NRC should confirm a different, more relaxed schedule for developing a regulatory framework for fusion energy systems under NEIMA. While some private developers are projecting prototype and commercial demonstration projects within the next few years,[13] the industry is unlikely to benefit from a licensing framework for commercial fusion power systems before NEIMA's 2027 deadline. The current licensing approach for fusion demonstration facilities appears to be providing sufficient safeguards while the NRC considers its next steps for the commercial facilities we hope to see in the coming years.

We look forward to engaging further with NRC on this important matter.

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[13] See, e.g., General Fusion, The Path to Fusion Energy: The Fusion Demonstration Plant, https://generalfusion.com/2021/06/the-path-to-fusion-energy-the-fusion-demonstration-plant/ (commercial demonstration project operational by 2025).