FUSION INDUSTRY ASSOCIATION

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May 22, 2024

Mr. John Lubinski
Director, Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C., 20555-0001

Dear Mr. Lubinski,

As the unified voice of the fusion industry, the Fusion Industry Association ("FIA") is writing to the U.S. Nuclear Regulatory Commission ("NRC") to share FIA's views regarding the ongoing limited-scope rulemaking for the regulation of fusion energy.

This letter provides FIA's initial reflections on the material presented by the NRC staff at the March 18, 2024 public meeting, including the updated proposed rule language definitions of "particle accelerator" and "fusion system" (ML24067A207), and the preliminary draft NUREG-1556 "Consolidated Guidance About Materials Licenses" Volume 22 "Program-Specific Guidance About Possession Licenses for Fusion Systems" (ML24067A227) ("preliminary draft guidance"). This guidance is critical to the staff, industry, Agreement States, and other stakeholders for the implementation of the byproduct material program for fusion energy. FIA is committed to working with NRC and all stakeholders to cultivate a NUREG-1556 Volume 22 that can serve as the foundation of a thriving fusion industry.

Further, FIA would like to commend the NRC staff for its openness and engagement with FIA and other stakeholders throughout this rulemaking process. The staff has run an admirably robust stakeholder engagement process, including staff's advanced publication of the preliminary draft guidance. This heightened engagement will result in a durable regulatory framework that will ensure the safe and effective development of commercial fusion technology for the American people.

1. **Definition of Particle Accelerator**

As presented during the March 18 meeting, the NRC staff have updated their preliminary proposed revisions to the definition of "particle accelerator" in 10 CFR Parts 20, 30, and 110, to read as follows:

> *Particle accelerator* means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant

particulate or other radiation into a medium ~~at energies usually in excess of 1 megaelectron volt~~. For purposes of this definition, accelerator is an equivalent term. Particle accelerators that induce plasma fusion to produce byproduct material are included in fusion systems as defined in this section.[1]

FIA appreciates that the staff's update to the proposed revision which now includes a clear reference to fusion systems. However, FIA continues to believe that the revisions to the definition provided by FIA in our December 15, 2023, letter would provide the greatest clarity:

> *Particle accelerator* means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 megaelectron volt, including fusion machines. For purposes of this definition, accelerator is an equivalent term.

FIA's proposed revisions explicitly clarify that fusion machines are indeed particle accelerators as the staff and Commission found in SECY-23-0001 and associated SRM, while also making the fewest changes to the existing definition. While the latest proposal from the NRC staff makes clear that particle accelerators can include *some* fusion machines, it does not specify that *all* fusion machines are particle accelerators. The FIA and its member companies agree with the Commission that *all* foreseeable fusion machines are particle accelerators and want to ensure the regulatory definition clearly reflects that technical understanding.

Further, it is unclear what purpose is served by the staff's proposal to delete the qualifying statement "at energies usually in excess of 1 megaelectron volt." No anticipated fusion machine would produce particles with a lower energy and so this change is not needed to accommodate the inclusion of fusion machines. Moreover, removing this threshold raises the possibility that the NRC's definition of "particle accelerators" could inadvertently apply to other technologies that are not particle accelerators.

2. Definition of Fusion Machine

The NRC staff have also updated the preliminary proposed rule language definition of "fusion system" in 10 CFR Parts 20 and 30 as provided in the presentation during the meeting:

> *Fusion system* means a system that, through use of byproduct material or to produce byproduct material, induces plasma fusion ~~reactions~~. The term fusion system includes particle accelerators that induce plasma fusion. The term fusion system also ~~and~~ includes any ~~associated~~ radiation, radioactive material, and supporting structures, systems, and components that are used to contain, process, or control radiation and radioactive materials used in or resulting from plasma fusion.[2]

FIA appreciates the staff's continued efforts to establish a definition that clearly references particle accelerators and references the primary components of the fusion machine that induce fusion. However, FIA remains confident that the definition for "fusion machine" included in H.R. 6544, the "Atomic Energy Advancement Act," passed by the House of Representatives is the

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[1] Note that red text and strike through represent the proposed revisions to the current definition.

[2] Note that red text and strikethrough represent the most recent changes to the formerly proposed definition.

simplest, most practical, and robust definition for fusion machines and should be reflected in the NRC's regulations.[3] FIA's views with respect to this definition are detailed in our December 15, 2023 letter to the staff.[4] As explained in our letter, the definition contained in the House legislation more appropriately focuses on the fusion-related technology in use at the fusion facility, and thereby avoids unnecessary inclusion of ancillary materials and systems that may be located on site but are not themselves actually part of the fusion machine.

3. Preliminary Draft Guidance, NUREG-1556 Volume 22

FIA greatly appreciates the time and effort required by the staff, on an aggressive schedule, to publish the preliminary draft guidance for fusion machines. Early engagement with the regulated community and other stakeholders on the details of this guidance is of the utmost importance given the high-level nature of NRC's byproduct material regulations, which generally rely on more discreet implementation at the guidance level. This guidance is critical to the staff, industry, Agreement States, and other stakeholders for understanding how NRC intends to regulate fusion energy, and the guidance will dictate day-to-day application of the program.

a. Applicability of NUREG-1556 Volume 22

It is unclear from the applicability statement in Section 1, "Purpose of Report," whether the NRC staff intend for Volume 22 to apply to the licensing and use of byproduct material by research and development (R&D) fusion machines. Clarity on this point is critical for ongoing and expected licensing activities. As drafted, Volume 22 expands on existing byproduct material guidance and, if applied to R&D, disproportionately focuses on systems and activities expected at commercial fusion machines. Volume 22 should apply solely to the use and possession of byproduct material by commercial fusion machines.

NRC's 10 CFR Part 30 framework, along with the guidance provided in existing volumes of NUREG-1556 (e.g. Volumes 7, 11, 21, etc.), has successfully ensured the safe use of byproduct material by R&D fusion machines for decades. Application of Volume 22 to R&D fusion machines would establish a new, more stringent regulatory treatment of byproduct material used by R&D fusion machines as compared to other uses of byproduct material without any clear health and safety basis.

Further, if Volume 22 were the exclusive guidance document to support licensing R&D fusion machines, publication could disrupt ongoing and expected licensing activities. Issuance in the middle of, or even upon the conclusion of, the licensing process for an R&D fusion machine could trigger action by the regulator to request conformity with the additional provisions of the Volume 22 guidance. This could negatively impact the continued progress of the nascent fusion industry and delay progress toward the clean, firm, abundant energy that fusion can provide for the world.

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[3] A similar version of this language is included in the Fusion Energy Act, which was introduced in the Senate on April 18. While the language in the Senate version is slightly different, FIA is supportive of the NRC adopting either version.

[4] Letter from Fusion Industry Association to J. Lubinski dated December 15, 2023 (ADAMS Accession No. ML23355A043).

Consistent with the NRC's Principles of Good Regulation,[5] particularly clarity and reliability, the Commission recognized this potential in SRM-SECY-23-0001[6] and directed the staff to "take into account the existence of fusion systems that already have been licensed and are being regulated by the Agreement States, as well as those that may be licensed prior to the completion of the rulemaking."

Accordingly, the applicability statement in Section 1 of the preliminary draft guidance should be clarified to state that Volume 22 applies solely to the use and possession of byproduct material by commercial fusion machines.

b. Technology-inclusive, risk-appropriate, objective-based guidance

At a high-level, the staff has put forth a strong effort into making the preliminary draft guidance technology-inclusive and performance-based, particularly given the diversity of fusion technologies. FIA did note a few instances where enhanced focus was given to Deuterium–tritium fusion (D-T) based systems and prescriptive requirements were mentioned. A few examples are:

- Section 8.9.1, General Description of Facility and Site: This section states that tritium "will be produced as a byproduct" and therefore "[i]nline tritium monitoring of atmospheric stacks is required." FIA would suggest staff revise the first sentence to state that tritium "may be produced" rather than "will be produced."

- Sections 8.9.6-7, Tritium handling systems and breeding blankets: These sections require license applications to include statements about their operating and emergency procedures for the named systems. However, as noted, not all fusion machines will use tritium or incorporate breeding blankets into their design. There is no option available under the preliminary draft guidance for an applicant to state that their machine does not include or require a tritium handling system or breeding blanket. FIA would therefore suggest revising this section to clarify that as an alternate to this requirement, license applicants may explain that their system does not include these components.

- Section 8.9.8 'Heat Removal': This section states, "Heat exchange systems should be fully enclosed to prevent activated materials and tritium from becoming airborne." This is a prescriptive manner for enabling the overarching performance criteria of minimizing release of materials and potential dose to workers and the public. FIA would suggest this section be revised to allow a license applicant to state how they will ensure activated materials and/or tritium do not become airborne, rather than relying on a prescriptive requirement.

FIA urges the staff to address the examples highlighted and to perform a fresh review of the guidance focusing on the commitment in the SECY-23-0001 rulemaking plan to be technology-inclusive and performance-based.

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[5] See NRC Principles of Good Regulation, https://www.nrc.gov/about-nrc/values.html

[6] SRM-SECY-23-0001, "Staff Requirements – SECY-23-0001 – Options for Licensing and Regulating Fusion Energy Systems" dated April 13, 2023 (ADAMS Accession No. ML23103A449).

c. Commencement of construction

Appendix C of the preliminary draft guidance states that:

> "However, if the licensing action meets the criteria in 10 CFR 51.22(c) for a categorical exclusion, and the NRC has not determined that an environmental assessment or an environmental impact statement is required in accordance with 10 CFR 51.22(b), then commencement of construction before the NRC staff concludes the environmental process **should not be the sole basis for denial of the license application**, as the NRC has already determined that this category of actions does not have a significant impact on the environment." (emphasis added)

FIA believes that if a fusion machine qualifies for a categorical exclusion under the regulations, commencement of construction prior to licensing should not serve as ANY basis for denial of the application. FIA recommends striking the sentence and replacing with wording similar to what is used in NUREG-1556 Volume 6 for irradiators:

> "Any construction activities undertaken before the issuance of a license are entirely at the risk of the applicant or licensee."[7]

This revision would allow applicants to make the commercial decision to begin construction at their own risk, given that the NRC has already categorically determined that the facility is subject to a categorical exclusion.

d. Mandatory Timeframe for Environmental Report and License Application

Appendix C also states:

> "In addition, the applicant will need to submit their environmental report and application for a byproduct material at least 9 months prior to the commencement of construction as required by 10 CFR 30.32(f)."

FIA recommends deleting this sentence. 10 CFR 30.32(f) is only relevant to "activit[ies] which the Commission has determined pursuant to subpart A of part 51 of this chapter will significantly affect the quality of the environment." By referencing 10 CFR 30.32(f) in this manner, Appendix C of the preliminary draft guidance implies that the NRC has already determined that all fusion machines will significantly affect the quality of the environment. To our knowledge NRC has not made such a determination for any existing fusion machine, particularly since all fusion R&D machines are currently categorically exempt from environmental review as per NUREG-1748. Further, FIA anticipates that many if not most fusion machines will not significantly affect the quality of the environment. Therefore, imposing the 10 CFR 30.32(f) nine-month submittal timeline as a de facto requirement is unnecessary and overly burdensome.

Additionally, it could be envisioned that a fusion machine may transition from an R&D focus to commercial operations without significant changes to the facility or design. Given the size and

[7] NUREG-1556 Volume 6, Rev. 1 at 8-18.

diversity of proposed fusion designs, it seems incongruent to assume that a fusion machine transitioning from an R&D purpose to a commercial purpose, would significantly alter its impact on the quality of the environment such that adding a nine-month delay to its licensing review process would be justified.

Finally, there is a government-wide effort to reduce permitting timeframes for clean energy facilities and this proposal to add in a nine-month delay, with no immediately obvious environmental or safety benefit seems to run counter to this.

e. Clarification on research and development for purposes of Categorical Exclusion

Section 8.5.3 states:

> "Fusion systems licenses limited to research and development and for educational purposes are not required to submit an environmental report since they meet the categorical exclusion."

FIA agrees with this statement, however additional clarification as to how the NRC will interpret R&D for this purpose is needed.

As the fusion industry continues to progress toward commercially viable power plants, the distinction between systems that are considered R&D versus those that are not could become unclear. Regarding the threshold for an R&D machine, for purposes of the categorical exclusion, FIA believes that a fusion machine could produce some energy or materials for sale, while still being operated primarily for R&D purposes.

Under NRC regulations in 10 CFR 50.22, there is a well-established precedent for a fission-based R&D facility to produce and sell some amount of energy, materials, or other non-energy services.[8] In addition, the Nuclear Energy Innovation and Modernization Act ("NEIMA"), the same law that directed NRC to establish a technology-inclusive regulatory framework for licensing fusion machines, further enabled this concept by expanding the thresholds that allow R&D licensees to recover a portion of their costs through sales of energy or non-energy services.[9]

FIA believes the NRC should establish a similar threshold in the guidance to clarify what is considered R&D for fusion, for purposes of the categorical exclusion. FIA offers the following criteria:

- Any fusion machine where the licensee does not seek to commercially sell materials, services, or energy; or

- Any fusion machine in which the licensee sells research and testing services and energy to others, subject to the condition that the licensee shall recover not more than 75 percent of the annual costs to the licensee of owning and operating the facility through sales of non-energy services, energy, or both, other than research and development or

[8] 10 C.F.R. § 50.21 similarly provides definition for R&D facilities, particularly where a facility is *"useful in the conduct of research and development activities," and could be instructive in the NRC's development of a definition for R&D fusion machines for purposes of the categorical exclusion.*
[9] *See* 42 U.S.C. § 2134(c).

education and training, of which not more than 50 percent may be through sales of energy, which reflects the thresholds established by NEIMA for R&D utilization facilities;[10] or

- Any fusion machine that will have a sufficiently small inventory of byproduct material so as to not require a decommissioning plan; or

- A fusion machine which is useful in conduct of research and development activities, or that is otherwise specifically authorized by law as a R&D facility.

Clearly describing R&D will aid developers in understanding their potential obligations with respect to submitting an environmental report, and accelerate R&D as the industry moves toward commercialization.

f. Material control & accounting

Section 8.10.3 "Material Control and Accountability" of the preliminary draft guidance states that:

> "Each licensee shall conduct a semiannual physical inventory to account for all licensed material received and possessed under the license"

FIA anticipates that for some facilities, conducting a physical inventory of all licensed material could entail an extensive, physically intensive process that may require full shutdown of the facility for several days, potentially weeks. It would also subject workers to higher radiation exposures inconsistent with ALARA, and not lead to a significant increase in understanding for effective hazard management. This would make frequent physical inventories impractical for commercial fusion power plants in this category. Particularly given these challenges, there does not appear to be a clear safety basis for the semiannual physical inventory requirement.

For some fusion machines, it may be that tritium retained in-vessel and associated process loops can only be truly deterministically quantified at the end of life when it can be destructively determined. However, validated models can be a highly accurate and appropriate method for determining the inventory of tritium and activated material inside a fusion machine. Use of these models, rather than a physical inventory, may be a fully acceptable way to determine inventories, depending on the expected amount of activated material, maintenance cycle frequency, and system design, and so use of these models or other testing and validation methodologies may make it reasonable to adjust the frequency of physical inventories.

FIA therefore proposes that the staff adopt wording similar to that used in other volumes of NUREG-1556 "or some other interval or method justified by the applicant and approved by the NRC."[11] This would enable individual applicants/licensees to justify inventory periods that consider the availability of alternative validation technologies, balance ALARA considerations, and align with expected maintenance cycles such that unnecessary exposure to radiation and shutdown of the facility are avoided.

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[10] These thresholds mirror those established by NEIMA. 42 U.S.C. § 2134(c).
[11] *See, e.g.*, NUREG-1556 Volume 21, Rev. 1 at 8-32.

g. Focus on byproduct material safety

FIA appreciates that the preliminary draft guidance generally stays focused on areas of the fusion machine that are important to the safe use and confinement of byproduct material. This approach is appropriate because it maintains the focus on the radiological hazards that the byproduct material used or created by each fusion machine could present on a technology-neutral basis. It also recognizes that regulation within the materials licensing framework does not contemplate plenary jurisdiction over the entire site hosting a fusion machine. As in many other commercial, industrial, and research settings, regulation of a potential radiological hazard is not the overwhelming, or the only, regulatory consideration for developers of fusion energy projects. Therefore, FIA welcomes NRC staff's approach to keep tightly focused on the hazards that the byproduct material could present as the entire regulatory picture for fusion energy projects matures.

However, there are some areas of the guidance that reach beyond that limit and specify regulatory review of equipment and processes that enable efficient fusion conditions but that are not relevant for safety.

One example is Appendix F, which notes construction monitoring and acceptance testing should be done for power supplies and magnets. These systems do not play any role in confining byproduct material from a public health and safety standpoint, only a fusion performance standpoint. Therefore, this inclusion in Appendix F appears to go beyond the scope of systems relevant to radiological safety.

A second example is that Section 8.9.9 requires backup power supplies for all facilities. However, many fusion machines will not need backup power supplies to maintain radiological safety. Therefore, the guidance in 8.9.9 should reflect that this requirement is applicant-specific, instead of requiring fission-like backup power provisions for all fusion machines.

Finally, much of the tritium guidance does not reflect the practical experience gained from existing fusion facilities like JET. For example, it should not be assumed a priori that fire detection systems need to shut down ventilation systems to minimize the risk of tritium oxidation. Due to the technical nature of this issue, individual FIA members plan to submit letters with more detailed comments on this area.

FIA urges the staff to revise these examples and review the guidance to ensure that the focus remains on the safe control and confinement of byproduct material in accordance with the NRC's authority and mission.

h. Focus on fusion only

Finally, the FIA encourages a thorough proofreading of the NUREG guidance to ensure that nuclear fission-related details are not accidentally included. Of special concern is a diagram on page 1-1 that shows a fusion-fission hybrid system, with a fission blanket pictured, as the example for Inertial Confinement Fusion. FIA members would be happy to provide an example diagram for this section, and we encourage a thorough review of the document before publication.

Thank you for your consideration of these issues, which are critical to the development and deployment of fusion energy technologies in the United States. We look forward to a continued dialogue with the NRC staff and the Commission.

Sincerely,

Andrew Holland
Chief Executive Officer
Fusion Industry Association

CC: Chair Christopher T. Hanson, NRC
Commissioner Annie Caputo, NRC
Commissioner David A. Wright, NRC
Commissioner Bradley R. Crowell, NRC
Duncan White, Office of Nuclear Materials Safety and Safeguards, NRC
Theresa Clark, Office of Nuclear Materials Safety and Safeguards, NRC
Cathy Kanatas, Office of Nuclear Materials Safety and Safeguards, NRC
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From:	Andrew Holland
To:	Duncan White; Dennis Andrukat
Cc:	Fowler, Sidney L.
Subject:	[External_Sender] FYI - FIA Letter on NUREG Guidance
Date:	Wednesday, May 22, 2024 5:40:34 PM
Attachments:	FIA NRC Letter RE NUREG and Guidance Final.pdf

Duncan and Dennis - just as an FYI, the FIA sent this into the Commission today - you'll see it on ADAMS soon, but just so you have it.

Andrew Holland
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