May 27, 2026

Subject: Breakthrough Institute Comment on Proposed Regulatory Framework for Fusion Machines [Docket ID NRC-2023-0071].

The Breakthrough Institute (BTI) appreciates the opportunity to comment on the Nuclear Regulatory Commission's (NRC) proposed rule, *Regulatory Framework for Fusion Machines*.[1] BTI is an independent 501(c)(3) global research center that advocates for appropriate regulation and oversight of nuclear reactors and radioactive materials to enable the new and continued use of safe and clean nuclear energy. BTI acts in the public interest and does not receive funding from industry.

The proposed rule establishes a regulatory framework for fusion machines by routing fusion machine licensing through the Part 30 byproduct material framework rather than the Part 50 utilization facility framework, consistent with Commission direction[2] and the ADVANCE Act's statutory framework.[3] BTI supports this pathway as regulating fusion machines under Part 30 is technology-inclusive and proportional to the hazard profile of near-term fusion machines.

The proposed rule does several different things at once: it establishes the near-term fusion machine framework under Part 30, it creates an interim waste disposal pathway in § 20.2008 that anticipates but does not depend on the integrated low-level waste rulemaking, it adjusts tritium-related reporting obligations, and it positions safeguards and proliferation as questions for other agencies. Some of these components are sound. Others reflect timing constraints that the NRC should address explicitly in the final rule rather than carry forward. Notably, in both the rule text and NRC public meetings on the draft rule, the NRC staff have declined to address proliferation in this rulemaking, reasoning that it will be addressed through related procedures like 123 agreements.

BTI submits these comments to support the Commission's near-term framework, identify issues that the agency should address before finalization, and raise structural questions that the

[1] U.S. Nuclear Regulatory Commission, "Regulatory Framework for Fusion Machines," Federal Register 91, no. 38 (February 26, 2026): 9476—9498, https://www.federalregister.gov/d/2026-03865.

[2] Staff Requirements Memorandum, SECY-23-0001, *Options for Licensing and Regulating Fusion Energy Systems*, April 13, 2023. https://www.regulations.gov/document/NRC-2023-0071-0001

[3] ADVANCE Act, Pub. L. No. 118-67, § 401, 138 Stat. 1462 (2024).

proposed rule has deferred. The comments address the six specific requests for comment in turn, then gaps regarding proliferation and safeguards questions, off-site dose methodology, decommissioning and financial assurance, and cross-rule coordination across the parallel Executive Order 14300[4] rulemakings.

Several of the recommendations concern issues that the NRC may address through the final rule preamble, NUREG-1556 Volume 22, or coordination with the parallel E.O. 14300 rulemakings. Where guidance clarification is recommended, the NRC should preserve the relevant performance-based expectation in the final rule record.

Tritium Reporting and Accountability (Specific Request for Comment #1)

Specific request for comment #1 asks whether to revise the reporting thresholds in §§ 30.55(c) and 20.2201 for tritium. The preamble acknowledges that licensees may not be able to rely on tritium inventory monitoring to discover all losses, and that one Agreement State has already issued an exemption to its reporting thresholds, identifying an operational challenge.[5] The current reporting framework was designed for scenarios in which discrete quantities of radioactive material might be stolen, lost, or diverted, situations where the material exists as a countable, trackable unit. Tritium in a fusion machine does not behave this way. It is produced in breeding blankets (whether FLiBe, lead-lithium, liquid lithium, or ceramic pebble configurations), consumed in the plasma, permeated into structural materials, taken up in depleted uranium storage beds, and recirculated through chemical and isotopic separation systems that are integral to normal operations.[6]

[4] Executive Order 14300, *Ordering the Reform of the Nuclear Regulatory Commission*, May 23, 2025.

[5] 91 Fed. Reg. 9,476.

[6] *A commercial D-T fusion plant's startup tritium inventory is governed less by its instantaneous burn rate than by the product of its fusion power, the inverse of its single-pass burn efficiency, and the mean processing time of its fuel cycle (the time required for tritium to transit from extraction through chemical and isotopic separation back to fueling). Typical mean processing times of six to twelve hours, combined with single-pass burn efficiencies on the order of one percent, produce startup inventories substantially larger than the instantaneous in-plasma inventory. Tritium also accumulates in breeding-blanket media (e.g., FLiBe, lead-lithium, liquid lithium, or ceramic pebble configurations), in depleted uranium storage beds, and through permeation into structural materials.*

A commercial Deuterium-Tritium (D-T) fusion plant operating in steady state will have tritium inventories driven less by its instantaneous burn rate and more by the mean processing time of its fuel cycle: a plant operating at a given fusion power with one-percent burn efficiency and a six-hour mean processing time requires a startup tritium inventory that is roughly the product of those factors, which is a much larger number than the amount being consumed at any instant. The preamble describes expected tritium inventories on the order of millions of Curies for commercial machines.[7]

A reporting regime built around specific-activity thresholds for lost or missing material was created in its current fashion predicated on the licensee's ability to quantify, with reasonable precision, how much material it has. For tritium in a fusion system, there will always be a significant degree of inaccuracy. The NRC should consider developing a fusion-specific tritium accountability framework based on bounding estimates and operational monitoring rather than precise inventory reconciliation. Such a framework could:

1. Require licensees to maintain validated computational models of tritium production, consumption, migration, and inventory distribution across the fuel cycle, with mean processing time as a reported operational parameter;
2. Trigger reporting based on deviations of measured values from expected operational parameters (e.g., release rates, retention in structural materials, recovery efficiencies) rather than only on inventory discrepancies measured against fixed thresholds; and
3. Distinguish steady-state continuous machines from batch-process machines (e.g., pulsed devices operating for short shots with full fuel recovery between pulses) in the applicable reporting expectations.

The NRC should raise the reporting thresholds in §§ 30.55(c) and 20.2201 for fusion machine licensees in the near term, but the forthcoming NUREG-1556, Volume 22 revision is the appropriate place to address the accountability framework question.

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[7] *The preamble notes that commercial companies pursuing fusion machines for deployment in the United States have communicated expected tritium inventories on the order of millions of curies, significantly less than ITER's reported inventory of approximately 4 kilograms (40 million curies). 91 Fed. Reg. 9,476.*

§ 20.2008 Waste Disposal and Part 61 Sequencing (Specific Request for Comment #2)

The proposed amendment to § 20.2008(a) is a significant provision in the rule, and its design choices have implications beyond fusion. The proposed rule would revise § 20.2008(a) to expressly cover waste resulting from fusion machines. The two-pathway approach is a reasonable interim response to a genuine problem. Under that approach, fusion waste could be disposed of if the licensee either demonstrates consistency with the § 61.7 waste class descriptions or disposes of the waste at a facility with a site-specific intrusion assessment showing that the projected dose to an inadvertent intruder would not exceed 0.5 rem per year. State-level implementation of the intruder assessment has been tailored to heterogeneous site contexts.[8] The NRC should more deliberately consider and specify how an annualized 0.5 rem/year risk is being applied to a conditional, discrete intrusion event where the annualized dose may not be appropriate risk framing.

Waste

The § 61.55 waste classification tables were built around fission product inventories from light-water reactors in the early 1980s and do not include many of the activation products that fusion machines are expected to generate.[9] The NRC acknowledges this gap in the preamble and explicitly defers revision of the § 61.55 tables to the integrated low-level radioactive waste disposal rulemaking.[10] That deferral is understandable given the current uncertainty about fusion waste stream compositions, but it also creates a sequencing problem. The NRC is asking commenters to evaluate a fusion-specific workaround without visibility into the broader Part 61 framework revision that the agency identifies as the proper vehicle for addressing the underlying waste-classification issue.

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[8] *In their respective performance assessments, Clive in Utah uses "off-highway vehicle enthusiasts" as the bounding intruder; WCS in Texas uses ranch and oil field workers among others.*

[9] *The NRC acknowledges in the preamble that fusion machines could create significant inventories of activation products that are not included in the existing waste classification tables. 91 Fed. Reg. 9,476.*

[10] *The Commission directed NRC staff to consider changing the waste classification tables after the completion of the integrated low-level radioactive waste disposal rulemaking for 10 CFR Part 61. SRM-SECY-08-0147.*

This sequencing concern is sharpened by E.O. 14300. The *Modernizing NRC Regulations for Byproduct Material Use* proposed rule, the Part 61 proposed rule, and the Part 20 revision will be issued and finalized on overlapping timelines that close after the fusion rule's comment period.[11] As a practical matter, commenters on the fusion rule cannot assess whether the § 20.2008 provision will be consistent with, redundant to, or in tension with what the Part 61 revision ultimately establishes.

Given the fusion rule's later finalization target, if the currently published rulemaking timelines hold, the NRC will have the benefit of completing E.O. 14300 rulemakings before issuing the final fusion rule. But the NRC must commit to reconciling the § 20.2008 provision with the finalized Part 61 framework before issuing the final fusion rule. The NRC's assertion in footnote 20 of the preamble that the draft proposed Part 61 rule "would not conflict with the fusion machine rule's proposed changes to § 20.2008" was written in the context of SECY-24-0045, before the E.O. 14300 timeline compressed and potentially expanded the scope of Part 61 reform.[12] The reconciliation of these rules, and the disposition of this comment, should specifically address two questions:

1. If the integrated Part 61 rule moves toward a performance-based classification framework, will the § 20.2008 provision become superfluous, or will it remain as a parallel requirement?
2. If the Part 61 rule revises the waste classification tables to include fusion-relevant activation products, will the § 20.2008 "consistency with § 61.7" pathway be updated to reference the new tables, or will it continue to rely on the case-by-case guidance-level analysis in NUREG-1556, Volume 22?

Alternative Intruder Dose Criterion

The dose-based intruder assessment pathway evaluates safety outcomes (projected dose to a hypothetical exposed individual) rather than relying on technology-calibrated radionuclide concentration proxies.[13] If a dose-based performance assessment is adequate for demonstrating safe disposal of fusion waste, there is a natural basis for expanding the same pathway to other

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[11] U.S. Nuclear Regulatory Commission, *Wholesale Revision of Regulations Under Executive Order 14300*, https://www.nrc.gov/about-nrc/governing-laws/advance-act/wholesale-revision-regs.

[12] 91 Fed. Reg. 9,476, n.20.

[13] *It seems that NRC staff drew this from § 61.42 for near-surface disposal facilities, as the limits and function seem equivalent.*

novel waste streams. Advanced fission reactors with non-light-water coolants and advanced fuel forms will generate waste streams that also have difficulty mapping onto the § 61.55 tables.

Accelerator-driven systems generate activation product profiles that, like fusion machine waste, do not map neatly onto the § 61.55 classification tables. As advanced reactor designs and accelerator-driven applications expand, the proportion of low-level waste that requires case-by-case classification adjudication will grow. The NRC should treat the § 20.2008 dose-based pathway not as a fusion-specific exception, but as the first instance of a performance-based authorization mechanism whose broader application should be contemplated as part of the integrated Part 61 rulemaking. Establishing this pathway in isolation, without articulating how it will be made available to other waste streams that present the same analytical situation, risks creating regulatory fragmentation.

Pending finalization of the upcoming Part 61 proposed rulemaking, the NRC should complete several supporting analyses to provide a defensible technical foundation for the § 20.2008 provision in the final rule. First, identify the fusion-machine activation products expected to fall outside the § 61.55 classification table source-term envelope, soliciting feedback from fusion companies and other experts. Second, confirm with the operating commercial LLW disposal sites whether their existing site-specific intrusion assessments bound that source term, and identify the Agreement State licensing actions required where they do not. Third, specify the methodology and acceptance criteria a licensee or disposal site would use in either the "consistency with § 61.7" pathway or the site-specific intrusion assessment pathway, recognizing that no NRC-validated intruder dose code is currently in active distribution. None of these analyses requires Part 61 finalization, and their completion would give the § 20.2008 provision technical substance independent of the Part 61 outcome.

§ 20.2002 Alternative Disposal and Low-Activity Fusion Waste (Specific Request for Comment #3)

Commercial fusion machines are expected to generate significant volumes of neutron-activated structural materials, much of which will be very low in specific activity. Routing all of that material to Part 61 disposal facilities imposes costs and consumes disposal capacity without a commensurate safety benefit. Specific request for comment #3 asks about the benefit of

expanding § 20.2002 guidance to address fusion machine waste and developing guidance for the reuse or recycling of low-activity fusion waste.

The NRC must develop guidance for clearance or conditional release of very low-activity fusion waste consistent with international standards, which enables more consistent export and international licensing of fusion machines in the future.[14] The IAEA has established clearance levels for decades, and many national regulatory authorities apply them routinely. The emergence of a technology that generates large volumes of low-activity material provides further practical impetus for revisiting the utility of a *de minimis* dose rate.

At a minimum, expanded § 20.2002 guidance specific to fusion waste would be valuable. The NRC could identify representative fusion waste streams, characterize their expected radiological profiles, and develop standardized alternative disposal analyses that individual licensees could reference rather than conducting facility-specific analyses from scratch. First-wall and plasma-facing components are likely to have contact dose rates on the order of thousands of sieverts per hour at end-of-cycle.[15] Even short-lived activation profiles in those components will require dedicated handling, characterization, and storage capacity in the years before they decay to manageable levels. The clearance or conditional release framework should not be confused with on-site indefinite storage, which the proposed rule explicitly does not contemplate as an accepted waste management endpoint.[16]

Export Controls (Specific Request for Comment #4)

Specific request for comment #4 asks if the NRC should propose export controls. Fusion machines fall within the Department of Commerce's (DOC) jurisdiction under the Export Administration Regulations, while the NRC retains authority over tritium and other byproduct material exports.[17]

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[14] See, e.g., International Atomic Energy Agency, *Application of the Concepts of Exclusion, Exemption and Clearance*, IAEA Safety Standards Series No. RS-G-1.7 (2004); European Commission, *Practical Use of the Concepts of Clearance and Exemption*, Radiation Protection No. 122 (2000).

[15] *For reference, first-wall components removed from the Joint European Torus (JET) at end-of-cycle have reported contact dose rates on the order of 2,000—3,000 sieverts per hour, dominated by short-lived activation products that decay substantially over a period of months to years but require dedicated handling and intermediate storage capacity during that period.*

[16] 91 Fed. Reg. 9,476 (noting that indefinite on-site storage is not an accepted waste management endpoint for fusion machine waste).

[17] 91 Fed. Reg. 9,476; Export Administration Regulations, 15 C.F.R. parts 730—774.

The NRC does not need to assert new export control authority over fusion machines themselves since that is a DOC function.

Compatibility Categories and Agreement State Capacity (Specific Requests for Comment #5 and #6)

The proposed compatibility designation of "B" for the fusion machine definition and paragraph 3(ii)(A) of the byproduct material definition is appropriate for ensuring consistent definitions across the National Materials Program. Definitional consistency, however, does not guarantee implementation consistency.

Thirty-eight of the thirty-nine Agreement States have assumed authority over 11e.(3) byproduct material, meaning that most commercial fusion facilities are likely to be licensed by state radiation control programs rather than the NRC directly.[18] The technical complexity of commercial fusion machine licensing (tritium inventories of millions of curies, novel activation product profiles, decommissioning challenges with no historical precedent in the materials licensing space, and the dispersion-modeling questions discussed below) is categorically different from the laboratory-scale fusion devices that Agreement States have regulated to date.

Several Agreement States have begun proactive capacity-building, while others have not. The NRC should clarify, in the final rule preamble or in a coordinated communication to the National Materials Program, what technical assistance, training, model licensing programs, or fusion-specific working group support it will provide to ensure Agreement State capacity. Coordination with the Conference of Radiation Control Program Directors (CRCPD) and the Organization of Agreement States (OAS) on fusion-specific guidance, training, and inspection support is also appropriate.

The Compatibility Category B designation may impose legislative amendment costs on Agreement States with rigid statutory accelerator definitions. However, these costs are small compared to the cost of definitional fragmentation across the National Materials Program, which would create state-dependent variation in what counts as a fusion machine for purposes of waste

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[18] 91 Fed. Reg. 9,476; Foley Hoag LLP, *Fusion Update: NRC Publishes Proposed Regulatory Framework For Fusion Machines* (March 2026).

pathway eligibility, application content, export coordination, and inspection scope. For a definitional question of this scope, it is our view that the federal-floor benefits exceed the implementation costs. Further, Agreement States have inherently assumed responsibility for these costs by petitioning to become an Agreement State.

Safeguards and Proliferation

The proposed rule's treatment of broader safeguards and proliferation is the most significant analytical gap in the record. The proposed rule's most direct engagement with proliferation appears in a single observation in the preamble: "In the event that the neutrons produced from a fusion machine are used to irradiate a subcritical assembly or blanket of nuclear material, then such use or production would automatically trigger IAEA safeguards, and the NRC would then control the resulting nuclear material for export."[19] That statement is accurate, but it describes a reactive framework that activates only after the proliferation pathway has been taken, and only in relation to exports. It does not address the prospective question of whether a sufficiently intense neutron-producing machine is itself a proliferation concern, independent of any current observation that nuclear material is being produced. A commercial D-T fusion machine is an extraordinarily intense neutron source, and the Part 30 framework was designed for accelerators and sealed sources, not for machines producing on the order of 10^{20} neutrons per second under steady-state operation.

Further, the preamble and rule do not consider the possible use of the fusion machine as a production facility by irradiating special nuclear material (SNM) in the blankets instead of the materials specified in the license. Although the primary use of a fusion machine is not to utilize SNM for a self-sustaining reaction, or to produce U-233 or plutonium, the NRC must ensure there are safeguards to prospectively prevent this occurrence, as opposed to the reactive "...the NRC would then control..." posture in this rule.

Much of the U.S. domestic proliferation concern around a fusion machine is already addressed by existing safeguards and controls on the materials and equipment that would be required to convert a fusion machine into a fissile-material production pathway. Consideration of domestic

[19] 91 Fed. Reg. 9,476 (observing that if neutrons produced by a fusion machine are used to irradiate a subcritical assembly or blanket of nuclear material, such use would automatically trigger IAEA safeguards).

threats does not justify a heavier NRC licensing posture under Part 30. However, the final rule must acknowledge that some fusion-machine capabilities may be proliferation-relevant and should be considered for the purposes of interagency export review, safeguards policy, and material-control coordination.

The NRC's current preamble discussion largely treats foreign proliferation and safeguards questions as matters governed by existing export-control and international safeguards frameworks. That is generally correct as a jurisdictional matter. The Department of Commerce controls exports of fusion machines under the Export Administration Regulations (EAR); the NRC controls exports of tritium and other byproduct material under the Atomic Energy Act (AEA); and other agencies, including DOE/NNSA and the Department of State (DOS), may have relevant roles depending on the technology, material, end use, and recipient. But the existence of this interagency framework does not eliminate the need for clarity in the NRC's record.

Because the NRC is the federal agency establishing the domestic licensing framework for the possession, use, and production of fusion-associated byproduct material, it should explain how its licensing requirements interface with the broader export-control and safeguards system. Under § 30.33(a)(5), the NRC may issue a specific license only if the proposed activity will not be inimical to the common defense and security. The proposed rule adds a fusion-specific license issuance provision in § 30.33(a)(6), but it does not explain how the existing § 30.33(a)(5) finding will be applied to fusion-machine licenses. For most Part 30 licensees, the common defense and security finding may require little discussion. For fusion-machine licensees that will possess or produce significant quantities of tritium, use tritium recovery or breeding-related systems, or transfer fusion-associated byproduct material, the finding should be supported by information on material procurement, inventory control, disposition, and transfer pathways. This would not create a new export-control regime or import Part 50 requirements into Part 30. It would simply explain how the NRC will make an existing statutory and regulatory finding in the fusion context.

The NRC should do three things:

1. State, on a technology-neutral basis, that a machine producing high neutron fluxes, characteristic of some proposed commercial fusion machines, carries proliferation significance regardless of whether the site currently holds safeguarded nuclear material,

and that the proliferation analysis should not be conditional on whether an operator declares a subcritical assembly or breeding target;

2. A § 30.32(k)(2) application content item should require fusion machine license applicants to describe their expected procurement and disposition arrangements for byproduct materials, and to identify how any planned export of the machine itself or of these byproduct materials will be routed through the appropriate agency: the DOC under the EAR for the machine, and the NRC under AEA section 82; and
3. Revise NUREG-1556 Volume 22 to explain how the § 30.33(a)(5) common defense and security finding should be reasonably applied to fusion machine license applications.

Off-Site Dose Methodology and the One-Rem Trigger

The proposed framework relies on an off-site dose assessment to determine, among other things, whether a fusion machine requires an emergency plan under § 30.32(i) (one rem at the site boundary as the triggering threshold). Emergency plans should be required for fusion machines, even if emergency planning zones are not required beyond the site boundary to align with the proposed Part 57 rule for microreactors and other reactors with comparable risk profiles,[20] which similarly establishes a 1-rem limit at the site boundary, requires an emergency plan regardless of the potential offsite dose, and does not expect an emergency planning zone due to the dose limit. This creates an inconsistency between the acceptable public risk assumed by the proposed licensing frameworks and the protections prescribed by the NRC to mitigate that risk. The NRC has not established a reason that the source of the risk (technology type) justifies a different standard than the AEA performance objective of protecting the health and safety of the public. Consistency must be maintained. When dispositioning this comment, the NRC should establish a basis for this provision, including the reason it is inconsistent with other rules, if it is maintained in the final rule.

We agree that the emergency plan should consider the "unique characteristics of the radionuclides generated or used by the fusion machine, such as dispersion and radiochemistry." The final rule's implementing guidance, in NUREG-1556 Volume 22 and any associated

[20] Nuclear Regulatory Commission, "Licensing Requirements for Microreactors and Other Reactors with Comparable Risk Profiles," Proposed Rule, Federal Register 91, no. 84, May 1, 2026, pg 23628—23766.

dispersion-modeling guidance, should identify acceptable methodologies, default assumptions where licensee-specific data are not available, and the conditions under which more conservative modeling assumptions are appropriate. This is also a place where Agreement State capacity and consistency across the National Materials Program matter most.

The NRC should:

1. Ensure regulatory consistency in emergency provisions, including considering whether low-consequence technologies, whether fusion or fission, are treated with commensurate rules. Establishing a requirement for an emergency plan is good safety practice, and the 1-rem limit provides a basis for when more substantial plans are necessary; and
2. Issue guidance that offers specific methodologies for the creation of fusion-specific emergency plans or ones that align all applicable devices under Part 30.

Decommissioning and Financial Assurance

The NRC states that the existing § 30.35 financial assurance framework provides sufficient flexibility for fusion machines. The NRC must substantiate that assertion rather than rely on the framework's general flexibility as the basis for the conclusion.

The decommissioning profile of a commercial D-T fusion facility (neutron-activated vacuum vessels and structural components, tritium-permeated systems, potentially significant volumes of activated waste with limited disposal pathways, and components whose contact dose rates may require dedicated handling and intermediate storage capacity) is categorically different from the Part 30 facilities for which § 30.35's tiers were developed. The NRC should develop or commission representative decommissioning cost estimates for D-T tokamak, stellarator, and other relevant design archetypes, and assess whether the existing financial assurance tiers and methodologies are adequate. Decommissioning funding plans will, in practice, be revisited every three years, and an inadequate or unrepresentative starting framework will create cumulative compliance friction across the licensee population.

Particle Accelerator Definition

BTI agrees with placing the proposed fusion machine definition within the existing particle accelerator definition. That approach is consistent with the ADVANCE Act and with the proposed rule's broader decision to regulate fusion-associated radioactive material under Part 30 rather than through the utilization-facility framework.

The proposed rule, however, should more clearly explain how fusion-specific licensing requirements interact with general accelerator licensing guidance. The preamble states that the definitional approach "would affirmatively establish that existing guidance for particle accelerators would not apply to fusion machines."[21] The proposed definition treats fusion machines as a subset of particle accelerators, while § 30.32(k) establishes fusion-specific application requirements. The rule does not expressly state that those fusion-specific requirements displace general accelerator guidance where the two might otherwise overlap.

For Agreement States that have their own particle accelerator definitions and licensing frameworks, this ambiguity could create interpretive difficulties. A brief regulatory provision clarifying that fusion machine applicants satisfy their Part 30 obligations through § 30.32(k) and the forthcoming NUREG-1556, Volume 22, rather than through general accelerator licensing guidance, would improve clarity. The final rule should include such a provision or, at minimum, address the supersession question explicitly in the preamble in a manner that Agreement States can implement consistently.

Fusion Machine Definition

The proposed definition of "fusion machine" has two elements: the device must be capable of (1) transforming atomic nuclei through fusion processes and (2) "directly capturing and using the resultant products." The second element appears intended to distinguish fusion machines from purely experimental apparatus or from devices that incidentally produce fusion reactions. But its scope is uncertain where fusion reactions are used as an intermediate step in a broader production process rather than as the productive output of the device.

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[21] 91 Fed. Reg. 9,476.

That ambiguity impacts accelerator-driven and hybrid systems. Some devices may use fusion reactions to generate neutrons, charged particles, heat, or radiation that then drive a separate downstream process, such as isotope production, materials irradiation, transmutation, or other nuclear or chemical production. Such systems may be technically capable of transforming nuclei through fusion processes and may use the resulting particles or radiation, but their productive output is not the fusion reaction product itself. The proposed rule does not clearly explain whether those systems are "fusion machines" or whether they remain subject to other existing regulatory pathways.

If hybrid accelerator-driven systems qualify as fusion machines whenever they use fusion-generated particles or radiation in a downstream process, they may become subject to a framework designed for devices whose primary regulated activity is the possession, use, and production of byproduct material associated with fusion machines. That could misalign the application-content requirements in § 30.32(k) with the actual safety and licensing issues presented by the device. If those systems do not qualify, then the second prong of the definition is doing limiting work that the NRC should articulate expressly, rather than leaving the question to case-by-case interpretation. The ambiguity is especially important for Agreement States. Agreement States will conduct much of the commercial materials licensing for fusion-related activities, and many already have their own particle accelerator definitions and licensing frameworks.

The NRC should tighten the second element of the fusion machine definition to clarify that the framework applies to devices designed to capture fusion reaction products (including neutrons, charged particles, electromagnetic radiation, or heat) as the primary productive output of the device, rather than as a means of driving downstream nuclear or chemical processes. This change is a Type 1 definitional modification under the Agreement State Compatibility Category framework and would be appropriately designated Category B, consistent with the existing compatibility designation for the fusion machine definition. The result would be a clearer line for Agreement State regulators and a defensible distinction between fusion machines and accelerator-driven hybrid systems.

Cross-Rule Coordination

This proposed rule is particularly sensitive to cross-rule conflicts. Because the fusion rule is expected to be finalized after several related NRC rulemakings, it will likely inherit much of the regulatory architecture within which fusion machines will operate rather than establish that architecture itself. The longer comment period for this rule is valuable, but it overlaps with shorter-period dockets on related subjects, making cross-rule assessment difficult.

The proposed byproduct material modernization rule warrants specific attention. Its decommissioning financial assurance recalibration is based on inventories that are several orders of magnitude below what fusion machine licensees will hold, leaving the § 30.35 gap discussed in Decommissioning and Financial Assurance unresolved. Its deletion of § 150.14 narrows NRC's reserved oversight of higher-inventory Agreement State licensees at the moment fusion expands that population. And its standard general license framework, while not reaching fusion directly, establishes a design pathway for codifying standard commitments from NUREG-1556 that may apply to future fusion deployments.

The NRC should:

1. Identify the specific provisions of the finalized byproduct material, Part 61, and Part 20 rules that affect fusion machine licensing, and commit to revisiting the fusion rule's provisions where material inconsistencies emerge;
2. Address the Agreement State compatibility transition for the new § 30.32(k) and § 20.2008 provisions explicitly, recognizing that most commercial fusion licensing will occur at the state level and that the Agreement State amendment cycle will lag the final rule's effective date; and
3. Coordinate with the CRCPD and OAS on fusion-specific technical assistance and training given the substantial state-level implications.

Summary of Recommendations

To summarize the recommendations in this comment:

1. *Tritium reporting and accountability.* Raise the §§ 30.55(c) and 20.2201 reporting thresholds for fusion machine licensees, and commit, in the final rule preamble, to a fusion-specific accountability framework in NUREG-1556, Volume 22 based on validated computational models, deviation-from-expected-parameters triggers, and a distinction between steady-state and batch-process machines.
2. *§ 20.2008 waste disposal.* Reconcile the § 20.2008 provision with the finalized Part 61 framework before issuing the final fusion rule, and articulate the dose-based pathway as the first instance of a performance-based authorization mechanism whose broader application should be contemplated in the integrated Part 61 rulemaking.
3. *§ 20.2002 alternative disposal.* Develop guidance for clearance or conditional release of very low-activity fusion waste, consistent with international standards, and expand § 20.2002 guidance to provide standardized alternative disposal analyses for representative fusion waste streams.
4. *Export controls.* Confirm DOC export jurisdiction over the machine itself and NRC export authority under AEA section 82. The NRC, DOC, DOE (including NNSA), and DOS should each clarify, through guidance or interagency memoranda, the route a licensee or prospective exporter is expected to follow.
5. *Compatibility and Agreement State capacity.* Identify, in the final rule preamble, the technical assistance, training, model licensing programs, and working group support the NRC will provide to ensure Agreement State capacity. Coordinate with the CRCPD and OAS on fusion-specific guidance, training, and inspection support.
6. *Safeguards and proliferation.* State, on a technology-neutral basis, that a machine producing high neutron fluxes, characteristic of some proposed commercial fusion machines, carries proliferation significance regardless of whether the site currently holds safeguarded nuclear material, and that the proliferation analysis should not be conditional on whether an operator declares a subcritical assembly or breeding target. Add a § 30.32(k)(2) application content item requiring fusion machine license applicants to describe their expected procurement and disposition arrangements for byproduct materials, and to identify how any planned export of the machine or its byproduct materials will be routed through the appropriate agency (per export control determinations). Revise NUREG-1556 Volume 22 to explain how the § 30.33(a)(5) common

defense and security finding should be reasonably applied to fusion machine license applications.

7. *Off-site dose methodology.* Require an emergency plan for fusion machine licensees, consistent with the technology-neutral 1-rem site-boundary threshold and the parallel treatment in the proposed Part 57 microreactor framework, which requires an emergency plan regardless of projected offsite dose and does not expect an emergency planning zone where dose remains within that boundary. If the NRC maintains any inconsistency between the Part 57 and fusion machine treatments in the final rule, establish a basis for that difference in the preamble. Specify, in NUREG-1556, Volume 22 and in associated guidance, acceptable methodologies, default assumptions, and the conditions under which more conservative assumptions are appropriate.
8. *Decommissioning and financial assurance.* Develop or commission representative decommissioning cost estimates for D-T tokamak, stellarator, and other relevant design archetypes, and assess whether the existing § 30.35 financial assurance tiers are adequate.
9. *Particle accelerator definition.* Establish, in the regulatory text, that fusion machine applicants satisfy their Part 30 obligations through § 30.32(k) and NUREG-1556, Volume 22, rather than through the general accelerator framework. Designate the supersession provision Compatibility Category B.
10. *Fusion machine definition.* Tighten the second prong of the fusion machine definition in § 30.4 to clarify that the framework applies to devices designed to capture fusion reaction products as the primary productive output, rather than as a means of driving downstream nuclear or chemical processes. Designate the modification Compatibility Category B.

Conclusion

Regulating near-term fusion machines under the Part 30 byproduct material framework is proportionate to the technology's hazard profile and consistent with the ADVANCE Act's statutory direction. The technology-inclusive application requirements and the flexible alternative pathway in § 30.32(k)(2)(iv) are well-designed for a technology whose commercial form is still taking shape.

BTI supports the NRC's overall regulatory approach. The recommendations in this comment are intended to strengthen that approach, not to replace it. Before issuing the final rule, the NRC should use the rulemaking record, final rule preamble, and NUREG-1556, Volume 22 to resolve the principal implementation questions raised by the proposed rule. The NRC should also ensure that the final fusion rule is reconciled with related rulemakings affecting byproduct material use, Part 61 waste disposal, Part 20 requirements, and materials licensing.

BTI appreciates the opportunity to submit these comments and would welcome further engagement with the staff on the issues raised in this letter.

Sincerely,

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