

May 26, 2026

Chairman Nieh, and Commissioners Wright, Crowell, Marzano, and Weaver
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Comments of the Connecticut Department of Energy and Environmental Protection on NRC
Rulemaking – Regulatory Framework for Fusion Machines
Docket ID: NRC–2023–0071

Dear Chairman Nieh, and Commissioners Wright, Crowell, Marzano, and Weaver:

The Connecticut Department of Energy and Environmental Protection (DEEP) appreciates the opportunity to provide comments on the U.S. Nuclear Regulatory Commission’s (NRC’s) proposed revisions to 10 CFR Parts 20, 30, 37, 50, 51, 72, 110, 150, 170, and 171.¹

Innovation in advanced nuclear technologies offers an important clean energy solution to meeting increasing energy demands. An exploration of increasing nuclear deployment must include a central commitment to ensuring safety, both to meet our shared mission of protecting public health and safety, but also to ensure that the public has the trust and reassurance needed to support this increased nuclear deployment. The State of Connecticut (hereinafter “Connecticut” or “State”) has taken deliberate steps to explore the role of advanced nuclear energy through a community-centered framework established under Connecticut’s Public Act 25-173. This approach enables municipalities to opt in to hosting advanced nuclear facilities and supports robust public engagement, technical evaluation, and informed local decision-making. Through this process, DEEP has found that transparency fosters public confidence, clarity, and trust in regulatory oversight. In the spirit of fostering transparency and engagement, DEEP recently held a public informational meeting on fusion technology to facilitate stakeholder engagement and raise awareness about the latest developments in fusion technology. A recording and presentation materials from the public informational meeting can be found at this [link](#).² DEEP submits these comments consistent with the policy framework established in the Connecticut General Statutes (C.G.S.) regarding the development and regulation of nuclear energy and the use of radioactive materials.

DEEP supports the development and utilization of atomic energy in a manner that protects public health and safety, promotes the common defense and security, and preserves the environment.

¹ “Regulatory Framework for Fusion Machines,” 91 FR 9476 (February 26, 2026).

²[https://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/5be67f572022960885258df70069a053/\\$FILE/Notice%20of%20Meeting%20Recording%20-%20Session%203.pdf](https://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/5be67f572022960885258df70069a053/$FILE/Notice%20of%20Meeting%20Recording%20-%20Session%203.pdf)

This framework reflects a deliberate balance in Connecticut's state policy: the State is directed to adapt its laws and regulations to evolving conditions in ways that encourage the safe development of industries producing or utilizing atomic energy, while at the same time protecting the public interest. DEEP remains committed to working with the NRC and to maintaining a regulatory program compatible with the Atomic Energy Act of 1954.

This statutory policy is implemented through a defined governance structure within the State's government. Pursuant to Section 16a-102 of the C.G.S., the Commissioner of DEEP serves as the State's lead official responsible for coordinating all atomic energy development and regulatory activities and ensuring consistency across State agencies. The Commissioner's statutory role encompasses coordination with the federal government, including the NRC, and reinforces DEEP's responsibility to ensure that regulatory programs are comprehensive, compatible, and effectively implemented.

As the 40th and most recent NRC Agreement State, DEEP has direct regulatory responsibility for the safe use of radioactive materials within the State. DEEP is a partner with the NRC in the National Materials Program and is responsible for implementing compatible requirements, conducting inspections, and performing licensing and enforcement activities. Accordingly, DEEP has a strong interest in ensuring that NRC rulemakings support effective, consistent, and implementable requirements nationwide.

DEEP fully supports the comments submitted to the NRC by the Conference of Radiation Control Program Directors (CRCPD) Board dated May 21, 2026. DEEP respectfully submits its own comments in Attachment A accompanying this letter.

DEEP's comments herein support the NRC's proposed risk-informed and performance-based framework for regulating near term fusion machines while emphasizing the need for additional technical clarity, long-term regulatory coordination, and implementation support as fusion technologies mature. DEEP's comments also address ensuring that key issues—including tritium accounting and behavior, activation products, waste management and disposal pathways, emergency planning assumptions, security applicability, and environmental monitoring—are managed through clear, technically defensible, and technology-specific guidance. DEEP stresses the importance of coordinated rulemaking, regulator training, and development of consistent national oversight approaches to ensure that the framework remains practical, adaptable, and protective of public health, safety, security, and the environment as commercial fusion deployment expands.

At the same time, the volume and pace of concurrent NRC rulemakings—more than twenty (20) underway, including multiple direct final rules, over a relatively short period of time—present significant challenges for Agreement States and other stakeholders. This compressed timeline limits the ability of DEEP to fully evaluate complex technical changes and the potential impacts, increasing the risk that implementation challenges may not be adequately addressed, and may render it pragmatically unfeasible to implement such technical changes within the timeframe prescribed.

It is essential that NRC rulemakings reflect a commitment to rigor, openness, and meaningful stakeholder engagement. Advancing significant regulatory changes without sufficient opportunity for review risks undermining public confidence—not only in existing programs, but also in the successful deployment of advanced nuclear technologies.

Given these considerations, DEEP respectfully recommends that the NRC:

- Provide public comment periods that are sufficiently long to allow Agreement States and other stakeholders to thoroughly review, analyze, and assess the technical, legal, operational, and implementation impacts of proposed rulemakings, particularly where changes are complex, far-reaching, or issued concurrently with other major regulatory actions;
- Sequence and pace rulemakings to provide meaningful spacing between significant regulatory changes and avoid requiring Agreement States to review and implement multiple complex rulemakings simultaneously; and
- Limit the use of direct final rules to truly non-controversial or minor administrative changes, ensuring that substantive or technically complex revisions are subject to full notice-and-comment rulemaking.

In closing, and before turning to DEEP's comments on this particular rulemaking in Attachment A, DEEP remains supportive of the NRC's efforts to modernize its regulatory framework and to fulfill its mission to protect public health and safety and advance the nation's common defense and security by enabling the safe and secure use and deployment of civilian nuclear energy technologies and radioactive materials through efficient and reliable licensing, oversight, and regulation for the benefit of society and the environment. Achieving these objectives while maintaining public trust and strong oversight will require a deliberate, transparent, and inclusive process that fully incorporates the experience and expertise of Agreement States.

Thank you for the opportunity to comment on this important matter.

Sincerely,



Katie S. Dykes
Commissioner
Connecticut Department of Energy and Environmental Protection

ATTACHMENT A

Specific Requests for Comments

DEEP appreciates the NRC's request for specific comments in Section IV of the Federal Register Notice (FRN) on the proposed "Regulatory Framework for Fusion Machines."³ In response to the NRC's questions, DEEP offers the following perspectives:

Response to Question #1: Should the NRC revise 10 CFR § 30.55(c) and § 20.2201 to change the reporting threshold to a higher activity for tritium? If so, what should be the new reporting threshold for tritium? Please provide the basis for your response.

DEEP does not support establishing a universally higher tritium reporting threshold within 10 CFR § 30.55(c) or § 20.2201. From DEEP's perspective, a blanket increase would unintentionally weaken oversight for non-fusion tritium users who would no longer be required to report the loss or theft of a significant portion of their inventory or a discrete radioactive component thereby endangering public safety and national security. DEEP recognizes that near-term fusion machines are expected to possess and process comparatively large quantities of tritium, including tritium that is circulated, stored, absorbed into structural materials, and embedded within system components during operation. Given the large quantities of tritium, strong oversight is crucial.

A key technical challenge associated with fusion systems is the well-documented ability of certain metals—such as titanium, zirconium, and erbium—to absorb significant quantities of hydrogen isotopes, including tritium. In particular, titanium can form stable hydrides that effectively retain tritium within structural or functional components until elevated temperatures or other operational conditions induce release. As a result, tritium absorbed into machine surfaces, vessel walls, getter systems, and internal components may not be readily quantifiable through conventional measurement techniques. Mass-balance accounting approaches based solely on input-output calculations may therefore indicate apparent "losses" that are not attributable to actual leakage, diversion, or release, but instead reflect material absorption, retention, redistribution, or in-vessel production.

Given the technical challenge noted above, DEEP believes this issue is best addressed as a material accounting and inventory characterization challenge rather than through establishment of a universally elevated reporting threshold. DEEP therefore recommends that the NRC maintain existing baseline reporting requirements while allowing fusion-specific accommodations to be addressed through license conditions, exemptions, or detailed licensing guidance tailored to individual facility designs and operational characteristics. Such an approach is more consistent with the NRC's proposed performance-based framework and better reflects the diversity of fusion machine technologies, tritium inventories, and accounting methodologies.

³ "Regulatory Framework for Fusion Machines," 91 FR 9476 (February 26, 2026).

DEEP further recommends that the NRC establish a clear framework distinguishing between:

- operational inventory fluctuations associated with absorption, retention, plating, transmutation, or in-vessel production;
- tritium consumed during fusion operations;
- tritium retained within structural or functional materials; and
- actual leakage or environmental release, as verified through direct monitoring and measurement.

This distinction is important because operational inventory uncertainties are fundamentally different from the loss or theft of a discrete radioactive component or container. A universally elevated reporting threshold would inadvertently allow the loss of individual tritium-containing items to fall below reporting requirements even where those items remain safety or security-significant.

DEEP also notes that for fusion facilities possessing significant tritium inventories, the existing 30-day 10 milliCurie (mCi) reporting criterion in 10 CFR § 20.2201(a)(2)(i) has limited practical regulatory value because normal material retention and accounting uncertainties substantially exceed that quantity. Existing licensing precedent demonstrates that tailored approaches can address these operational realities while still maintaining robust accountability requirements for discrete items and containers.

Given the limitations of traditional mass-balance methodologies in fusion environments, DEEP recommends that determinations of actual leakage or release be supported through defense-in-depth monitoring strategies that combine engineered process and containment monitoring, with environmental surveillance capable of detecting and quantifying offsite impacts.

Finally, DEEP emphasizes that development of a practical, scientifically defensible, and implementable tritium accounting framework will require continued coordination among the NRC, states, industry stakeholders, and technical experts as fusion technologies continue to evolve.

Response to Question #2: The NRC is particularly interested in feedback on this proposed approach to amend 10 CFR 20.2008 to provide options for safe waste disposal. Does this approach comprehensively address potential waste generated by fusion machines? Are there other approaches the NRC should consider? If yes, please provide the basis for your response.

DEEP generally supports the NRC's proposed revisions to 10 CFR § 20.2008 and appreciates the NRC's overall risk-informed and technology-inclusive approach to the regulation of fusion machines. DEEP agrees that a modernized and flexible waste management framework is necessary to support the safe deployment of emerging fusion technologies while continuing to protect public health, safety, security, and the environment.

At the same time, DEEP believes several additional issues should be addressed to ensure that the proposed framework remains comprehensive, technically durable, and implementable as fusion technologies mature and move toward commercial-scale deployment.

A primary concern relates to the long-term management and disposal of activated materials generated by fusion systems operating in high-energy neutron environments. Many fusion designs have the potential to activate structural and plasma-facing materials, producing radionuclides that may exceed existing Class C low-level radioactive waste limits. For some systems, it may not be technically feasible to ensure that all activation products remain below Greater-Than-Class-C (GTCC) thresholds, particularly where radionuclide inventories are determined through computational modeling rather than direct measurement.

DEEP is concerned that, absent a clearly established disposal pathway for GTCC waste, fusion facilities could ultimately become de facto long-term storage locations for activated materials. Such an outcome would create significant regulatory, operational, environmental, financial assurance, and public confidence challenges. While draft NUREG-1556, Volume 22 appropriately recognizes that certain activated materials may decay below GTCC thresholds over time and supports the use of extended interim storage and decay-in-storage approaches, DEEP believes additional regulatory clarity is still necessary regarding how GTCC waste will be managed if decay periods extend significantly longer than anticipated.

Accordingly, DEEP recommends that the NRC, in coordination with federal partners, proactively address GTCC waste management as part of the broader fusion regulatory framework. This should include clarification of:

- long-term disposal pathways for GTCC waste;
- expectations for onsite interim storage durations and controls;
- financial assurance and long-term stewardship responsibilities; and
- roles and responsibilities among federal agencies, licensees, and host jurisdictions.

DEEP further recommends that this rulemaking remain closely coordinated with the NRC's ongoing modernization of 10 CFR Part 61 waste classification tables are updated with expected fusion isotopes. Existing waste classification tables and performance assessment assumptions were developed decades ago and may not fully reflect the radionuclide inventories and activation products expected from modern fusion systems. A coordinated approach is necessary to ensure that waste classifications, intruder analyses, and disposal performance assessments appropriately account for fusion-specific waste streams and evolving activation profiles.

DEEP also supports the flexibility reflected in draft NUREG-1556, Volume 22 regarding extended interim storage, decay, recycling, and eventual disposal of activated materials. Allowing certain materials to decay prior to disposal or reuse represents a practical and risk-informed approach during the early stages of fusion deployment, particularly where shorter-lived activation products predominate.

Finally, DEEP emphasizes the importance of robust waste characterization, transparency, and lifecycle controls. Licensees should clearly identify anticipated radionuclides, expected decay

periods, modeling assumptions, analytical methodologies, and projected waste disposition pathways throughout facility operations and decommissioning. Maintaining clear and transparent characterization of fusion waste streams will be essential to sustaining regulatory confidence, ensuring effective oversight, and maintaining public trust as these technologies evolve.

Response to Question #3: What would the benefits be of expanding existing guidance for alternative disposal under 10 CFR § 20.2002, “Method for obtaining approval of proposed disposal procedures,” to specifically address fusion machine waste? Should the NRC develop guidance focused on reusing or recycling low-activity fusion machine waste? Are there alternative approaches the NRC should consider? Please provide the basis for your response.

DEEP agrees that the NRC’s proposed amendments to 10 CFR § 20.2008 establish an appropriate and flexible foundation for the disposal of fusion-machine-generated waste. DEEP supports the NRC’s overall performance-based and risk-informed approach, particularly the use of dose-based methodologies and intruder dose evaluations to address radionuclides and activation products that are not currently contemplated within existing 10 CFR Part 61 waste classification tables.

At the same time, DEEP believes the NRC should consider expanding supplemental guidance under 10 CFR § 20.2002 to more specifically address alternative disposal pathways, recycling, reuse, and clearance approaches for low-activity fusion waste streams. As fusion technologies evolve, many activated materials may become suitable for reuse, recycling, or alternative disposition following appropriate decay periods and characterization. Additional guidance in this area would provide greater regulatory clarity while supporting waste minimization, sustainability, and efficient lifecycle management of fusion-related materials.

DEEP supports the development of safe and well-defined recycling and reuse strategies for materials generated by fusion systems where such practices can be demonstrated to remain protective of public health, worker safety, and the environment. Encouraging recycling and material recovery could significantly reduce the volume of waste requiring long-term disposal, help mitigate future demands on limited disposal capacity, and support more sustainable operation and decommissioning practices for fusion facilities.

DEEP recommends that the NRC continue exploring regulatory approaches that enable practical recycling and reuse pathways while maintaining appropriate oversight, characterization requirements, and radiological controls. Such guidance should clearly address:

- acceptable characterization methodologies for activated materials;
- criteria for release, reuse, or recycling following decay storage;
- treatment of materials containing mixed or difficult-to-characterize activation products;
- recordkeeping and traceability expectations; and
- coordination with disposal and clearance requirements under 10 CFR Part 61 and related guidance.

DEEP also emphasizes the importance of ensuring that any guidance developed under 10 CFR §

20.2002 remains closely coordinated with the NRC's broader modernization of 10 CFR Part 61. Maintaining consistency across waste classification, disposal, recycling, and performance assessment frameworks will be essential to creating a coherent and durable regulatory structure for fusion-generated waste streams as the industry matures.

Response to Question #4: Should the NRC propose export controls related to fusion machines? Please provide the basis for your response.

DEEP recognizes that regulatory authority for export associated with fusion machines, fusion-related technology, and associated byproduct material remain matters of exclusive federal jurisdiction.

DEEP supports continued NRC coordination with other federal agencies regarding export controls and national security considerations as fusion technologies move toward commercialization. Maintaining appropriate federal oversight is important to ensure protection of the common defense and security and to prevent the unauthorized transfer of sensitive materials, technologies, or technical information.

Response to Question #5: Does the proposed rule provide adequate clarity on the licensing process, including designated Compatibility Categories, and if not, where is additional clarity needed? Please provide the basis for your response.

DEEP generally agrees that the proposed rule and accompanying draft NUREG-1556, Volume 22, establish a sufficiently flexible and technology-inclusive framework for the licensing of near-term demonstration and first-of-a-kind fusion facilities. DEEP supports the NRC's overall performance-based approach during this early stage of fusion technology development, recognizing that regulatory flexibility is important given the rapid pace of innovation and the diversity of emerging fusion concepts.

DEEP also finds that the proposed compatibility framework would generally be workable with the resolution to our comments on the Draft Licensing Guidance (NUREG-1556 Volume 22) offered later in this attachment.

DEEP believes that additional licensing guidance will be necessary as fusion technologies evolve beyond first-of-a-kind and demonstration-scale deployments. While a generalized performance-based framework is appropriate for the current stage of development, a one-size-fits-all regulatory approach may become increasingly difficult to implement effectively as commercial fusion technologies diversify and mature. Fusion technologies encompass a broad range of confinement methods, fuel cycles, materials, operational characteristics, and safety systems, including tokamaks, stellarators, inertial confinement systems, and other emerging concepts. As these technologies advance, DEEP recommends that the NRC develop more detailed, technology-specific licensing guidance and standardized review criteria for established machine designs and operational configurations. More detailed guidance would:

- promote greater consistency across the National Materials Program;
- improve regulatory predictability for applicants, host communities, and regulators;

- support more efficient and technically consistent licensing reviews;
- improve the collection and evaluation of information related to tritium management, activation products, waste management, decommissioning, and accident analysis; and
- reduce the potential for significant variation in implementation among jurisdictions.

DEEP also strongly recommends that the NRC develop targeted training programs for Agreement State personnel to ensure regulators possess the technical expertise necessary to evaluate fusion applications and oversee operations effectively. In addition to foundational instruction on fusion technologies and radiation protection principles, DEEP believes training should include machine-specific and technology-specific content tailored to the designs being deployed. Given the diversity of fusion concepts, regulators will require detailed familiarity with:

- design-specific operating principles;
- tritium handling and accountability systems;
- neutron activation and shielding considerations;
- activation products and waste characterization;
- confinement and safety systems; and
- environmental and effluent monitoring approaches.

DEEP further recommends that the NRC training programs evolve alongside operational experience and technological development so that Agreement State personnel remain prepared to consistently and effectively implement regulatory requirements across a broad range of fusion technologies.

Overall, DEEP believes the proposed framework provides an appropriate foundation for near-term fusion licensing, but additional model-specific guidance and regulator training will be necessary to support consistent and effective oversight as the industry matures and commercial deployment expands.

Response to Question #6: Are there unintended consequences or impacts not considered by the NRC by including fusion machines in the definition of “particle accelerator”? Are there unintended consequences or impacts not considered by the NRC with respect to the proposed compatibility designations of the “fusion machine” and paragraph 3(ii)(A) of the “byproduct material” definitions? Please provide a basis for your response.

DEEP supports the proposed revisions to the definition of “particle accelerator” and related terms to incorporate fusion machines, consistent with the statutory changes enacted in the ADVANCE Act.

Connecticut has already codified the ADVANCE Act definitions for by-product material and fusion machine into the Connecticut General Statutes. Accordingly, DEEP supports the NRC’s efforts to align federal regulations with statutory definitions, as this promotes regulatory clarity, consistency, and compatibility between federal and Agreement State programs.

Cumulative Effects of Regulation (CER)

DEEP provides the following responses to the specific request for comments in “Section VIII. Cumulative Effects of Regulations” of the FRN:

Response to CER Question #1: In light of any current or projected CER challenges, would the proposed effective date of 30 days after the date of publication of a final rule provide sufficient time to implement the new, proposed requirements? Please provide a rationale for your response.

DEEP recognizes that, as an Agreement State that incorporates many NRC requirements by reference, implementation of compatible regulations can often occur more efficiently than in states that must undertake extensive independent rulemaking processes. Accordingly, DEEP does not view the core regulatory adoption requirements associated with this proposed rule as the primary implementation challenge. DEEP also notes that Agreement States and NRC staff have already demonstrated the ability to work collaboratively with developers to support near-term licensing and regulatory oversight of emerging fusion technologies using existing regulatory authorities and flexible, performance-based approaches.

DEEP believes the proposed rule and accompanying draft NUREG-1556, Volume 22, provide an appropriate degree of regulatory flexibility to support early-stage and first-of-a-kind fusion licensing activities. However, successful long-term implementation will depend heavily on the timely development of supporting guidance documents, inspection procedures, training programs, and technical resources necessary to ensure consistent oversight across jurisdictions.

DEEP’s primary implementation concerns therefore relate less to adoption of the regulations themselves and more to the supporting infrastructure needed for effective and technically consistent regulation of fusion technologies, including:

- finalization of licensing guidance and inspection procedures;
- development of technology-specific training programs for NRC’s and Agreement States’ personnel;
- establishment of appropriate licensing fee structures and program codes;
- development of guidance related to tritium accounting, activation products, waste characterization, and emergency preparedness; and
- coordination of future guidance updates as fusion technologies continue to evolve.

DEEP further notes that fusion facilities are generally more comparable in technical complexity and regulatory review effort to medical isotope production accelerators and cyclotron facilities than to conventional medical accelerator programs that form the basis for many existing state fee structures and inspection models. Oversight of fusion machines will require specialized expertise in areas such as neutron activation, tritium handling and accountability, shielding analysis, activation product characterization, and high-energy radiation environments.

Accordingly, while DEEP believes near-term implementation of the proposed framework is achievable, DEEP emphasizes that continued NRC support through detailed guidance development, training, and technical coordination with Agreement States will be essential to

maintaining consistent, effective, and risk-informed oversight as fusion technologies mature and commercial deployment expands.

Response to CER Question #2: If CER challenges currently exist or are expected, what should be done to address them? For example, if more time is required for implementation of the new requirements, what period of time is sufficient? Please provide a rationale for your response.

As discussed above, DEEP's primary implementation concerns relate less to the adoption of the regulations themselves—which is largely accomplished in Connecticut through incorporation by reference—and more to the supporting infrastructure necessary for effective, technically consistent, and sustainable oversight of fusion technologies. In particular, successful implementation will depend on the timely development of licensing guidance, inspection procedures, technology-specific training programs, fee structures and program codes, and additional guidance addressing areas such as tritium accounting, activation product characterization, waste management, and emergency preparedness.

DEEP also notes that, similar to its incorporation of NRC regulatory requirements by reference, the State's radioactive materials fee structure is closely tied to NRC fee categories and program codes. At present, the proposed rule does not establish fusion-specific fee structures or program codes that would appropriately reflect the level of technical review, inspection effort, and regulatory oversight necessary for fusion facilities. This creates uncertainty regarding whether sufficient program resources will be available to support the specialized expertise and regulatory activities that fusion technologies will require, particularly given the adaptable, performance-based, and technology-specific licensing framework contemplated by the proposed guidance.

Effective oversight of fusion technologies will require specialized expertise in areas such as neutron activation, tritium handling and accountability, shielding analysis, activation product characterization, and high-energy radiation environments. At the same time, DEEP believes that Agreement States and the NRC have already demonstrated the ability to work collaboratively with developers to support near-term licensing and regulatory oversight of emerging fusion technologies using existing regulatory authorities and flexible, performance-based approaches. DEEP therefore believes near-term implementation of the proposed framework is achievable, provided the NRC continues to support Agreement States through coordinated guidance development, technical training, and ongoing regulatory engagement as fusion technologies mature and commercial deployment expands.

Response to CER Question #3: What other (NRC or other agency) regulatory actions (e.g., orders, generic communications, license amendment requests, inspection findings of a generic nature) influence the implementation of this proposed rule's requirements? Please provide a rationale for your response.

For fusion facilities involving tritium use and groundwater monitoring, DEEP notes that the U.S. Environmental Protection Agency (EPA) drinking water standards and associated dosimetric

assumptions remain based on older methodologies that may not fully reflect current dose conversion methodologies.

The State believes greater coordination between the NRC and EPA regarding dosimetric assumptions and dose conversion factors would improve consistency across environmental protection frameworks and better align with the NRC's proposed risk-informed and performance-based regulatory approach.

Response to CER Question #4: What are the unintended consequences, and how should they be addressed? Does this proposed rule create conditions that would be contrary to this proposed rule's purpose and objectives? Please provide a rationale for your response.

DEEP believes that one of the primary potential unintended consequences associated with this proposed rule arises from its interaction with several other significant NRC rulemakings currently underway, including revisions to 10 CFR Parts 20, 37, and 61. While each of these rulemakings addresses different aspects of the regulatory framework, they are highly interrelated in practice for fusion technologies, particularly with respect to radiation protection standards, tritium accountability, waste classification and disposal, security requirements, decommissioning considerations, and activation product management.

Because these rulemakings are proceeding concurrently, there is a risk that individual regulatory changes may be developed or implemented without sufficient integration across the broader framework governing fusion facilities. This could result in inconsistencies between licensing requirements, waste management expectations, security provisions, and dose assessment methodologies. For example, changes to 10 CFR Part 20 radiation protection requirements may directly influence implementation of this fusion rule, while ongoing 10 CFR Part 61 revisions will significantly affect the classification, storage, and disposal pathways available for activated fusion materials. Similarly, future changes to 10 CFR Part 37 security requirements could materially affect how certain tritium inventories or activated components are regulated within fusion facilities.

DEEP believes these risks can be mitigated through coordination, spacing, and integration among the related rulemakings, including development of harmonized guidance, aligned implementation schedules, and clear communication regarding how overlapping requirements are intended to function together within the broader fusion regulatory framework. DEEP further recommends that the NRC provide sufficient spacing between related rulemakings and major implementation actions to allow Agreement States, licensees, and other stakeholders adequate time to evaluate, implement, and integrate each set of changes before additional interconnected requirements are finalized.

DEEP also notes that while the proposed performance-based and technology-inclusive approach provides important flexibility during the early stages of fusion development, increased flexibility also creates greater potential for inconsistent implementation across the National Materials Program. As fusion technologies diversify and deployment expands, the absence of sufficiently detailed licensing guidance could result in significant variations among jurisdictions in areas

such as tritium accounting methodologies, activation product characterization, waste classification, accident analysis assumptions, and inspection practices.

To address this concern, DEEP reiterates the importance of developing more detailed, machine-specific licensing guidance as fusion technologies mature beyond first-of-a-kind deployments and move toward standardized commercial designs. Technology-specific guidance, inspection procedures, and training programs will be essential to promoting consistent implementation, maintaining regulatory predictability, and ensuring that safety, security, and environmental protection standards are applied uniformly across jurisdictions.

Accordingly, while DEEP supports the NRC's overall objectives of enabling innovation through a flexible and risk-informed framework, DEEP believes the long-term success of the proposed rule will depend on continued coordination with related rulemakings and the eventual transition toward more detailed and standardized guidance as fusion technologies evolve toward broader commercial deployment.

Response to CER Question #5: Please comment on the NRC's cost and benefit estimates in the regulatory analysis that supports this proposed rule.

DEEP believes the NRC's regulatory analysis does not fully capture the actual costs associated with implementing this rulemaking.

Specifically, the analysis does not adequately address:

- the need for fusion-specific fee categories and program codes;
- state regulatory costs associated with revising machine-based regulations;
- staff training and technical readiness needs;
- licensing and inspection resource demands; and
- long-term waste management and decommissioning oversight costs.

Fusion facilities will require substantially greater technical review effort than conventional accelerator programs currently used as the basis for many existing state fee structures. Without dedicated NRC fee categories and associated guidance, states may lack the information necessary to appropriately recover regulatory costs and allocate sufficient program resources.

DEEP therefore recommends that the NRC develop dedicated fusion-machine fee structures and incorporate state implementation costs more comprehensively into its final regulatory analysis.

Additional Comments on Draft Licensing Guidance (NUREG-1556 Volume 22)

DEEP offers the following comments regarding draft NUREG-1556, Volume 22, “Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Possession Licenses for Fusion Systems,” to help ensure that the guidance remains sufficiently comprehensive, adaptable, and practical for the licensing of emerging fusion technologies.

Comment #1: Consideration of Alternative Fusion Fuel Cycles

DEEP notes that the draft guidance is largely oriented toward deuterium-tritium (D-T) fusion systems and provides comparatively limited discussion of alternative fuel cycles, such as proton-boron (p-B11) and other non-D-T concepts. Although the proposed rule acknowledges that fusion technologies may utilize different reaction pathways, much of the associated licensing guidance remains focused on tritium-based systems.

DEEP recommends that the NRC expand the guidance to more explicitly address non-D-T fusion approaches, potentially through a supplemental appendix, technology-specific attachment, or future guidance updates. Providing additional discussion of alternative fuel cycles would promote more consistent regulatory expectations and improve clarity for developers pursuing fusion concepts with significantly different radionuclide inventories, activation products, and operational characteristics.

Comment #2: Expanded Discussion of Tritium Forms and Behavior

DEEP also recommends that the NRC broaden its discussion of tritium forms within Section 8.5. The current draft primarily addresses gaseous tritium (HT) and tritiated water (HTO), but fusion facilities may involve tritium in a wider variety of chemical and physical forms, including organically bound tritium (OBT), tritium retained within getter systems, material-bound or surface-absorbed tritium, and solid hydride forms.

Because radiological behavior, monitoring techniques, dose pathways, and engineering controls can differ substantially depending on the specific tritium form present, additional clarity in this area would improve consistency in licensing and operational oversight. More comprehensive treatment of tritium chemistry and retention mechanisms would also assist regulators and applicants in developing appropriate environmental monitoring programs, effluent controls, contamination monitoring approaches, and bioassay requirements.

Comment #3: Practical Approaches for Activation Product Listings

DEEP further believes that additional flexibility may be necessary regarding isotope listing expectations for activation products, particularly radionuclides within the atomic number range 84-96. For many near-term fusion systems, individually identifying and tracking every potential activation product may not be operationally practical or technically meaningful.

DEEP notes several factors supporting a more flexible approach:

- many activation products are identified through predictive modeling rather than direct measurement;
- some radionuclides may exist only in trace quantities or as impurities;

- alpha-emitting isotopes generally lack default exempt quantities under 10 CFR § 30.71, Schedule B; and
- prior licensing precedent has demonstrated the practicality of grouping certain radionuclides under aggregate activity limits for oversight purposes.

Accordingly, DEEP recommends that the NRC consider approaches that allow grouped accounting or aggregate possession methodologies for certain activation products, particularly where direct measurement is impractical and activation profiles are highly dependent on material composition, impurities, and operational history.

Comment #4: Guidance on Tritium Behavior

DEEP recommends that the NRC expand the technical guidance in Section 8.9 to better reflect the unique physical and chemical behaviors of tritium. It is expected that many fusion facilities will manage large tritium inventories, and clearer expectations are needed to ensure appropriate engineering controls, maintenance practices, and worker protection.

DEEP recommends that the NRC:

- *Address tritium chemical transformations.* Tritium can undergo beta-driven reactions (e.g., forming tritiated ammonia or methane), which affect environmental monitoring and dose assessments.
- *Clarify material-degradation considerations.* Tritium permeates and degrades ceramics, glass, and certain polymers; guidance should include expectations for material selection and anticipated replacement intervals.
- *Highlight limitations of organic materials and Teflon.* Polymers can degrade under tritium exposure and may produce corrosive byproducts; metallic seals should be recommended for higher-activity systems.
- *Provide guidance on tritium behavior in metals.* Tritium binds to oxide layers and can re-emerge at the surface, and moisture can trigger localized releases; these behaviors affect contamination control and equipment longevity.
- *Clarify PPE expectations.* Due to rapid isotopic exchange, common glove materials allow tritium diffusion. The NRC should emphasize appropriate glove-change frequencies and personal protective equipment (PPE) selection.
- *Reinforce dose management strategies tailored to tritium.* Ventilation and decontamination are the primary tools for controlling dose given tritium's limited external-shielding considerations.

Providing clearer technical guidance in these areas will help ensure that licensees and regulators effectively manage the radiological and industrial hazards associated with tritium in fusion systems.

Comment #5: Verification of Radiation Shielding After Seismic Events

DEEP recommends that the NRC revise Section 8.9 (Item 9: Facilities and Equipment) to establish explicit post-seismic operational requirements for fusion facilities following certain earthquake events that could affect shielding integrity. The current draft appropriately requires applicants in designated seismic areas to design concrete shielding and foundations using structural standards such as ACI 318-95 or ANSI/AISC 341-10 to ensure integrity during an

earthquake. However, additional operational requirements are warranted to address seismic events occurring at facilities outside designated seismic areas, as well as events that exceed the seismic assumptions used in the original shielding design basis for facilities located within designated seismic areas.

Specifically, DEEP recommends that the guidance requires fusion facilities to:

- Immediately shut down the fusion machine following:
 - a seismic event occurring at a facility not located within a designated seismic area, as defined by the U.S. Geological Survey; or
 - a seismic event that exceeds the assumptions or design basis used for shielding and structural seismic analyses at facilities located within designated seismic areas.
- Perform a comprehensive post-event inspection of shielding structures, foundations, and shielding support systems to identify cracking, displacement, settling, void formation, or other degradation that could affect shielding performance.
- Repair or remediate any identified deficiencies affecting shielding integrity prior to resuming operation.
- Conduct a post-startup radiation shielding survey following restart to verify that shielding performance remains adequate and that radiation levels remain consistent with licensing and design assumptions.

DEEP believes these requirements are consistent with the NRC's risk-informed and performance-based regulatory framework and appropriately reflect the inherent safety characteristics of fusion systems. Because fusion reactions terminate rapidly upon shutdown and generally do not require prolonged post-shutdown cooling to maintain confinement integrity, a shutdown-inspection-verification approach provides a practical and protective method for ensuring continued shielding effectiveness following seismic disturbances. Establishing these expectations would improve regulatory clarity and help ensure consistent post-event evaluation of shielding integrity across fusion facilities.

Comment #6: Clarification of RSO/HP Presence During Maintenance

DEEP recommends that the NRC refine the language in Section 8.9.9 regarding when the Radiation Safety Officer (RSO) or health physics staff (HP) must be physically present during maintenance. The draft guidance currently requires RSO or HP presence during maintenance on "any component exposed to the neutron flux," which is overly broad and may include components with negligible activation potential.

DEEP recommends that the NRC clarify this requirement by referring to components exposed to a measurable or radiologically significant neutron flux, or by providing a dose-rate or activation-based threshold. This clarification would:

- support a risk-informed approach by focusing oversight on components with meaningful radiological hazards;
- improve operational practicality, avoiding unnecessary RSO/HP presence for items with negligible activation; and

- align with the NRC’s performance-based framework by allowing licensees to use modeling or initial surveys to determine when direct HP supervision is warranted.

Clarifying this language will ensure that specialized radiological oversight is prioritized for maintenance activities that present actual worker or facility risk, while enabling efficient routine maintenance on non-activated or minimally activated components.

Comment #7: Guidance Related to Power Failures

DEEP recommends that the NRC provide additional clarity in the draft guidance related to power failures, particularly those described in Section 8.9.9, to ensure that fusion facilities maintain a clearly defined and reliable strategy for monitoring radiological conditions when primary power is lost.

While the draft NUREG notes that continuous electrical power is necessary to keep radiation monitoring equipment operational, the “Response from Applicant” section should be expanded to explicitly require applicants to describe how they will detect and monitor radioactive releases during a loss of power. DEEP recommends incorporating the following specific elements into the guidance:

- *Identification of Monitoring Methods:* Applicants should be required to specify whether monitoring for unexpected radioactive releases during a power outage will be performed using permanently installed radiation monitors supported by backup power sources (e.g., UPS systems, batteries, diesel generators) or through portable, handheld survey instruments.
- *Release Detection Capability:* The guidance should emphasize the importance of maintaining accurate and timely monitoring to detect and quantify potential releases that may occur if engineered controls—such as vacuum systems, ventilation, or negative pressure—are compromised due to the loss of power.
- *Procedures for Manual Surveys:* If handheld instruments are intended for use during power failures, the application should include detailed procedures, survey locations, and frequencies for manual radiological assessments. This is particularly important in areas where airborne radioactivity levels may increase when ventilation or containment systems are interrupted.
- *Integration with Emergency Procedures:* The facility’s monitoring approach during power outages should be aligned with its emergency procedures, including criteria for determining when respiratory protection requirements may be lifted after ventilation systems have been restored.

Requiring these details will help ensure that fusion facilities retain the capability to evaluate radiological hazards in real time during power interruptions, thereby enhancing the protection of facility personnel and the public.

Comment #8: Security Program Requirements – Applicability of 10 CFR Part 37 to Fusion Facilities

DEEP recommends that the NRC re-evaluate the statement in Section 8.10.1 suggesting that most fusion licensees are unlikely to possess aggregated Category 1 or 2 quantities of radioactive

material. Technical projections indicate that fusion facilities may reach these thresholds as tritium inventories increase and activation products accumulate during routine operations.

- *Tritium Considerations*: Fusion facilities may contain large tritium inventories. Although tritium is not listed in Appendix A to 10 CFR Part 37, DEEP recommends that the NRC formally assess whether tritium should be incorporated into the 10 CFR Part 37 framework or addressed through supplemental guidance, given evolving fuel-cycle strategies and potential increases in centralized storage.
- *Accumulation of Activation Products*: High neutron fluxes in fusion systems will generate activation products—some of which (e.g., Co-60) are already regulated under 10 CFR Part 37, while others are not yet listed. The NRC should provide guidance on how increasing activation over time may trigger 10 CFR Part 37 applicability so facilities can anticipate security transitions.
- *Gaps in 10 CFR Part 37 Isotopic Listings*: Relying on case-by-case license conditions for fusion-relevant isotopes introduces regulatory uncertainty. DEEP recommends establishing standardized thresholds for isotopes expected to be generated in fusion systems.
- *Needed Updates to Definitions in 10 CFR § 37.5*: Current definitions do not reflect the low theft potential of very large components or material stored within robust structures. DEEP recommends adding definitions for “large components” and “robust structures,” consistent with the NRC’s prior treatment in EGM 2014-001 and NUREG-2155, to reduce unnecessary reliance on exemptions.
- *Revision of “Aggregated” Definition*: The present definition considers only activity and barrier breach, without regard to whether combined items could feasibly be removed or transported. DEEP recommends revising the definition to exclude materials whose size, weight, configuration, or detectability make unauthorized removal not credible.

DEEP recommends that the NRC:

- Evaluate tritium for potential inclusion in 10 CFR Part 37.
- Clarify how activation products will be treated over a facility’s lifetime.
- Establish security thresholds for fusion-specific isotopes.
- Update definitions for “large components” and “robust structures.”
- Revise the “aggregated” definition to incorporate physical feasibility.

These improvements will ensure that the security framework for fusion facilities is risk-informed, consistent, and aligned with the radiological hazards expected in commercial fusion operations.

Comment #9: Dosimetry

DEEP recommends that Section 8.10.4.1 include an explicit discussion reminding applicants that neutron dose evaluation must account for the energy-dependent Quality Factors (QF) defined in 10 CFR § 20.1004(b). Fusion systems generate a wide range of neutron energies, and accurate assessment of occupational dose is directly dependent on using the appropriate QF values or fluence-to-dose conversion factors corresponding to the neutron energy spectrum.

Although the regulatory basis for QFs is established in 10 CFR Part 20, DEEP believes the guidance for fusion facilities should reinforce this requirement because:

- Fusion environments may produce both thermal and high-energy neutrons, creating complex mixed-field conditions.
- Dose measurements that do not account for neutron energy distribution may significantly under or overestimate the effective dose equivalent.
- Many neutron detection systems have energy-dependent response characteristics; the guidance should emphasize the need for energy-appropriate instrumentation, correction factors, or spectrometry.
- Properly applying the QF is essential for ensuring that licensees meet the requirements of 10 CFR §§ 20.1201 and 20.1501 for occupational dose limits and monitoring.

DEEP recommends adding a statement within Section 8.10.4.1 noting that applicants must ensure neutron dose calculations reflect the neutron energy spectrum expected during fusion system operations and apply the corresponding QFs as specified in 10 CFR Part 20.

The NUREG should also encourage applicants to describe the methods, instrumentation, or analytical models they will use to characterize neutron energy distribution and apply appropriate QF or fluence-to-dose conversion data.

Incorporating this clarification will ensure more consistent, accurate dose assessments and strengthen radiation protection programs across fusion facilities.

Comment #10: Include Additional Conditions Requiring Bioassay

DEEP recommends that the NRC revise Section 8.10.4.2 to explicitly list additional scenarios under which a bioassay should be required for workers handling tritium or activation products. These situations are consistent with health physics best practices, and they align with internal-dose monitoring triggers used across state radiation control programs.

Recommended Additions to Section 8.10.4.2 (“When Bioassay is Required”):

- Tritium lability events, including spills or releases of highly labile HTO or other readily exchangeable tritium compounds.
- Skin contamination or suspected skin absorption involving HTO or other tritiated compounds capable of permeating the skin.
- Work performed in tritium-handling areas where engineered ventilation is reduced, impaired, or lost, including gloveboxes, enclosures, or areas experiencing loss of negative pressure.
- Maintenance or system breaches where tritium-containing components (pumps, lines, valves, breeding blanket components, etc.) are opened to the atmosphere.
- Personnel exposure to airborne tritium concentrations resulting from process upsets, ventilation failures, or alarm activation in tritium monitoring systems.
- Any event involving contact with tritium-containing liquids, including cryogenic or process liquids, where inhalation or absorption potential exists.

These additions will reinforce the importance of rapid and accurate internal dose assessment in the tritium-rich environment characteristic of most fusion systems.

Comment #11: Environmental Surveillance for Tritium Groundwater and Drinking Water Monitoring

DEEP recommends that the NRC revise Section 8.10.10 (Environmental Surveillance) to explicitly address the potential for tritium migration into groundwater and the need for routine groundwater and drinking water monitoring at fusion facilities possessing significant tritium inventories.

Many fusion systems will store, process, and generate tritium in quantities that—if released through leaks, equipment failures, or migration pathways—can enter subsurface soils and groundwater. Across the United States, historical experience from nuclear and non-nuclear facilities demonstrates that tritium is highly mobile in groundwater and can impact private wells, public drinking water supplies, and nearby surface waters. Because the Safe Drinking Water Act (SDWA) establishes enforceable Maximum Contaminant Levels (MCLs) for radionuclides, including tritium, licensees must be able to ensure that routine operations and accidental releases do not result in exceedances of SDWA standards in drinking water sources.

DEEP recommends that the NRC add language to Section 8.10.10 specifying that environmental surveillance programs for fusion facilities should include:

- Groundwater monitoring wells positioned downgradient of tritium-handling systems, storage areas, waste systems, and other potential release points.
- Routine sampling for tritium in groundwater, with increased monitoring frequency following abnormal occurrences, equipment failures, or environmental release events.
- Evaluation of potential impacts on drinking water sources, including private or public wells within the hydrologic influence of the facility.
- Reference to SDWA requirements, including the need to demonstrate that licensed activities will not cause exceedances of federal drinking water standards.
- Consideration of hydrologic transport pathways in the site conceptual model used for environmental monitoring planning.

An environmental surveillance program that omits subsurface monitoring cannot adequately evaluate tritium migration or protect public drinking water resources. Explicit NRC guidance on groundwater and drinking water monitoring will help ensure that licensees develop robust environmental protection programs aligned with the SDWA and consistent with national best practices.

Comment #12: Need for Expanded Guidance on Fusion Dust Management

DEEP recommends that the NRC expand the guidance in Section 8.10.6.2 (Maintenance) to more fully address the radiological and industrial safety risks associated with fusion dust (sometimes referred to as activated dust). While the draft NUREG acknowledges dust accumulation as a maintenance concern, additional detail is needed to ensure licensees appropriately evaluate and control this unique hazard during routine and corrective maintenance. Recommended Enhancements to Section 8.10.6.2:

- *Radiological Characterization:* Fusion dust generated from plasma-surface interactions within the vacuum vessel may contain elevated levels of tritium and activation products. DEEP recommends that the NUREG direct applicants to characterize dust for isotopic content, particle size distribution, and tritium loading to properly assess internal dose potential for maintenance personnel.
- *Removal and Containment Procedures:* Maintenance involving vessel openings or component replacement must control the spread of activated particles. DEEP recommends that the guidance specify the use of engineered containment and removal systems—such as HEPA-filtered vacuum systems, gloveboxes, or hot-cell configurations—to prevent worker exposure and inadvertent contamination of workspaces.
- *Monitoring for Mobilized Dust:* In addition to gaseous tritium monitoring, DEEP recommends that the NRC explicitly require licensees to evaluate the need for airborne particulate monitoring during maintenance activities with potential for dust mobilization.
- *Industrial Safety Considerations:* Metallic fusion dust can present flammability and explosivity hazards, particularly when exposed to air or moisture. These risks should be addressed within maintenance procedures and tied to the facility's fire protection strategy, including considerations related to loss-of-coolant or oxidation-driven events.
- *Waste Management and Decommissioning:* Fusion dust may become a complex waste stream depending on activity levels and chemical composition. DEEP recommends that the guidance instruct applicants to define criteria for when dust becomes waste and ensure that decommissioning funding plans account for its safe handling, storage, and disposal.

By providing clearer and more detailed expectations for the characterization, control, monitoring, and disposal of fusion dust, the NRC will help ensure consistent safety practices and strengthen radiological protection during maintenance activities at fusion facilities.

Comment #13: Section 8.10.9 (Emergency Planning): Need for Clear, Consistent Assumptions in Tritium Fire Scenarios

DEEP recommends that the NRC strengthen the guidance in Section 8.10.9 (Emergency Planning) by providing clearer expectations for how applicants should model tritium behavior in fire-driven accident scenarios. Because fire is identified as a credible initiating event for the uncontrolled release of radioactive material, the chemical and physical assumptions used in these analyses are central to ensuring consistent, conservative, and technically defensible offsite dose evaluations.

Key Areas Requiring Clarification

- *Chemical Form of Tritium:* The assumed chemical form of tritium dominates the resulting dose analysis. Dose conversion factors for tritiated water (HTO) are orders of magnitude higher than for elemental tritium (HT), and insoluble tritiated particulates may present even higher dose potential.⁴ Clear NRC guidance is needed on which chemical form(s) must be assumed for fire scenarios to ensure consistency across applicants.

⁴ U.S. Department of Energy. Tritium Handling and Safe Storage. DOE-STD-1129-2015, U.S. Department of Energy, 2015

- *Fire Scenarios as Potential Bounding Accidents*: Fire-induced releases near tritium-bearing systems are frequently identified as bounding cases in safety analyses⁵. DEEP recommends that NRC explicitly state that applicants are expected to evaluate such scenarios when determining whether emergency planning requirements under 10 CFR § 30.32(i) apply and describe criteria for when these scenarios constitute bounding releases.
- *Tritium Oxidation Assumptions*: Published literature shows wide variability in tritium oxidation fractions during fire or high-temperature events. The U.S. Department of Energy practice often defaults to 100% oxidation of HT to HTO to ensure a health-protective analysis. NRC guidance should indicate what oxidation fractions are considered acceptable or bounding for licensing analyses.
- *Dependence on Facility-Specific Conditions*: Oxidation rate, chemical form, and airborne dispersion of tritium are strongly influenced by geometry, ventilation, and environmental conditions at the time of release. Guidance should address how applicants must incorporate these parameters to avoid oversimplified or non-conservative modeling assumptions.

DEEP recommends that Section 8.10.9 be revised to include explicit, standardized expectations for modeling tritium chemical form, oxidation assumptions, and fire-driven dispersion. Without clear guidance, applicants may adopt divergent methodologies, resulting in inconsistent offsite dose estimates and uneven determinations of emergency planning requirements across the National Materials Program.

Comment #14: Appendix H (Instrumentation): Inclusion of Stephenson Passive Diffusion Cell

DEEP recommends that the NRC revise NUREG-1556 Volume 22 Appendix H to include the Stephenson Passive Diffusion Cell as an available method for airborne tritium monitoring. This passive diffusion dosimeter is widely used in tritium laboratories to measure airborne tritiated water vapor (HTO) and provides a low-cost, low-maintenance option for personnel exposure assessment and atmospheric mapping in tritium-handling areas.

Because fusion facilities may rely heavily on tritium systems and may have locations where continuous electronic monitors are impractical, DEEP recommends adding this instrument to the list of acceptable air-monitoring tools to ensure the guidance reflects the full range of practical monitoring options.

⁵ Brown, Alexander L., et al. "Tritium Fires: Simulation and Safety Assessment.", Apr. 2022. <https://doi.org/10.2172/1862102>