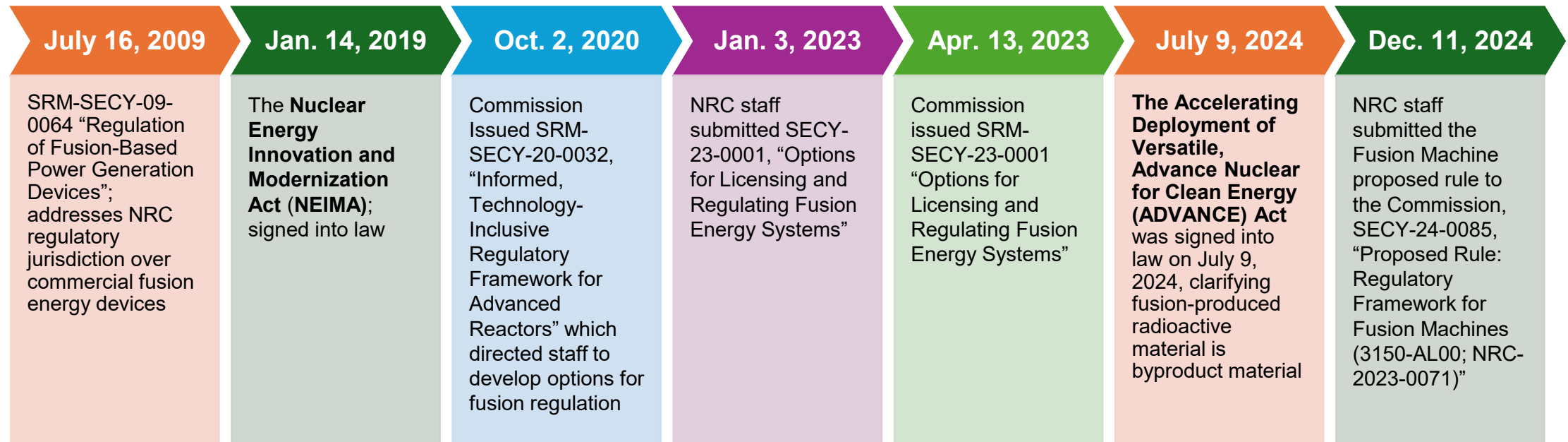


# **Fusion Machine and ADVANCE Act Updates**

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**Duncan White and Allyce Bolger  
Office of Nuclear Material Safety and Safeguards  
August 12, 2025**

# The Journey Continues...



# External Engagement

## Meetings with external stakeholders

- Public meetings
- Government-to-Government
- Site visits: DOE, commercial, and international
- Professional societies (ASME, HPS)

## Consultation with other regulators

- Agreement States
- Department of Energy
- Food and Drug Administration
- Federal Aviation Administration
- Department of Transportation
- International community

# Proposed Rule: Regulatory Framework for Fusion Machines

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- Provided to NRC Commission on December 11, 2024 (SECY-24-0085)
- Limited rulemaking
- Technology neutral and risk-informed
- Incorporates new and revised definitions from ADVANCE Act of 2024
- ADAMS Accession No. [ML24019A060](#)



# Fusion Machine Licensing Guidance

NUREG-1556, Volume 22 (revised proposed draft version released on March 12, 2025 ([ML24295A002](#)))

- Applies to fusion machines for research and development or commercial deployment
- Risk-informed and technology neutral
- Leverages existing 10 CFR Part 30 requirements applicable to all licensees
- Emphasizes containing, shielding, processing, or controlling radiation and radioactive materials
- Limited to specific components where radioactive materials are present (i.e., not facility-wide)



# Section 205 of the ADVANCE Act

The Accelerating Deployment of Versatile, Advance Nuclear for Clean Energy (ADVANCE) Act was signed into law on July 9, 2024

Adds a new definition of “fusion machine” to the Atomic Energy Act of 1954, as amended (AEA)

Incorporates “fusion machine” into the definition of “byproduct material” in Section 11e(3)(B) of the AEA

Made conforming changes to the Nuclear Energy Innovation and Modernization Act (NEIMA) to replace the term “fusion reactor” with “fusion machine”

**Tasked the NRC with performing a study on mass-production of fusion machines and submitting a report to Congress on the results (Section 205 (c))**



# ADVANCE Act Section 205(c) Requirements

Perform	Perform a study on performance-based, design-specific licensing frameworks for mass-manufactured fusion machines
Consult	Study to be performed in consultation with Agreement States and private fusion sector
Evaluate	Evaluate the design, manufacturing, and operations certification process for aircraft used by the Federal Aviation Administration (FAA) as a potential model for fusion machines
Develop	Develop an estimated timeline for the NRC to issue consolidated guidance or regulations for licensing mass-manufactured fusion machines, considering the results of the study and anticipated need
Submit	Submit a report to Congress by July 9, 2025

# Overview of Section 205 Report

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Highlights ADVANCE Act implementation as a key agency priority and notes the importance of identifying efficiencies in fusion machine licensing

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Summarizes existing external and internal regulatory frameworks that could be leveraged in the development of a framework for licensing mass-manufactured fusion machines

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Discusses the NRC's estimated timeline to issue guidance or regulations for the licensing of mass-manufactured fusion machines

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Identifies completed, ongoing, and future actions the NRC is taking to enhance its regulatory framework for fusion machines

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Discusses licensing considerations within the National Materials Program

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Report sent to Congress on July 10, 2025 ([ML25120A080](#))

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# External and Internal Regulatory Frameworks Reviewed

## NRC certification frameworks:

- sealed sources and devices
- transportation packages
- spent fuel casks
- microreactors

## Certification frameworks used outside the NRC:

- The FAA's design, manufacturing, and operations certification of aircraft
- The Food and Drug Administration's (FDA) review of radiation therapy medical devices
- The Department of Transportation's regulation of safety-related components for vehicles
- Agreement State emerging technologies

# What Did We Learn?

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There are several concepts in both external and internal frameworks that the NRC could adopt to efficiently develop a licensing framework for mass-manufactured fusion machines:

- Design type categories used by the FAA
- Equivalence reviews used by the FDA
- Sealed source & device certification used by the NRC
- Transport package and spent fuel cask certification used by the NRC
- Nth of a Kind (microreactors)
- Leveraging Agreement State experience in licensing emerging technologies (e.g., fusion and medical)

# Indicators for Industry Readiness

Indicators that could be used to inform the process:

- Technical achievements
- Full-scale demonstration of novel components
- Mass-manufacturing of fusion machine parts
- Supply chain management
- Funding certainty
- Economic viability



# **Section 205 Report: Completed and Ongoing Actions**

- Publication of “Vision and Strategy: Regulating Fusion Machines Across the National Materials Program”
- Continue efforts to publish final rule on fusion machines and associated consolidated licensing guidance
- Monitor the development and assess the adoption of third-party codes and standards for fusion machines
- Monitor industry milestones and technical developments for integration into future fusion machine guidance
- Continue development of a training program for fusion machines

# **Section 205 Report: Future Actions**

- Following initial licensing, deployment, and operation of the first commercial fusion machine in the United States
  - Update or issue new guidance for commercial fusion machines
  - Incorporate any NRC and Agreement State lessons learned and best practices to better risk-inform licensing reviews
- Evaluate existing suite of health physics computer codes
  - Update SCALE and MELCOR for independent validation of an application's shielding and safety designs during licensing

# ADVANCE Act Section 401 Report

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- Advanced Methods of Manufacturing and Construction for Nuclear Energy Projects
- Report focused on advance reactors but included fusion machines
- Brief discussion on current efforts for standards and codes
- Report sent to Congress on January 6, 2025 ([ML24292A171](#))



# NRC's Vision and Strategy: Regulating Fusion Machines Across the National Materials Program

- **Vision**
  - NRC's Principles of Good Regulation
- **Strategic Focus**
  - Regulatory Optimization
  - Technical Readiness
  - Partnership and Coordination
- **Outcomes**
  - Regulatory Preparedness
  - Prototypes, Demonstrations, and Other Single-Site Projects
  - Broader Adoption

**Released on March 11, 2025**  
(ML25069A706)



# Fusion Training for the NMP

**Currently Available: November 2023 MIT fusion seminar available in Collaborative Learning Environment (CLE)**

## **Phase I: Fusion Fundamentals (March – May 2026)**

- Part 1 will provide an introduction into basic science, mathematics, and physics associated with fusion
- Part 2 will provide an overview of near-term fusion machine design approaches and their associated hazards

## **Phase II: Regulatory Training (July 2027)**

- Changes to regulations and new guidance associated with fusion machines concurrent with final rule
- Update G-108 and G-109 inspection and licensing courses

## **Phase III: Formal Fusion Technology Course (TBD)**

- Instructor-led fusion technology course



# Standing Committee on Fusion Machine Oversight

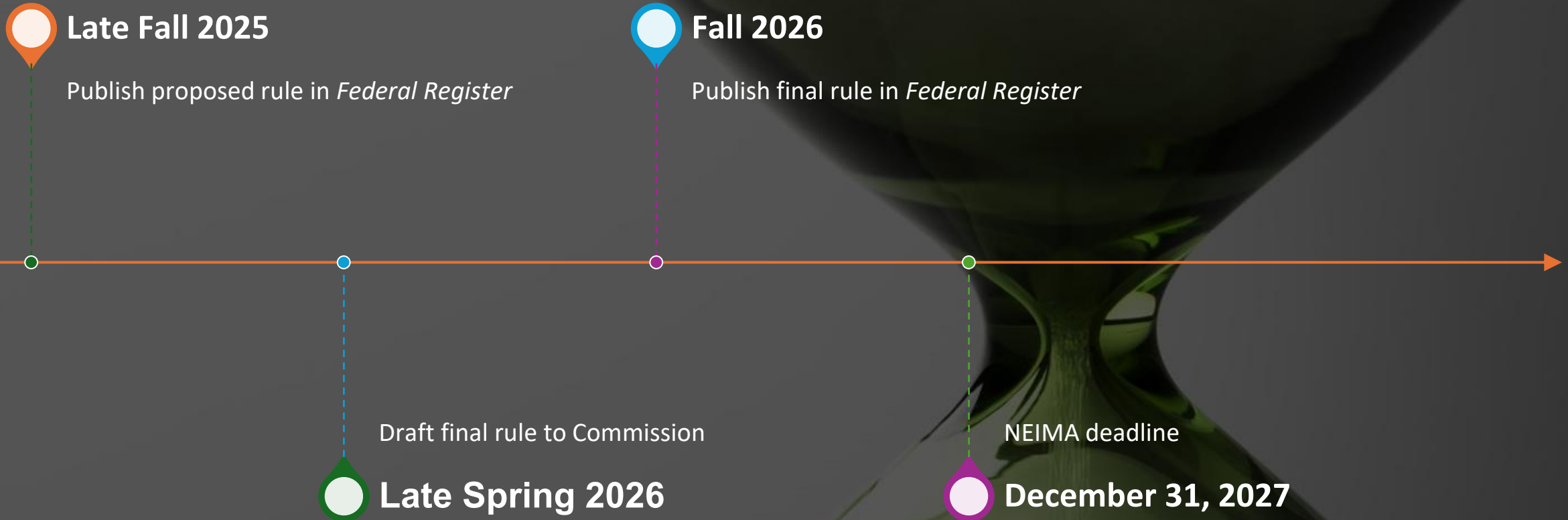
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## NRC/Agreement State advisory committee for fusion regulatory program development

- Share lessons learned and best practices
- Provide technical assistance to the NMP on licensing and inspection issues
- Track readiness of commercial fusion technology development
- Provide recommendations to the NMP on regulatory issues
- Provide input to guidance for IMPEP review process
- Provide input on qualification and refresher training
- Charter: ML25183A025



# Upcoming Milestones



# Updated Website

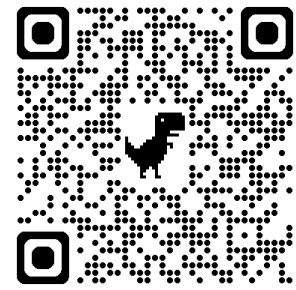
<https://www.nrc.gov/materials/fusion.htm>



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  - Materials Transportation
  - National Materials Program
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  - Frequently Asked Questions About NRC Reactors
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  - State Directors and Liaison Offices
  - Fusion



Spotlight  
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### Fusion

Nuclear fusion is the process by which two atomic nuclei—the central cores of atoms, made up of protons and neutrons—combine to form a heavier nucleus, releasing energy. This reaction occurs naturally in the sun and stars, and technologies to replicate it for energy applications are currently in development. Unlike nuclear fission, which splits atoms, fusion does not produce long-lived radioactive waste. While fusion technology is still in development, the Nuclear Regulatory Commission (NRC) is engaging with stakeholders to understand the regulatory considerations associated with potential future fusion facilities.

### Fusion Machines (not Reactors)

Unlike traditional nuclear power, which relies on fission reactors to split atoms, nuclear fusion will likely be generated in machines designed to replicate the high-temperature and high-pressure conditions found in the sun. These machines, such as tokamaks and stellarators, use powerful magnetic fields or lasers to heat and confine hydrogen isotopes until they fuse, releasing energy. Creating and sustaining the high temperatures and pressure conditions for fusion on Earth has been a major technological challenge since the first controlled fusion in 1952, but significant progress has been made in recent decades. While often referred to as "fusion reactors," fusion machines are not reactors in the sense normally associated with nuclear power because they do not rely on a self-sustaining chain reaction to produce energy. Instead, fusion machines require a continuous external energy input to maintain the conditions necessary for fusion to occur.

### Authority for Fusion

On July 9, 2024, the enactment of the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024, or the ADVANCE Act, amended the definition of byproduct material in Atomic Energy Act of 1954 (AEA) to include radioactive material produced by fusion machines. The AEA, in Sections 81 and 82, among other things prohibits the possession of byproduct material except as authorized by the NRC. Section 211 of the AEA authorizes the NRC to discontinue this authority in a State by Agreement with the governor of the State. Thus, in certain "Agreement States," the possession of byproduct material, including radioactive material produced by fusion machines, is regulated by the State rather than the NRC.



- Public Meeting Information
- Fusion Machine Rulemaking Status
- Fusion Machine Mass Production Status
- Frequently Asked Questions
- International Engagement
- NRC And Agreement State Partnership In Fusion

- ### Related Information
- Regulatory Framework for Fusion Energy Systems Rule
  - Public Rulemaking
  - Byproduct Material
  - National Academy of Sciences - Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant
  - U.S. Department of Energy Fusion Energy
- Page Last Reviewed/Updated Friday, June 27, 2025

- Fusion Basics
- Vision & Strategy
- Public Meeting Information
- Rulemaking
- Mass Production
- FAQs
- Fusion Activities in Agreement States
- NRC & Agreement State Partnership in Fusion
- International Activities

# NRC Fusion Team



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