U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Rulemaking: Regulatory Framework for Fusion Systems

NRC Public Meeting

January 17, 2024

Agenda

Time	Topic	Speaker
2:00 pm	Welcome & Meeting Logistics	Dennis Andrukat
	Opening Remarks	Theresa Clark
	NRC Presentation – Status of Preliminary Proposed Rulemaking and Guidance	Duncan White Christianne Ridge Cindy Rosales-Cooper
	Stakeholder Feedback Presentations: • Fusion Industry Association • Helion • Commonwealth Fusion Systems	Stakeholders
	Questions & Answer Session / Public Feedback	All
4:50 pm	Closing Remarks & Adjourn	Dennis Andrukat

Topic times are estimated and, depending on the participation level, the meeting could adjourn earlier than scheduled. If there are concerns with a potential early meeting adjournment, please inform the point of contact for this meeting.

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Opening Remarks

Theresa Clark, Deputy Director

Division of Materials Safety, Security, State, and Tribal Programs

Office of Nuclear Material Safety and Safeguards

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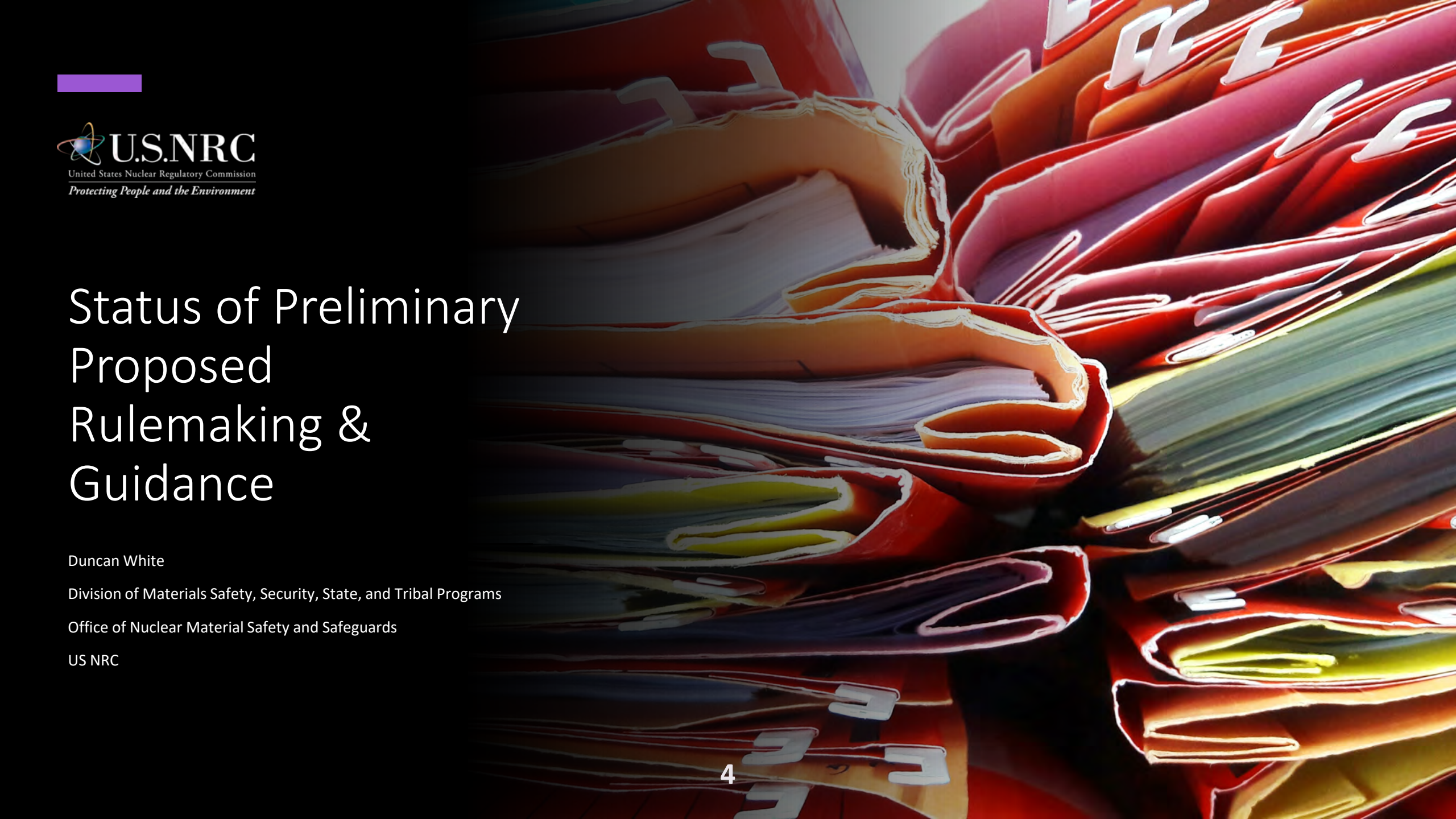

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Status of Preliminary Proposed Rulemaking & Guidance

Duncan White

Division of Materials Safety, Security, State, and Tribal Programs

Office of Nuclear Material Safety and Safeguards

US NRC

Preliminary Proposed Definitions

Fusion System:

Fusion system means a system that, through use of byproduct material or to produce byproduct material, induces ~~nuclear~~ fusion reactions and includes any associated radiation, radioactive material, and supporting structures, systems, and components that are used to contain, handle, process, or control radiation and radioactive materials.

Status of Fusion Licensing Guidance Development

NUREG-1556, Volume 22

- Initial draft of licensing guidance to be completed this month
- Preliminary draft version expected to be shared at a future public meeting
- Additional changes to the preliminary draft guidance may be identified during NRC internal and Agreement State reviews
- Draft will be published for formal comment in the *Federal Register* along with the proposed rule

Handout

Fusion Licensing Guidance Development

Preliminary Draft NUREG-1556, Volume 22, portions:

- **8.5.3** Financial Assurance and Recordkeeping for Decommissioning
- **8.7.1** Radiation Safety Officer
- **8.7.2** Individuals Authorized to Handle Licensed Material
- **8.10.12** Security Program
- **8.11** Waste Management
- **Appendix G** Methodology for Determining Public Dose
- **Appendix M** Model Waste Management Procedures
- **Appendix N** Radiation Safety Training

Update on Specific Guidance Sections

- Emergency Preparedness
- Waste Management

Guidance for Emergency Plan & Procedures

Modeled after comparable 10 CFR Part 30 applicant guidance in NUREG-1556 (e.g., Volumes 12 and 21)

Guidance for performing dose evaluations under existing 10 CFR 30.32(i)(1)(i) for possession of radioactive material in excess of existing 10 CFR 30.72 Schedule C quantities

Guidance for establishing written procedures to handle events that may require intervention by emergency personnel (e.g., spills or releases of radioactive material)

- Identify roles and responsibilities
- Appropriate response equipment
- Notification and reporting
- Contact information for radiation safety officer (RSO) and other response personnel
- Agreements with offsite response organizations (e.g., local fire department and emergency medical services (EMS))

Waste Management

Radiation protection program must address waste management

- Minimization
- Characterization
- Handling
- Secure storage
- Disposal

Authorized disposal methods

- Decay in storage
- Release within effluent limits
- Transfer to an authorized recipient
- Other methods authorized under 10 CFR 20.2002 through 20.2005

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Waste Management
Transfer to an Authorized Recipient

Current 10 CFR 20.2008 allows accelerator waste to be disposed of with low-level waste. Waste from near-term fusion systems will fall under that provision.

Proposed new 10 CFR 20.2008(c) would require an inadvertent intrusion analysis for fusion system waste that has novel physical, chemical, or radiological characteristics.

Proposed 10 CFR 20.2008(c) requirement would apply to disposal facilities accepting fusion system waste, not to fusion system licensees directly.

Proposed NUREG-1556 Volume 22 would provide guidance for identifying waste with "novel" characteristics that trigger the need for an inadvertent intrusion analysis.

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Guidance for Waste Management

Waste types and radionuclide concentrations that the NRC considered during the development of low-level waste regulations (10 CFR Part 61) would generally not be considered novel under the proposed 10 CFR 20.2008(c) and would not trigger the need for an inadvertent intrusion analysis.

Previously-considered physical and chemical characteristics

Example waste types include (but are not limited to):

- Activated metals
- Cement-solidified liquid
- Contaminated soil
- Building rubble
- Ion-exchange resins
- Polymer-solidified liquid
- Contaminated equipment
- Incinerator ash

Previously-considered radionuclides

- Radionuclides listed in 10 CFR 61.55 waste classification tables (includes tritium)
- Chlorine-36, cesium-135, europium-152, europium-154, uranium-235, and uranium-238 at or below concentrations provided in the proposed guidance

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Guidance for Waste Management

Identification of wastes with novel radioactive characteristics depends on adequate waste characterization

Proposed guidance is consistent with NRC guidance for completing the Uniform Waste Manifest (NUREG/BR-0204):

A radionuclide is deemed to be present in a waste if it meets any of the following criteria:

- the concentration is greater than 1 percent of the concentration limit for that radionuclide in the disposal facility waste acceptance criteria (WAC)
- the radionuclide does not appear in 10 CFR 61.55 tables or the disposal facility WAC and the concentration is greater than 0.26 megabecquerel (MBq) per cubic centimeter;
- the activity represents a reportable quantity under Department of Transportation regulations (i.e., 49 CFR 172.101, Appendix A)
- the activity is 1 percent of the total activity within the disposal container.

Contents of Application – Waste Management

- Outline of procedures for:
  - Waste collection
  - Handling
  - Storage
  - Disposal
- A request for authorization for extended interim storage of waste, if applicable
- For waste to be transferred to an authorized recipient: a description of the anticipated waste and an assessment of whether the waste has novel physical, chemical, or radiological characteristics
- Plan for financial assurance for waste disposal during decommissioning, if required under 10 CFR 30.35

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External Stakeholder Presentations

Fusion Industry Association (FIA)

FUSION
INDUSTRY ASSOCIATION

Benefits & Cost

The FIA: *Building the Global Fusion Energy Industry*

FIA Mission

The Fusion Industry Association is **the voice** of the growing fusion industry. It is a membership organization that supports efforts to accelerate commercial fusion energy through advocacy and education.

The FIA's members are the investor-backed fusion developers, and its affiliate members are the companies and organizations that will build the global fusion energy economy.

The FIA's goals are to **accelerate commercially viable fusion energy** by advocating for policies, partnerships, regulations, and industry incentives that support our member companies as they develop commercial fusion power.

Overview: The Private Fusion Industry Today

- 43 verified private fusion companies
- **$6.2 billion in investment**
- Accelerating number of new fusion companies
- Increasing optimism on timescales
- Growing interest from governments in Public Private Partnerships
- Growing geographical diversity
- But – technical challenges remain

Why Now?

Fusion is coming

Today's Scientific and Technological Advances Enable Breakthroughs

New Materials
New materials, including High Temperature Superconductors, advanced lasers, new alloys, power management chips, and more enable smaller, cheaper machines.

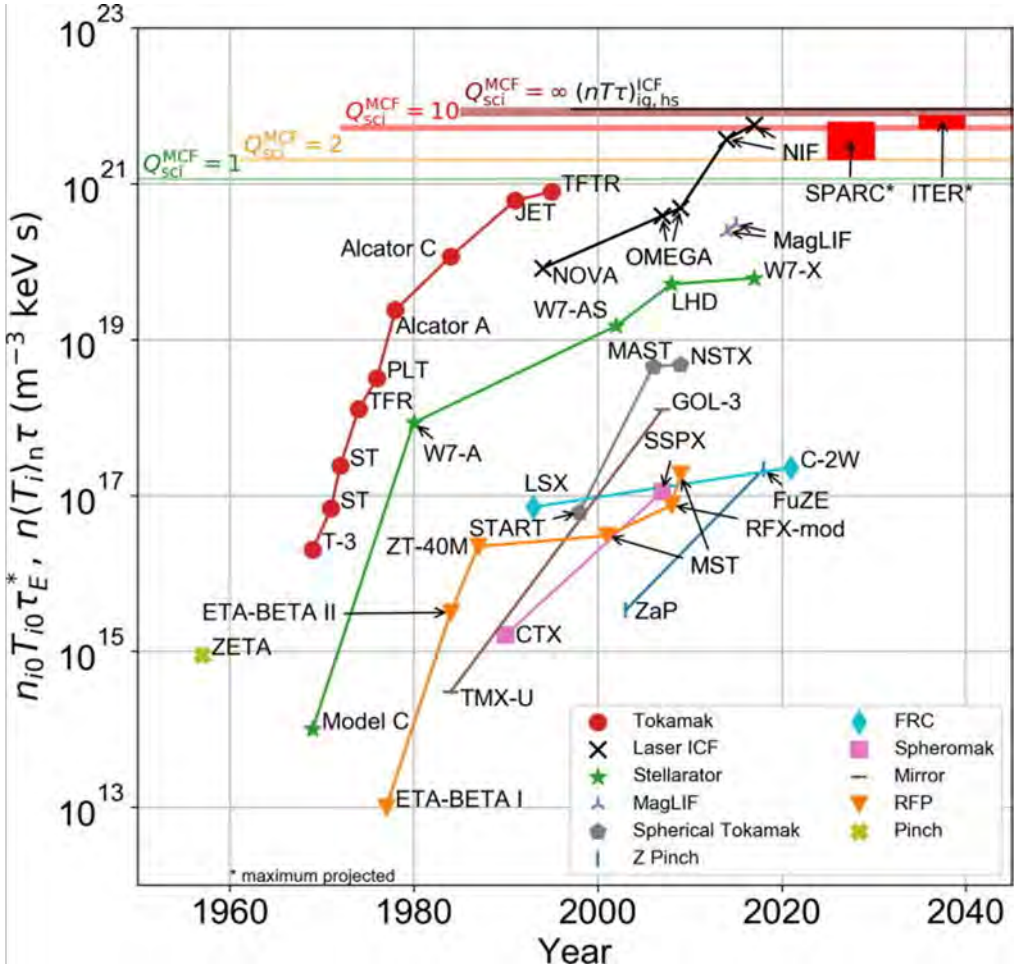
High Speed Computing
Advances in computing power allow advanced modeling and the application of artificial intelligence to experiments.

Greater Scientific Understand of Plasmas
Breakthrough fusion experiments at NIF and elsewhere will bring greater fidelity to models and enable faster experimentation.

Advanced Manufacturing
Will allow quick and cheap production of components in complex shapes and with new materials.

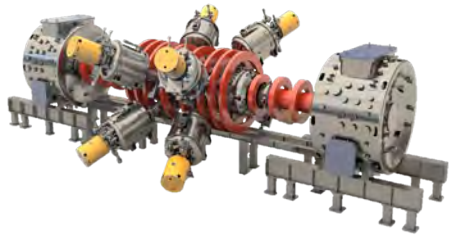
Business Model Improvement
The application of the Silicon Valley-style venture capital has injected funding, urgency, and greater tolerance of risk.

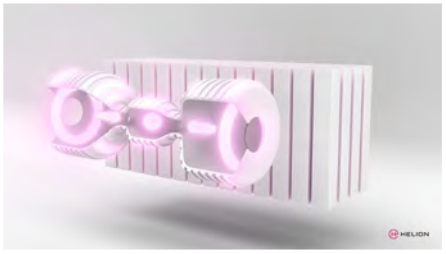
Historical progress shows continuous advances towards fusion energy



Industry's Timeline

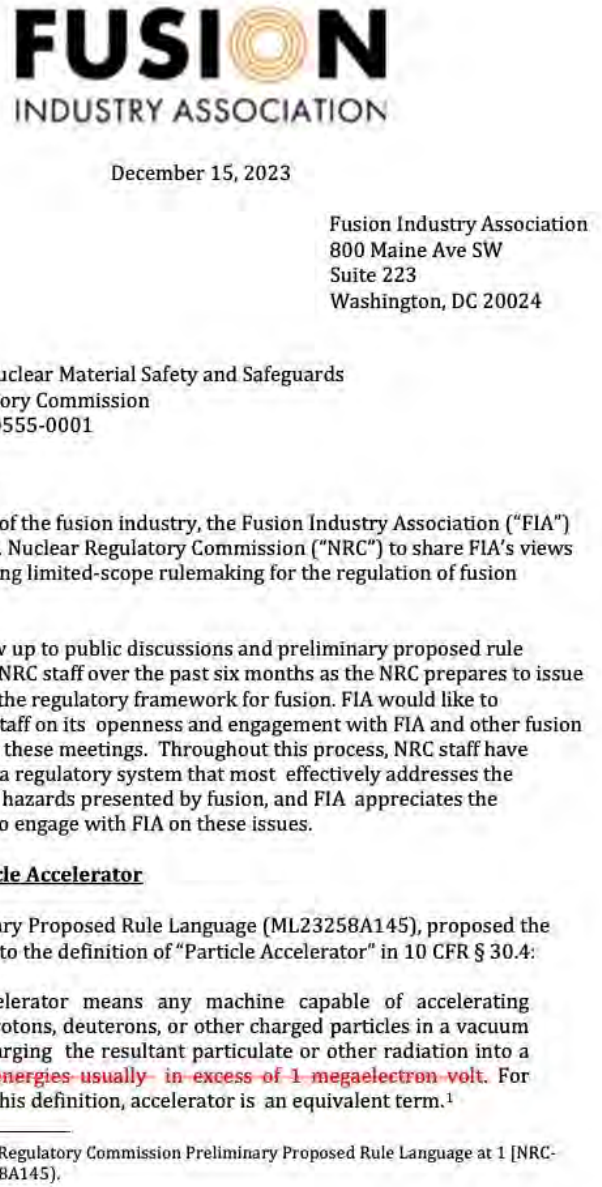
60 years of research	Mid 2020s	Late 2020s	Early 2030s	Mid 2030s
• Scientific basis for fusion energy	• Scientific Proof of Concept	• Design and build Pilot Plants	• Operate Pilot Plants, first sales	• Commercial Fusion, rapid scale-up to global deployment





December 15 Letter

- FIA's comments submitted in letter form on December 15.
- Available from NRC or on FIA website: https://www.fusionindustryassociation.org/fia-sends-letter-regarding-nrc-fusion-rulemaking/



FUSION INDUSTRY ASSOCIATION

December 15, 2023

Fusion Industry Association
800 Maine Ave SW
Suite 223
Washington, DC 20024

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

Dear Mr. Lubinski,

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

This letter is a follow up to public discussions and preliminary proposed rule language issued by NRC staff over the past six months as the NRC prepares to issue a proposed rule on the regulatory framework for fusion. FIA would like to commend the NRC staff on its openness and engagement with FIA and other fusion stakeholders during these meetings. Throughout this process, NRC staff have focused on building a regulatory system that most effectively addresses the technical issues and hazards presented by fusion, and FIA appreciates the willingness of staff to engage with FIA on these issues.

Definition of Particle Accelerator

The NRC's Preliminary Proposed Rule Language (ML23258A145), proposed the following revisions to the definition of "Particle Accelerator" in 10 CFR § 30.4:

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

[1] United States Nuclear Regulatory Commission Preliminary Proposed Rule Language at 1 [NRC-2023-0071] (ML23258A145).

The Commission's decision was clear

- The 5-0 vote by the Commissioners to initiate a rulemaking under the byproduct materials regulatory regime (10 CFR Part 30), and separate the regulatory oversight of fusion from the utilization facilities regime (10 CFR Parts 50 & 52) that regulate nuclear fission energy was appropriate for the technology and the risk.

- This decision will give fusion developers the regulatory certainty they need to innovate as they grow fusion energy into a viable new energy source, while also most effectively protecting the safety, security, and health of the public.

Limited-Scope Rulemaking

- A limited-scope rulemaking should be as simple as possible.
- *"Under the limited-scope rulemaking approved under Option 2, the staff should take into account the existence of fusion systems that already have been licensed and are being regulated by the Agreement States, as well as those that may be licensed prior to the completion of the rulemaking"*

STAFF REQUIREMENTS – SECY-23-0001 – OPTIONS FOR LICENSING AND REGULATING FUSION ENERGY SYSTEMS

Definitions: Particle Accelerator

- The Commission's decision to place fusion in Part 30 relies on the legal understanding that all fusion machines meet the definition of particle accelerators. It is important that the definition is updated
- However, the proposed rule does not explicitly add fusion to the definition of Particle Accelerator. Our proposal is simple: explicitly add **"fusion machines"** to the definition of Particle Accelerator.

Particle Accelerator

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

RED = proposed amendment

*10 C.F.R. § 30.4

Definitions: Fusion Machine

- If the intent is to limit the definition to specific components, rather than adopt a facility-wide definition, then the proposed definition is still overly broad and ambiguous.
- For example: the phrase *"associated radiation [and] radioactive material"* could be read to describe material such as activated components that are awaiting disposal or spare tritium fuel in storage.

* An NRC fusion machine license would include the entire inventory of radioactive materials and associated structures onsite, and the license would therefore apply to ancillary materials and structures. This does not mean it is necessary or appropriate, though, for the fusion machine definition to include all site wide materials and structures.

Definitions: Fusion Machine

- Similarly, *"supporting structures used to contain, process, or control radioactive materials"* could mean that facility structures are included in the definition of a fusion machine
- If the purpose of this rulemaking is to develop a regulatory definition that narrowly describes fusion machines, not the whole facility, this should be changed.
- As a comparison, NRC definitions for particle accelerator, irradiator, and nuclear reactor all focus on the technological device, not the overall facility.

Definitions: Fusion Machine

FIA Suggestion:

- consider adopting the following definition for fusion machines in the recently proposed Fusion Energy Act (H.R. 5244):

Fusion Energy Machine

The term ‘fusion energy machine’ means a particle accelerator that is capable of—

- (1) transforming atomic nuclei, through fusion processes, into other elements; and
- (2) directly capturing and using the resultant products, including particles, heat, and other electromagnetic radiation, for a commercial or industrial purpose.

Guidance

- FIA **supports** the creation of a new fusion-specific volume
- ”Limited” direction from Commission must apply to NUREG Guidance as well as Rulemaking.
- As a general matter, we want to emphasize the importance of maintaining a risk-informed approach in the NUREG Guidance.
  - One of the chief advantages of the byproduct material framework is that it is flexible to the variety of approaches to fusion, with the details of the major requirements corresponding to the level of risk presented.
  - Based on the NRC discussion in public meetings to date, we feel it's important to reiterate the value of this risk-informed approach and encourage the commission to maintain it
- On specifics, we are concerned especially that the Guidance on Emergency preparedness could move too far towards the specific “reactor concepts” we all know are required when the NRC regulates utilization facilities. The key point of the byproduct material framework is the flexibility to scale based on risk.
- As the NRC staff publishes more proposed guidance, FIA and our members will have more to say, particularly on emergency response issues and inventory controls on byproduct materials.

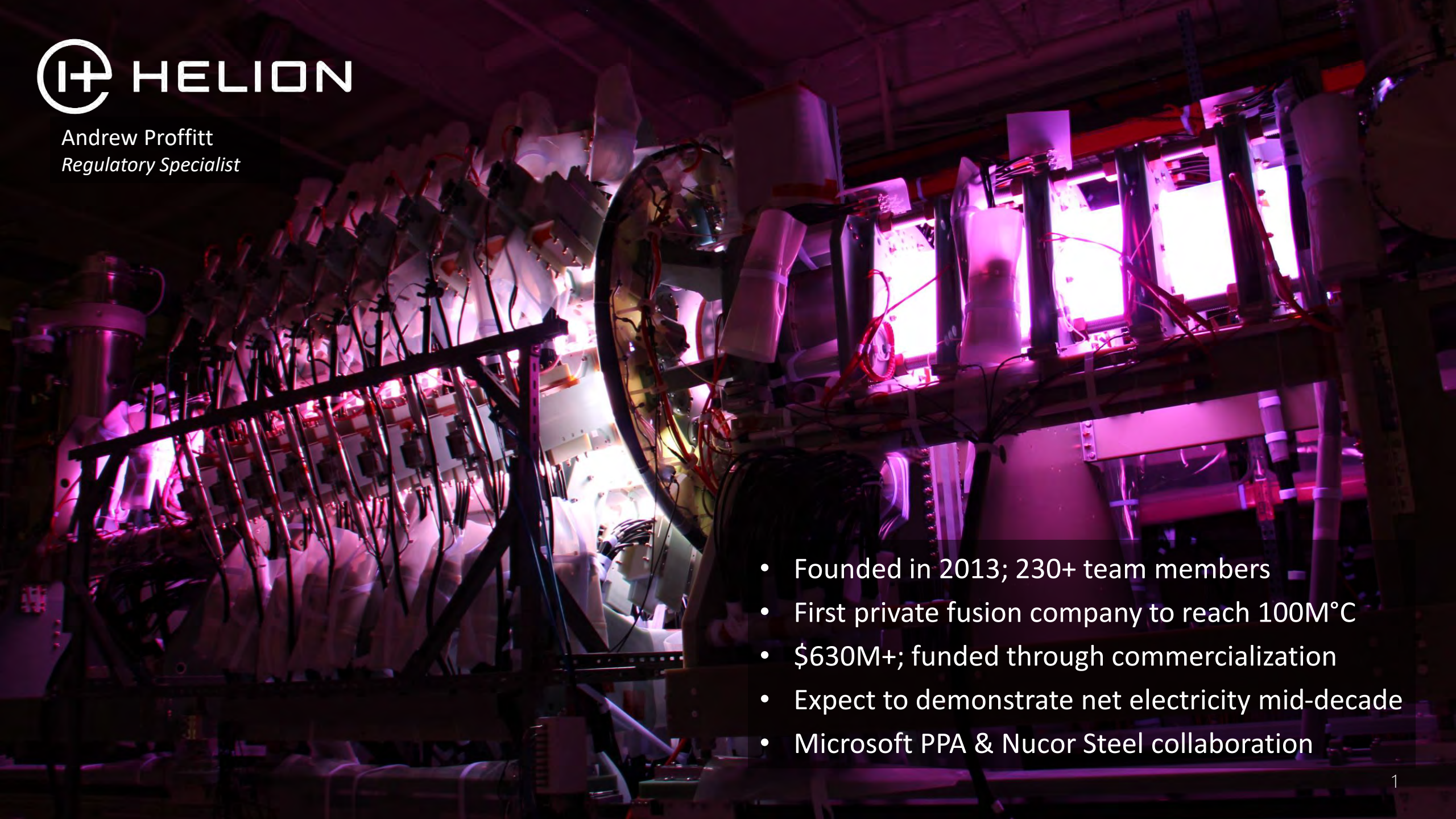
FIA Membership


Affiliate Members
BAYFUSION
Kansai Electric Power
power with heart
SIMIC
since 1975
A PASSION FOR CHALLENGES
Google
OPTICA
Advancing Optics and Photonics Worldwide
Formerly OSA
THALES
AMPLEON
Mitsubishi Corporation
CleanTech Alliance™
TWI
TVA
BUTTING
1777
KIND
Sumitomo Corporation of Americas
Enriching lives and the world
COHERENT
EXO FUSION
equinor
eni
Southern Company
Roland Berger
framatome
BILFINGER
BILFINGER NOELL GMBH
FLUOR
NEXT STEP FUSION
METOX™
ALSYMEX
ALCEN
radiasoft
SVC
SOCIETY of VACUUM COATERS
IF JAPAN
FARADAY FACTORY
CDE
ENERGIZING IDEAS
CORNELL DUBILIER
BRUKEP
Sapiental
digiLab
peak
SCHOTT
STELLAR
ENERGY FOUNDATION
ENERGY for the COMMON GOOD
Soon enough to make a difference
LEONARDO
ONTARIO POWER GENERATION
Cryoelectra
RF Technology for Particle Accelerators
CLEARPATH ACTION
HTS
HIGH TEMPERATURE SUPERCONDUCTORS
OAK RIDGE
CHAMBER OF COMMERCE
IN BUSINESS FOR BUSINESS
CURTISS-WRIGHT
DIVERSIFIED TECHNOLOGIES, INC.
KTC
Keller Technology Corporation
EST. 1918
We manufacture the future.
Morgan Lewis
KINECTRICS
COSYLAB
TERRA PRAXIS
WOODRUFF • SCIENTIFIC
ARNOLD MAGNETIC TECHNOLOGIES
American Conservation Coalition
AEROSPACE
AMPEGON
pillsbury
AIR LIQUIDE
research instruments
ASG SUPERCONDUCTORS
INTERLOCK ENERGY
STRONG ATOMICS
NEW LIGHT FUSION CONSULTANTS
TRUMPF
EPRI
FRAZER-NASH CONSULTANCY
A KBR COMPANY
IDOM
FUSION ENERGY INSIGHTS
K&L GATES
ENERCON
ETEC
EAST TENNESSEE ECONOMIC COUNCIL
tecnatom
TELEDYNE BROWN ENGINEERING
ATDG
TRIANGLE DESIGN GROUP LLC
OXFORD SIGMA
OCEM
POWER ELECTRONICS

Thank you

https://www.fusionindustryassociation.org/

Helion



HELION

Andrew Proffitt
Regulatory Specialist

- Founded in 2013; 230+ team members
- First private fusion company to reach 100M°C
- $630M+; funded through commercialization
- Expect to demonstrate net electricity mid-decade
- Microsoft PPA & Nucor Steel collaboration

1 Formation

Deuterium and helium-3 are heated to plasma conditions. Magnets confine the plasma in a Field Reversed Configuration (FRC).

2 Acceleration

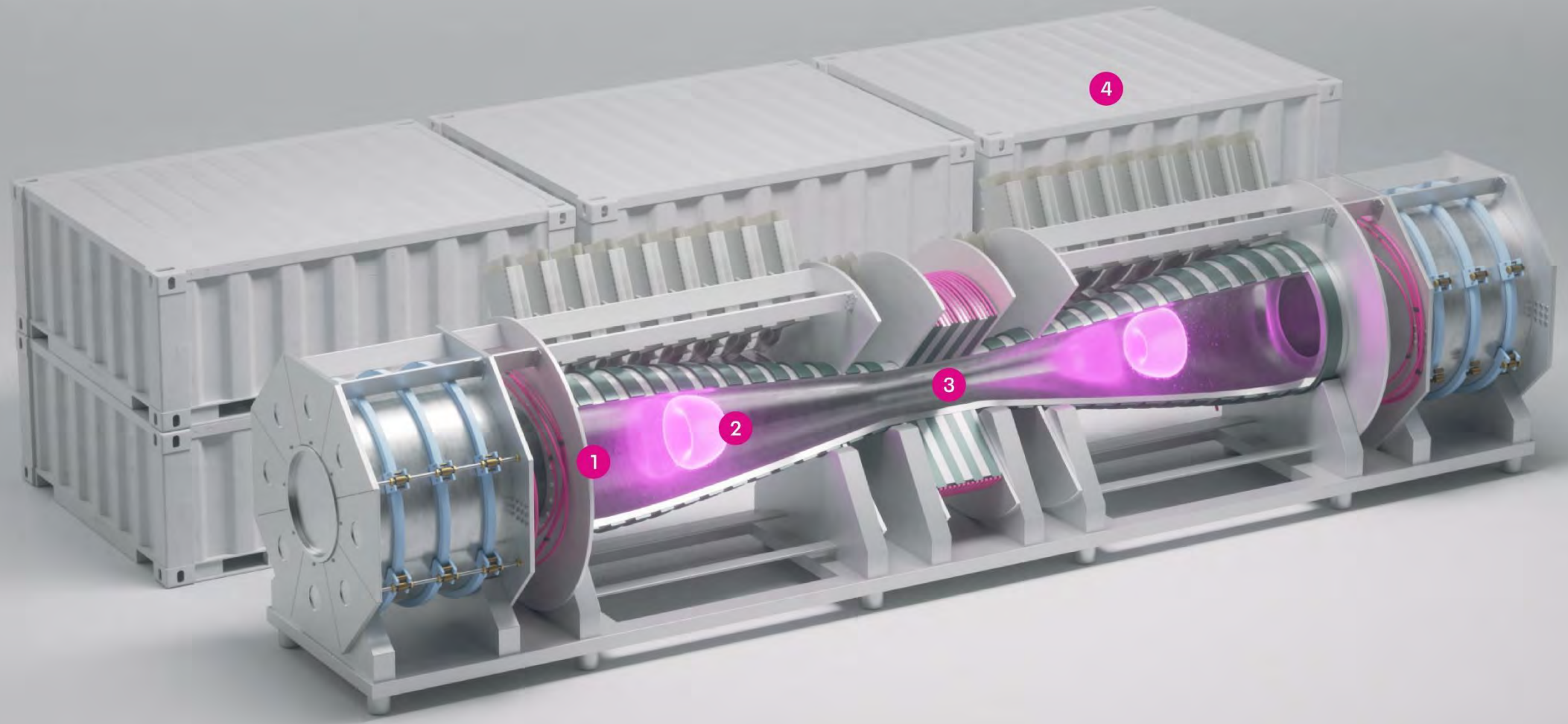
Magnets accelerate the FRCs until they collide in the center of the device.

3 Compression

The merged plasma is compressed until it reaches 100 M°C. Fusion occurs and the plasma expands.

4 Electricity Recapture

As the plasma expands, it pushes back on the magnetic field. The change in field induces current, which is directly recaptured as electricity.



Helion fusion generators use non-radioactive fuel: deuterium-helium-3

$$^{2}_{1}\mathrm{H} + {}^{3}_{2}\mathrm{He} \rightarrow {}^{1}_{1}\mathrm{H} + {}^{4}_{2}\mathrm{He}$$

Deuterium-helium-3 fusion does not produce radioactive byproducts nor radiation

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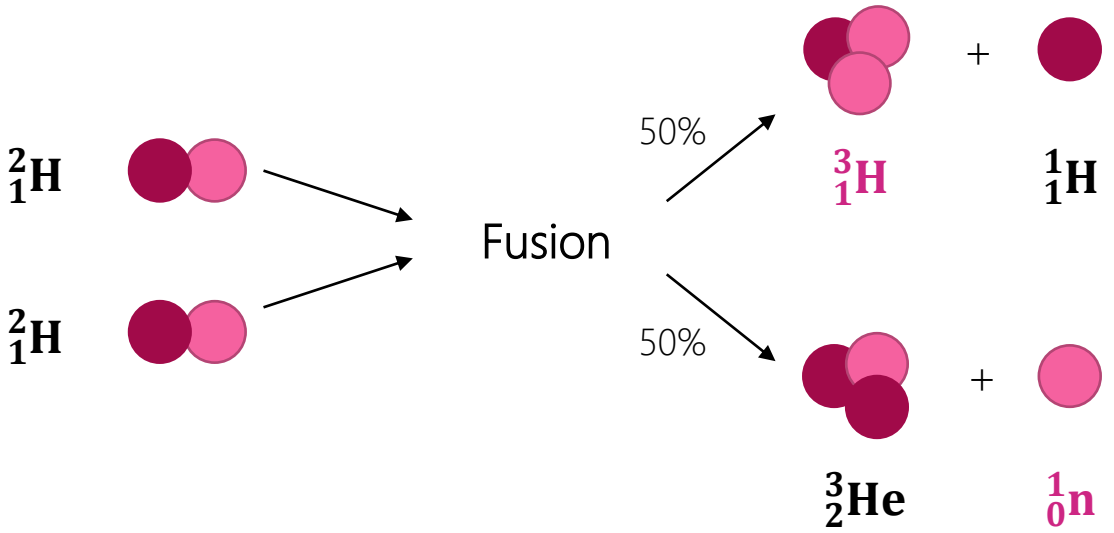


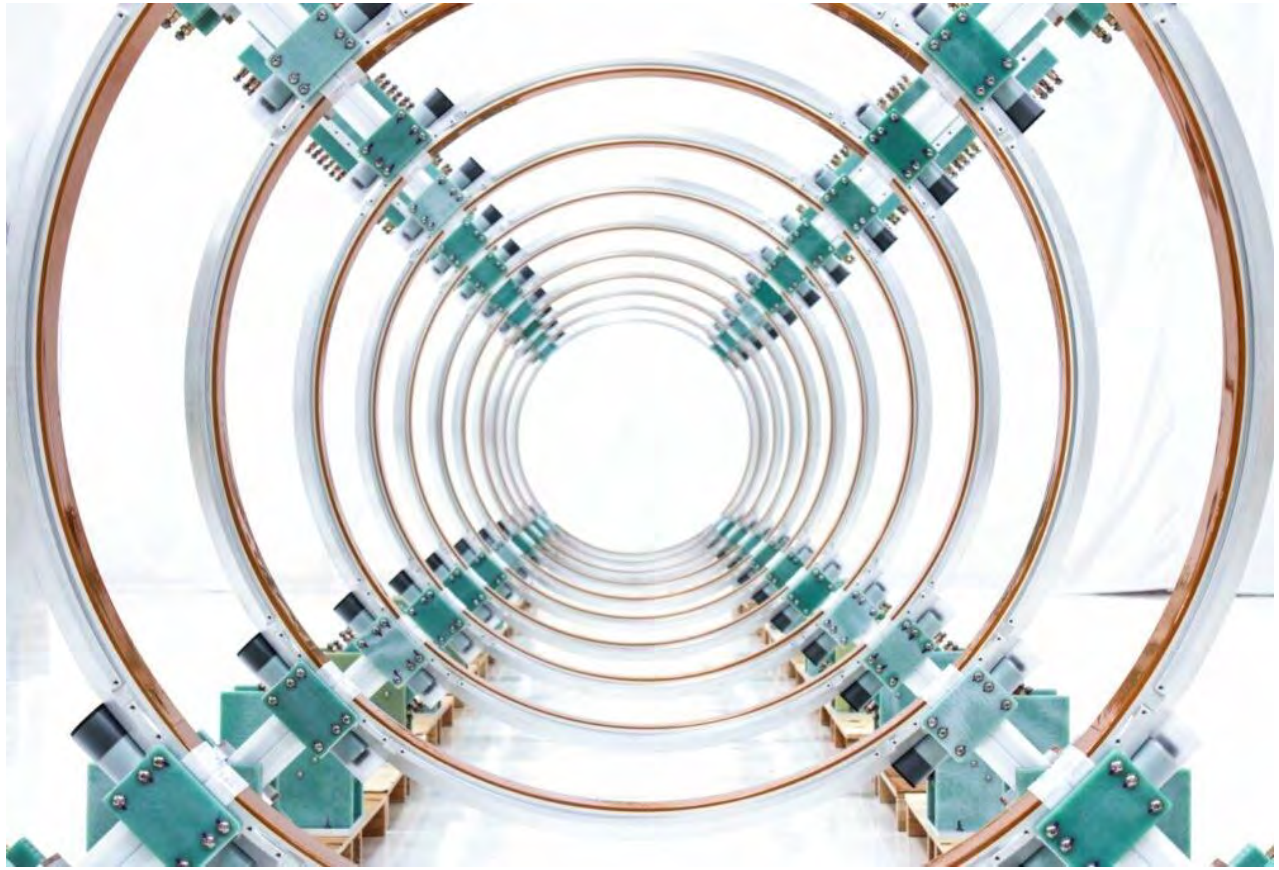
$$^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow \begin{cases} {}^{3}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} & (50\%) \\ {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n} & (50\%) \end{cases}$$

Deuterium-deuterium fusion side reactions do produce radiation and byproducts

Helion generators can be sited in existing industrial parks

Helion's key requests to the NRC staff:

- Directly tie fusion generators to **particle accelerators**
- Continue **stakeholder engagement**, particularly on EP and waste
- Initiate consideration of future licensing regime which can support **mass deployment**



Regulatory treatment of fusion generators should be consistent with other uses of byproduct material

"NRC staff expects that for purposes of minimizing dose to workers and members of the public, the safety focus of fusion energy systems will be on the **control**, **confinement**, and **shielding** of radioactive material present at the site rather than on the performance and control of the **device**."

Fusion generator characteristics, NRC SECY-23-0001

~~criticality~~

- No fissile material present

reactions cease

- Energy and radioactive material production stop in off-normal scenarios

low doses

- To workers and members of the public during credible accident scenarios

Description of Rulemaking: Scope

The major objective of revising 10 CFR Part 30, which could include the creation of a new 10 CFR part, is to enhance regulatory clarity and predictability by providing definitions of "fusion" and "fusion energy system" and updating the definition of "particle accelerator" to explicitly define radioactive material associated with the operation of a commercial fusion energy device as byproduct material. Additionally, the NRC staff would develop a content-of-application

NRC SECY-23-0001 Enclosure 1: Rulemaking Plan

NRC definition of particle accelerator should explicitly address fusion generators

- Atomic Energy Act does not currently mention *fusion* nor provide definition of *particle accelerator*
- Responsibility lies with NRC to clearly and legally connect fusion to the AEA byproduct material framework
- Notice and comment rulemaking provides robust process for codifying Commission decision

‘fusion system’ definition should be narrowed, consistent with staff position and NRC precedent

- Proposed definition **broadly** includes the majority of a fusion facility outside of the generator which uses, produces, and consumes byproduct material
- Directly evolved from SECY paper which **holistically** assessed potential fusion facilities against the Atomic Energy Act utilization facility criteria
- Other NRC device definitions focus solely on the device/machine and not **ancillary equipment**

> *Nuclear reactor* means an apparatus, other than an atomic weapon, designed or used to sustain nuclear fission in a self-supporting chain reaction.

> *Irradiator* means a facility that uses radioactive sealed sources for the irradiation of objects or materials and in which radiation dose rates exceeding 5 grays (500 rads) per hour exist at 1 meter from the sealed radioactive sources in air or water, as applicable for the irradiator type, but does not include irradiators in which both the sealed source and the area subject to irradiation are contained within a device and are not accessible to personnel.

Early, technically focused workshops on NUREG-1556 guidance will benefit development

- Helion proposes starting with two workshops in Spring 2024:
  - Emergency planning
  - Low-level waste management

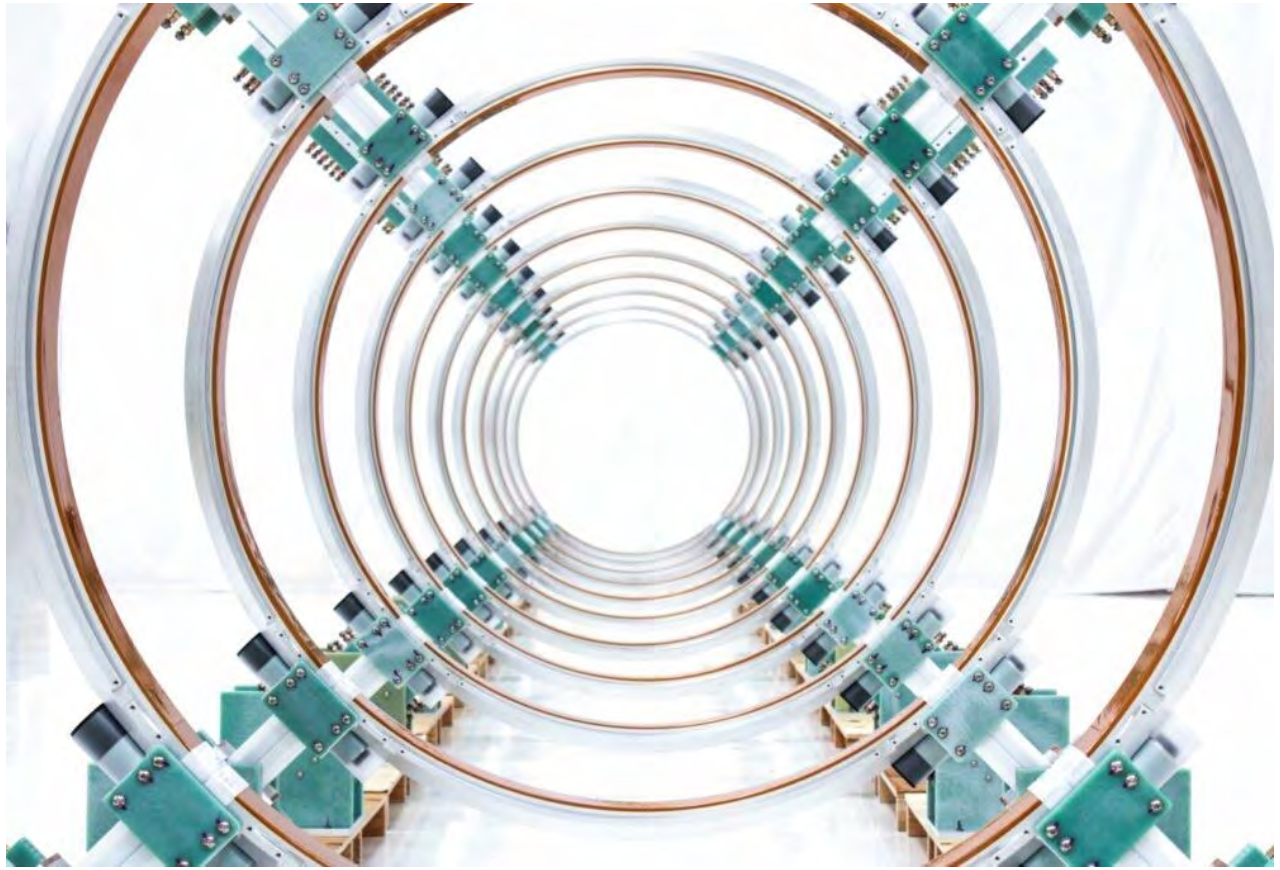
Looking toward the future: fusion generators can be mass-manufactured

- Well suited for production and assembly on a factory line
- Do not require forging/fabrication of immense structures
- Factory-built, transported, and quickly installed in industrial buildings
- Once proven, capable of rapid deployment

NRC should acknowledge the need for a more agile licensing process to support this potential

Helion's key requests to the NRC staff:

- Directly tie fusion generators to **particle accelerators**
- Continue **stakeholder engagement**, particularly on EP and waste
- Initiate consideration of future licensing regime which can support **mass deployment**



Commonwealth Fusion Systems (CFS)

Fusion Rulemaking Effort

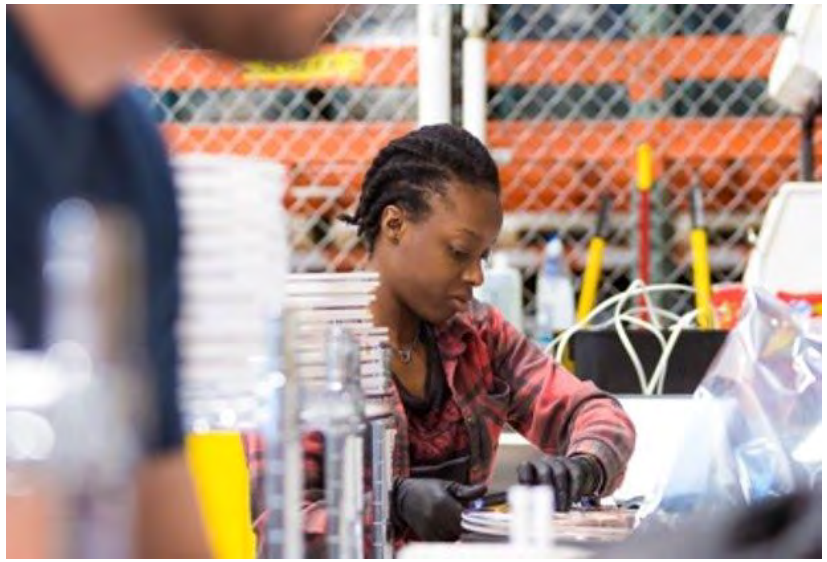
CFS' Initial Input

Tyler Ellis, Ph.D.
Mike O'Neill
January 17, 2024

Commonwealth Fusion Systems

CFS on a path to deliver commercial fusion energy

- CFS Founded in 2018, spun out of MIT with the goal of commercializing fusion energy to combat climate change
- Raised more >$2 billion
- Built a high caliber, diverse team
- >630 employees


Risk retirement in concrete steps

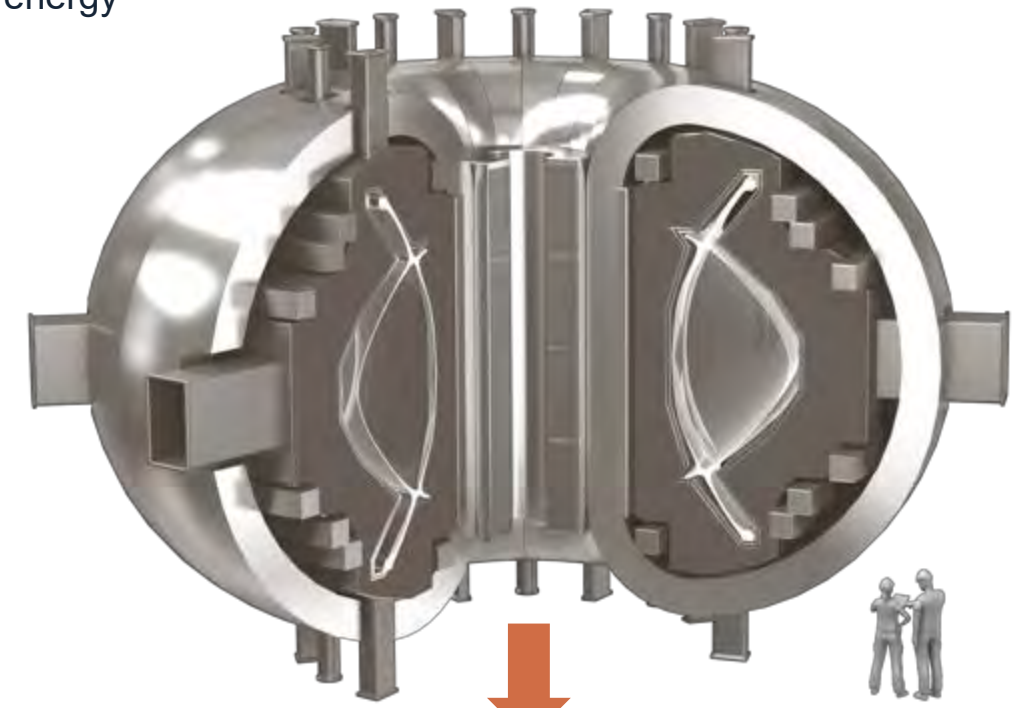
COMPLETED:
Alcator C-Mod
Record-setting tokamak

COMPLETED:
Demonstrate groundbreaking HTS magnets

CONSTRUCTION UNDERWAY FOR 2025 LAUNCH:
SPARC Q>1
Achieve net fusion energy

Commercially-relevant net fusion energy for the first time

Early 2030s:
ARC deployed
~400MW



Carbon-free commercial power on the grid

Limited Rulemaking Considerations

Fusion Energy Rulemaking Goals and Emphasis

- To support the limited rulemaking process, our goal is to ensure the fusion regulatory program appropriately protects public health and safety while also striking the right balance of rulemaking durability and regulatory flexibility to support continuous innovation.
- This first section emphasizes the importance of **explicitly tying "fusion energy" to "particle accelerators" within the byproduct materials framework** for two reasons:
  - To shore up the statutory basis for the byproduct material approach to fusion energy; and
  - To ensure that all stakeholders can rely on the decades of precedent that underpins particle accelerator materials licensing.

SPARC under construction in Devens, MA

A direct tie to "particle accelerators" solidifies the byproduct materials statutory foundation for fusion

- **CFS is not aware of a stronger statutory basis for placing fusion in the Part 30 framework than locating it within the existing particle accelerator category.**
- When implementing updates to the Atomic Energy Act in 2005, NRC defined “particle accelerator” as: “[A]ny machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 megaelectron volt.” (10 CFR 20.1003, 30.4)
- This definition also describes fusion systems.

A direct tie to "particle accelerators" solidifies the byproduct materials statutory foundation for fusion

- NRC Commissioners intended to make this tie between fusion machines and particle accelerators explicit by following Option 2 of SECY-23-0001.
- The rulemaking plan that staff offered signals the intention of “updating the definition of ‘particle accelerator’ to explicitly define radioactive material associated with the operation of a commercial fusion energy device as byproduct material.”
- **This part of the Commission-endorsed rulemaking plan should be implemented fully and would apply to all fusion machines.**

“Fusion Machine” definition is moving through Congress

- CFS supports the position of the FIA and agrees with the definition of “fusion machine” currently working through the US Congress in the Fusion Energy Act (HR 5244):

  “Fusion Energy Machine.—The term ‘fusion energy machine’ means a particle accelerator that is capable of—

  “(1) transforming atomic nuclei, through fusion processes, into other elements; and

  “(2) directly capturing and using the resultant products, including particles, heat, and other electromagnetic radiation, for a commercial or industrial purpose.”

- This definition would appropriately characterize fusion machines as particle accelerators and solidify the statutory foundation for placing materials licensing for fusion machines in a byproduct materials framework.

This approach fits appropriately within NRC’s historical discretion in defining which devices would be considered particle accelerators, complies with the Commissioner's directive in SRM-SECY-22-0001, and aligns with Congressional intent under NEIMA and pending Fusion Energy Act.

Relying on Practice and Precedent for Particle Accelerators

- Particle accelerators, and the material that they activate, had been within the purview of state regulation for decades before Congress expanded NRC's jurisdiction in 2005.
  - Commissioners directed NRC staff to account for "the existence of fusion systems that already have been licensed and are being regulated by the Agreement States, as well as those that may be licensed prior to the completion of the rulemaking".
- **CFS strongly agrees with and endorses NRC staff's initial steps to build the new fusion-specific volume of NUREG-1556 on the experience embodied by Vol. 21.**
- This approach has let us progress safely and efficiently towards SPARC operation.

SPARC Tokamak Hall under construction in Devens, MA

Relying on Practice and Precedent for Particle Accelerators

- CFS is concerned that the rulemaking discussion undertaken to date erodes confidence that fusion developers can utilize the practices used for decades in the particle accelerator context.
- Raises questions that fusion produced radioactive materials are some kind of new category of byproduct material and not, as the Commissioners indicated, a part of the familiar category of accelerator-produced radioactive material.
- **This approach increases regulatory uncertainty for fusion energy developers which needs regulatory certainty to support substantial capital investments in the US fusion economy.**
  - For example, NRC staff's proposal on 10 CFR 20.2008 may conflict with the waste provisions of the Energy Policy Act of 2005, which could create unintended regulatory uncertainty for all stakeholders.
  - If fusion machines are particle accelerators, as the Commission appears to have intended via its April 2023 decision, then the presence of that proposed rulemaking text is not necessary, and this uncertainty will be avoided.
- Providing this regulatory certainty also promotes the Commission's *Principles of Good Regulation*.

Regulatory Guidance Considerations

Responses to Questions on Emergency Preparedness

- Question 1: § 30.4 Definitions - Fusion facilities may benefit from an update to the emergency classification definitions in Part 30 to include general emergency, unusual event, and other changes, consistent with a performance based, technology neutral approach. What are the benefits or consequences of this approach to fusion systems and materials licensees under Part 30?

- **Since both alerts and site area emergencies already cover all situations, both without and with off-site consequences, there doesn't appear to be any clear benefit for this proposal. Additionally, general emergency is currently defined as an event which has or will have substantial reactor core damage, since fusion power plants are incapable of core melt scenarios, this doesn't seem to be applicable.**

Responses to Questions on Emergency Preparedness

- Question 2: § 30.32 Application for specific licenses - 10 CFR 30.32 (i)(1) has emergency plan requirements based on Schedule C quantities for existing materials facilities and technologies. What would be the benefits or consequences of requiring all fusion system applicants to submit a maximum dose evaluation and specific emergency response plan for the expected quantities that will be present and generated at the facility instead of applying the quantities in §30.72 “Schedule C Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release”?

- **It is not clear why fusion should be treated differently than any other 10 CFR 30 licensed facility. This seems to conflict with both the Clarity and Reliability principles from the NRC's *Principles of Good Regulation*. Evaluation showing the maximum dose to an off-site person is under 1 rem can reliably be done with deterministic analyses given the quantities and types of radioactive materials at fusion power plants. If a fusion facility can demonstrate that they would remain under 1 rem during a release of radioactive material, there does not seem to be any clear benefit for also requiring a specific emergency plan.**

Responses to Questions on Emergency Preparedness

- Question 3: § 30.32 Application for specific licenses - The staff is considering whether to clearly specify, in the preliminary proposed 10 CFR 30.32(k)(2), the requirement for response capabilities for protecting onsite personnel, as well as coordination with fire, medical, and local law enforcement agencies, as needed, during an emergency as intended in NUREG-1140. What would be the benefits or consequences of doing so?

- **This requirement is already covered within site area emergency so there does not appear to be any clear benefit for this redundant addition.**

Activated Materials Listing on License Applications

- A suggestion made at an earlier public meeting to list out every single activated isotope separately on a 10 CFR 30 fusion license application does not seem to align with standard practice today.
- This suggestion raises questions of necessity and feasibility including:
  - What would be the minimum half-life of and justification for the isotopes that need to be listed?
  - If an isotope only exists for a fraction of a second, does it make sense for it to be listed on the license application given that it would decay away well before any waste disposal or handling would occur?
- **CFS recommends maintaining current standard practice on listing activated materials in license applications "Any radioactive material with Atomic Nos. 1 through 83 Integral to fixed equipment and structures/removed equipment."**

Observation on Security

- **CFS agrees that the current security requirements of 10 CFR 20 are adequate for near-term designs of fusion power plants.**
- It's not clear why the security requirements of 10 CFR 37 need to be included since fusion power plants are not envisioned to contain Category 1 or 2 materials listed in Appendix A to Part 37.
- Tritium is not listed as a Category 1 or 2 material by either NRC or IAEA.
  - Tritium is a low-energy 18.6 keV beta emitter which isn't powerful enough to pass through the outermost layer of skin and is significantly more benign than the Category 1 or 2 isotopes.
  - Tritium has been shipped across the US in certified metal beds with 10 g (100,000 Ci) of capacity without incident for many decades; increased frequency of shipments should not demand recharacterizing tritium as a Category 1 or 2 material when the radioactive hazard remains unchanged.

No additional operator training requirements needed

- NUREG-1556 Volume 21 already contains training requirements for the individuals responsible for the radiation safety program which is the main area that can impact public health and safety.
- Fusion facilities maintain a low radiological risk by virtue of their design as opposed to operator action.
- As such, fusion facility operators do not play a significant role in maintaining public health and safety, and instead focus on maintaining efficient operations and not damaging plant equipment to protect the company’s investment.
- It is the licensee’s responsibility to ensure their operators have an appropriate operator training program for the facility.
- **Since operators do not play a significant role for public health and safety, additional operator training program requirements aren't needed for the NUREG.**

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Commonwealth Fusion Systems

Question & Answer Session

We encourage questions and feedback from all stakeholders during this meeting on the development of the proposed rule and preliminary draft guidance. We are not officially accepting comments today and will not provide any formal responses to any feedback provided during this meeting.

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Protecting People and the Environment

Upcoming Events/Milestones

Proposed Rule Schedule

- A full preliminary draft version of the guidance to be shared at a future public meeting (tentative timeframe of early March)
- Proposed rule and draft guidance to Commission by September 2024

Additional Information

Public Meeting Information

- *January 17, 2024:*
  - *Presentations: ADAMS Accession No. ML23355A144*
  - *Handout: ADAMS Accession No. ML23355A143*
- *October 11, 2023: Meeting summary (ADAMS Accession No. ML23258A146)*
- *November 1, 2023: Meeting summary (ADAMS Accession No. ML23258A169)*
- *November 9, 2023: Meeting summary (ADAMS Accession No. ML23258A182)*

Public Information

- NRC Public Website: https://www.nrc.gov/materials/fusion-energy-systems.html
- Docket ID: NRC-2023-0071 (*www.regulations.gov*)
- Meeting Notice / Feedback Form: https://www.nrc.gov/pmns/mtg?do=details&Code=20231416

Thank You!

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