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## POLICY ISSUE (Notation Vote)

December 20, 2021

SECY-21-0109

FOR: The Commissioners

FROM: Daniel H. Dorman  
Executive Director for Operations

SUBJECT: RULEMAKING PLAN ON USE OF INCREASED ENRICHMENT OF  
CONVENTIONAL AND ACCIDENT TOLERANT FUEL DESIGNS FOR LIGHT-  
WATER REACTORS

PURPOSE:

The purpose of this paper is to request Commission approval to initiate a rulemaking to amend U.S. Nuclear Regulatory Commission (NRC) requirements for the use of light-water reactor (LWR) fuel containing uranium enriched to greater than 5.0 weight percent uranium-235 (U-235; increased enrichment fuel). The staff has identified regulations in Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR), "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 71, "Packaging and Transportation of Radioactive Materials," that specify a 5.0 weight percent enrichment criterion. In addition, the staff would perform a more comprehensive review of regulations associated with uranium enrichment throughout the life cycle of fuels for LWRs. The goal of this review would be to identify regulations that could be modified to increase flexibility and reduce exemption requests for the use of increased enrichment fuel while maintaining safety. The rulemaking process would produce a generic approach informed by public input, rather than handling issues through individual exemption requests, which would be the case for requests to use increased enrichment fuel under the current regulatory framework.

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SUMMARY:

The nuclear power industry has expressed interest in using fuels for LWRs containing uranium enriched to greater than 5.0 weight percent U-235, up to 10.0 weight percent U-235. The current regulations do not prevent the licensing of fuels enriched to this range of weight percent U-235. However, the development of the current framework did not consider common use of this range of enrichments, and such use would likely result in numerous exemption requests.

Two regulations place conditions on the use of fuel enriched beyond 5.0 weight percent U-235—10 CFR 50.68, “Criticality accident requirements,” and 10 CFR 71.55, “General requirements for fissile material packages.” If reactor licensees choose to adopt increased fuel enrichments, these requirements could potentially provide for significant additional licensee burden without a comparable increase in transportation or nuclear power plant (NPP) safety. Absent rulemaking, the staff expects that reactor licensees transitioning to fuel enriched above 5.0 weight percent U-235 would likely request exemptions. Other regulatory requirements may impose similar, potentially unnecessary burdens.

While rulemaking is not necessary to support the licensing of fuel enriched over 5.0 weight percent U-235, the staff is proactively considering rulemaking now to reduce unnecessary exemption requests and facilitate increased regulatory efficiency and consistency while continuing to ensure safety. Commission approval to initiate rulemaking on this topic would allow the staff to thoroughly review the potential regulatory implications of increased enrichment fuels and identify and assess the potential costs and benefits of changing regulatory requirements that impact their use. Rulemaking would provide options for a generic resolution of these issues and invite stakeholder participation in decisions affecting this regulatory area, rather than on a case-by-case basis that would result from the current regulatory framework.

BACKGROUND:

The nuclear power industry has identified potential advantages of increased enrichment fuel, as described in the Nuclear Energy Institute white paper, “The Economic Benefits and Challenges with Utilizing Increased Enrichment and Fuel Burnup for Light-Water Reactors,” issued February 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21259A191). Additionally, industry has informally expressed interest during public meetings in the use of increased enrichment in their accident tolerant fuel designs and inquired whether the NRC is planning to pursue rulemaking to address this interest. In response to this industry interest in LWR fuels enriched to 5.0 to 10.0 weight percent U-235, staff formed a working group to assess the need for rulemaking associated with the potential adoption of increased enrichment in LWR fuels.

One regulation initially evaluated by this working group is 10 CFR 70.24, “Criticality accident requirements.” This regulation ensures that licensees handling certain quantities of special nuclear material have the appropriate monitoring systems in place for detecting a criticality accident. During the evaluation, the staff noted that in the 1990s, numerous NPP licensees requested exemptions from installing and maintaining a criticality monitoring system as required by 10 CFR 70.24. Licensees argued that the expenditure of resources for the criticality monitoring systems did not result in a comparable increase in plant safety due to a low probability of a criticality accident. As discussed in SECY-97-155, “Staff’s Action Regarding Exemptions from 10 CFR 70.24 for Commercial Nuclear Power Plants,” dated July 21, 1997 (ADAMS Accession No. ML20211L130), the staff evaluated the likelihood of an inadvertent

criticality accident during fuel handling operations at NPPs and concluded that such events would be unlikely for power reactor facilities due to existing administrative and design controls based on no more than 5.0 weight percent fuel enrichment. As a result, the NRC issued 10 CFR 50.68 to offer NPP licensees an alternative to 10 CFR 70.24, provided they meet certain criteria. One of these criteria is limiting enrichment of fresh fuel assemblies to 5.0 weight percent U-235.

Another regulation that specifies 5.0 weight percent U-235 is 10 CFR 71.55(g). This regulation identifies conditions under which a uranium hexafluoride (UF<sub>6</sub>) transportation package design does not need to be evaluated under optimum moderation and reflection assumptions for criticality reviews. Other packages are evaluated under such assumptions pursuant to 10 CFR 71.55(b). These conditions include: (1) packages are leaktight following the tests specified in 10 CFR 71.73 for hypothetical accident conditions and the valve body doesn't impact any other part of the packaging, other than where it is attached to the UF<sub>6</sub> cylinder, (2) adequate quality control in the manufacture, maintenance, and repair of packaging, (3) each package is tested to demonstrate closure before each shipment, and (4) the uranium is enriched to not more than 5.0 weight percent uranium-235.

Thus, looking forward, if the industry's interest results in many NPP licensees seeking to adopt increased enrichment fuels, absent rulemaking, the staff expects that licensees will likely pursue exemptions from regulations due to the 5.0 weight percent criteria discussed above. Rulemaking to facilitate the safe and secure use of increased enrichment fuel could be more efficient than issuing individual license exemptions. If the Commission approves this rulemaking plan, the staff will develop a regulatory basis to fully identify those regulations potentially impacted by increased enrichment fuels and to evaluate regulatory options for their potential modification.

## DISCUSSION:

### Title

Increased Enrichment of Conventional and Accident Tolerant Fuel Designs for Light-Water Reactors

### Regulations

10 CFR 50.68, 10 CFR 71.55, and potentially other regulations

### Regulatory Issue

While current regulations do not prevent the licensing of fuels enriched above 5.0 weight percent U-235, the current regulatory framework requires that licensees comply with potentially unnecessarily burdensome regulations from which they have historically sought exemptions. As previously discussed, 10 CFR 50.68 provides for an alternative to 10 CFR 70.24. Specifically, 10 CFR 50.68 states, in part, "Each holder of a construction permit or operating license... shall comply with either 10 CFR 70.24 of this chapter or the requirements in paragraph (b) of this section." The staff notes that if reactor licensees transition to using fuel enriched above 5.0 weight percent U-235, then 10 CFR 50.68 would not be available as an alternative to 10 CFR 70.24 due to the specific fuel enrichment limit criterion. Therefore, the staff would expect many reactor licensees to again request an exemption from 10 CFR 70.24. The rulemaking process

would enable staff to generically evaluate the technical basis of the 5.0 weight percent criterion and how increasing enrichment relates to criticality safety.

Additionally, 10 CFR 71.55 specifies an enrichment of 5.0 weight percent U-235 regarding packages containing UF<sub>6</sub>. Packages containing greater than 5.0 weight percent are required to be evaluated under optimum moderation and reflection assumptions for criticality reviews. The rulemaking process would enable staff to evaluate the technical basis of the 5.0 weight percent limit and explore possible alternatives to potentially enable transport package designs with higher enrichment to use the moderator exclusion provision if appropriate. The staff will use the regulatory basis to evaluate technical options available, such as package design modifications, that could inform the need for rulemaking.

The staff recommends evaluating existing regulations and conducting rulemaking to streamline NRC reviews while continuing to ensure an appropriate safety focus. This evaluation would be done in anticipation of potential licensing requests for use of increased enrichment fuels, which may begin as soon as the mid-2020s.

### Existing Regulatory Framework

#### *Regulations*

Two regulations specify an enrichment threshold of 5.0 weight percent enriched U-235—10 CFR 50.68, and 10 CFR 71.55.

Specifically, 10 CFR 50.68 is an alternative to the criticality monitoring requirement given in 10 CFR 70.24 and states, in part, “The maximum nominal U-235 enrichment of the fresh fuel assemblies is limited to five (5.0) percent by weight.” In 10 CFR 71.55(g), the NRC provides an exception to the single package criticality analysis in 10 CFR 71.55(b) for UF<sub>6</sub> packages where, in part, the “uranium is enriched to not more than 5 weight percent uranium-235,” among other criteria.

During development of the regulatory basis for this rulemaking, if approved, the staff intends to perform a comprehensive review of regulations associated with the life cycle of fuels for operating LWRs. The staff may identify regulations, in addition to those identified above, whose revision is appropriate given the use of increased enrichment fuel. For instance, the regulatory basis would evaluate if there are impacts to requirements associated with security, emergency preparedness, source terms, and spent fuel pool management. Additionally, in the regulatory basis phase, the staff will evaluate the 5.0 weight percent criterion and assess whether a proposed rule should include a specific enrichment criterion.

The staff has identified guidance documents, as well as other documents that concern LWR fuel uranium enrichment and special nuclear material management that would require revision should the corresponding regulatory requirements be revised. These include:

- Interim Staff Guidance (ISG) DSS-ISG-2010-01, Revision 0, “Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools,” dated September 29, 2011 (ADAMS Accession No. ML110620086). This document provides guidance to the NRC staff to support the review of methods for performing criticality analyses submitted for demonstrating compliance with 10 CFR 50.68.

- Regulatory Guide (RG) 1.240, Revision 0, “Fresh and Spent Fuel Pool Criticality Analyses,” issued March 2021 (ADAMS Accession No. ML20356A127). This new RG describes an approach that the NRC staff considers acceptable to demonstrate that regulatory requirements are met for subcriticality of fuel assemblies stored in fresh fuel vaults and spent fuel pools at LWR power plants.
- NUREG-2216, “Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material: Final Report,” issued August 2020 (ADAMS Accession No. ML20234A651). This recently issued NUREG provides guidance to the NRC staff for reviewing an application for package approval issued under 10 CFR Part 71.

#### Explanation for Identifying Rulemaking as the Preferred Solution

The NRC published 10 CFR 50.68 in 1998 in response to numerous requests from operating reactor licensees for exemptions from the criticality monitoring requirements specified in 10 CFR 70.24. A similar situation could occur if industry interest continues to focus on the use of increased enrichment fuel. While the NRC’s current regulatory framework supports licensee use of fuels with enrichments greater than 5.0 weight percent U-235, the staff anticipates that rulemaking could result in fewer requests for exemptions related to the use of increased enrichment fuel, affording a more efficient review of licensing actions. Additionally, the rulemaking process would increase transparency and provide multiple opportunities for formal public engagement on the use of increased enrichment fuel. Early in the rulemaking process, during the development of a regulatory basis, the staff intends to hold public meetings to better understand stakeholder views to inform NRC decision-making more fully. The staff notes that, in many cases, this rulemaking would not eliminate the need for license amendment requests (LAR) associated with the use of increased enrichment fuel. For example, where enrichment limits may be specified in a facility’s current licensing basis; an amendment would be needed for a change. While the LAR process also provides an opportunity for public engagement; this would only be on a facility-specific basis, and the circumstances of that opportunity vary depending upon the specific request.

During the development of the regulatory basis, staff would also more fully evaluate the number of licensees interested in using this fuel and the timing of potential rulemaking to address industry’s estimated adoption of increased enrichment fuel by the mid to late 2020s. If licensees choose to request the use of increased enrichment fuel prior to the completion of the potential rulemaking, licensees may do so pursuant to existing regulatory paths (e.g., exemption requests or compliance with 10 CFR 70.24).

If the Commission approves the initiation of rulemaking, the staff will engage with the public to evaluate how best to address the use of increased enrichment LWR fuel. The staff would develop a regulatory basis to define the scope and recommendations for impacted regulations before drafting a proposed rule.

#### Description of Rulemaking: Scope

The staff has identified two regulations that specify 5.0 weight percent U-235 enrichment to be evaluated in the regulatory basis—10 CFR 50.68 and 10 CFR 71.55. The staff acknowledges this list may not be comprehensive and that it could identify other pertinent regulations during the regulatory basis phase. The staff intends rulemaking activities to focus on regulations for conventional and accident tolerant fuel designs for LWRs that may be impacted by increasing



fuel enrichment to above 5.0 weight percent. However, advanced reactor fuel designs are expected to use enrichments greater than 5.0 weight percent. As such, the staff plans to further evaluate applicability to advanced reactor fuel designs in the regulatory basis to ensure alignment with the Part 53 rulemaking (ADAMS Accession No. ML19340A056). The staff notes that, if the rulemaking schedule and stakeholder interest align, this rulemaking scope could be expanded, or a separate rulemaking could be initiated for advanced reactor fuel designs.

#### Description of Rulemaking: Preliminary Backfitting and Issue Finality Analysis

The Commission's backfitting provisions in 10 CFR Part 50; 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material"; and 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste," and the issue finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," are not expected to impact this rulemaking activity. Backfitting provisions are not expected to apply because this rulemaking would allow for a more efficient licensing review and is intended to only be applicable if a licensee chooses to use increased enrichment LWR fuel above 5.0 weight percent U-235. The rulemaking is expected to provide additional flexibility to licensees by reducing the number of exemption requests. Additionally, under the NRC's Principles of Good Regulation, the rulemaking would promote efficiency, clarity, reliability, and openness. The rulemaking is not expected to impose new requirements on existing licensees.

#### Description of Rulemaking: Estimated Schedule

Deliver regulatory basis: 18 months after the Commission issues its staff requirements memorandum.

Deliver the proposed rule to the Commission: 12 months after the regulatory basis comment period closes.

Deliver the final rule to the Commission: 12 months after the proposed rule comment period closes.

#### Description of Rulemaking: Preliminary Recommendation on Priority

Based on the Common Prioritization of Rulemaking methodology (ADAMS Accession No. ML18263A070), the preliminary priority for this rulemaking activity is high. This rulemaking scored 33 of 45 points (high priority) because: (1) it would be a significant contributor toward attaining the NRC's safety and security goals of ensuring the safe and secure use of radioactive materials due to maintaining and enhancing regulatory programs using information gained from operating experience, lessons learned, and advances in science and technology; (2) it would significantly support the NRC's Principles of Good Regulation by increasing openness, clarity, reliability, and efficiency; (3) it would provide a future regulatory benefit to the NRC and licensees, considering Commission and congressional interest in licensee use of advanced fuel technologies; and (4) it would respond to public interest in this regulatory area and facilitate public participation. The priority for a rulemaking activity can change over time. Common reasons for a change in priority are new Commission or senior management direction or changes in the rulemaking scope.

### Description of Rulemaking: Estimate of Resources

The staff developed a preliminary cost-benefit analysis to assess the rulemaking alternative. The staff estimates that this rulemaking would require 3.5 years, as discussed in the enclosure, and would achieve a net benefit of approximately \$6.6 million, considering the rulemaking costs and a bounding estimate of the savings from projected averted license exemption requests assuming all operating nuclear plants pursue use of higher fuel enrichment. Separately, in the Nuclear Energy Institute white paper described above, industry has analyzed seven different scenarios in which substantial additional benefits could be achieved. A more detailed estimate of the costs of the rule, including any safety implications of using higher enriched fuel, will be evaluated as part of the regulatory basis. Based on these preliminary estimates, the staff believes that proceeding with rulemaking would use NRC and industry resources efficiently to assess potentially affected regulations and engage interested stakeholders.

Also, this rulemaking could enable more efficient regulatory reviews and facilitate the potential benefits of higher burnup cores and reduced environmental impacts as described below:

- **More Efficient Regulatory Reviews:** Facilitating increased fuel enrichments by rulemaking could enhance the efficiency of future licensing reviews by reducing the number of requests for exemptions. It would clarify the licensing process for increased fuel enrichment, and would provide for public participation during the rulemaking process.
- **Higher Burnup Cores and Longer Fuel Cycles:** While virtually all U.S. boiling-water reactor plants operate on a 24-month fuel cycle, only about 20 percent of pressurized-water reactor (PWR) plants do. An increase in fuel enrichment and burnup limits could potentially allow PWR plants to operate on a 24-month fuel cycle instead of an 18-month cycle. Industry contends that this change to longer cycles could reduce their replacement power costs and reduce the number of outages over the remaining life of these plants, also potentially resulting in lower cumulative worker exposures.
- **Potential Reduction of Environmental Impacts of the Fuel Cycle:** Given the above, greater utilization of the uranium fuel through higher burnup cores and longer fuel cycles could reduce the number of spent fuel assemblies, which could present a potential benefit with regard to the environmental impacts of the fuel cycle.

### Cumulative Effects of Regulation

This rulemaking would have a net positive impact on the cumulative effects of regulation for the following reasons:

- The rulemaking would reduce regulatory burden because the changes under consideration would not be required for licensee implementation but would decrease the need for additional licensing actions, such as exemptions in certain circumstances.
- Reasonable assurance of adequate public health and safety and the common defense and security would still be maintained through the deliberate and reasoned rulemaking process.
- Early stakeholder engagement during the regulatory basis development process would promote a shared understanding of rulemaking options.

The staff is also maintaining awareness of other potential rulemaking efforts impacting operating LWRs, such as the 10 CFR 50.46c rulemaking.<sup>1</sup> Because the use of increased enrichment fuel inherently lends itself to longer fuel cycles and higher burnup, the analyses required by 50.46c would provide an avenue to support higher burnup cores and the staff will look further for any cumulative regulatory impacts in the regulatory basis. In addition, the staff is maintaining awareness of the decommissioning rulemaking<sup>2,3</sup> for licensees considering fuels with increased enrichment and higher burnup. Additional evaluation could be performed during the regulatory basis, as appropriate. The staff is unaware of any other rulemakings that could have a cumulative effect with the proposed rulemaking activity at this time.

#### Agreement State Considerations

This rulemaking is not expected to impact Agreement States because it implicates NPPs, which are regulated exclusively by the NRC. However, the staff will engage the Agreement States and federally recognized Native American Tribal governments during the development of the regulatory basis if any impact is identified.

#### Guidance

The staff will continue to evaluate the need to modify ISG DSS-ISG-2010-01, Revision 0, RG 1.240, Revision 0, and NUREG-2216 or develop new guidance if rulemaking is pursued.

#### Advisory Committee on Reactor Safeguards Review

The staff recommends the proposed and final rules be subject to review by the Advisory Committee on Reactor Safeguards (ACRS).

#### Committee to Review Generic Requirements Review

The NRC staff expects review by the Committee to Review Generic Requirements (CRGR) would not be necessary because the recommended rulemaking would provide for a potential relaxation of requirements and would not constitute backfitting or require changes for any licensee. If there is an indication of a potential backfit, the staff will engage the CRGR early during development of the regulatory basis.

#### Advisory Committee on the Medical Use of Isotopes Review

Review by the Advisory Committee on the Medical Use of Isotopes (ACMUI) would not be necessary because the recommended rulemaking is not related to the medical use of isotopes.

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<sup>1</sup> SECY-16-0033, "Draft Final Rule—Performance-Based Emergency Core Cooling System Requirements and Related Fuel Cladding Acceptance Criteria (RIN 3150-AH42)," dated March 16, 2016 (ADAMS Package Accession No. ML15238A947).

<sup>2</sup> SECY-18-0055, "Proposed Rule: Regulatory Improvements for Production and Utilization Facilities Transitioning to Decommissioning," dated May 7, 2018 (ADAMS Accession No. ML18012A019).

<sup>3</sup> SRM-SECY-18-0055, "Staff Requirements – SECY-18-0055 – "Proposed Rule: Regulatory Improvements for Production and Utilization Facilities Transitioning to Decommissioning (RIN 3150-AJ59)," dated November 3, 2021 (ADAMS Accession No. ML21307A046).



Analysis of Legal Matters

The Office of the General Counsel has reviewed this rulemaking plan and has not identified any issues necessitating a separate legal analysis at this time.

COMMITMENT:

If the Commission approves initiation of the rulemaking, in accordance with SECY-16-0042, "Recommended Improvements for Rulemaking Tracking and Reporting," dated April 4, 2016 (ADAMS Accession No. ML16075A070), the staff will add the rulemaking activity to the agency's rulemaking tracking tool.

RECOMMENDATION:

The NRC staff recommends that the Commission approve initiation of the rulemaking process on the use of LWR fuel containing uranium enriched to greater than 5.0 weight percent U-235.

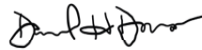
The staff also recommends that the Commission approve its recommendations on ACRS, CRGR, and ACMUI review.

RESOURCES:

The enclosure includes an estimate of the resources needed to complete this rulemaking.

COORDINATION:

The Office of the General Counsel has no legal objection to this rulemaking plan. The Office of the Chief Financial Officer has reviewed this paper and has no concerns with the resource estimates in the enclosure.



Signed by Dorman, Dan  
on 12/20/21

Daniel H. Dorman  
Executive Director  
for Operations

Enclosure:  
Resource Estimates (Non-Public)

SUBJECT: RULEMAKING PLAN ON USE OF INCREASED ENRICHMENT OF  
CONVENTIONAL AND ACCIDENT TOLERANT FUEL DESIGNS FOR LIGHT  
WATER REACTORS DATED: December 20, 2021

Ticket OEDO-21-00250-NRR

**ADAMS Accession Nos.:** ML21232A232 (Pkg.); ML21232A237 (SECY Paper) SECY-012

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