POLICY ISSUE
(Information)

October 6, 2020 SECY-20-0093

FOR: The Commissioners

FROM: Margaret M. Doane
Executive Director for Operations

SUBJECT: POLICY AND LICENSING CONSIDERATIONS RELATED TO MICRO-REACTORS

PURPOSE:

The purpose of this paper is to (1) inform the Commission of licensing topics related to nuclear micro-reactors that may necessitate departures from current regulations, related guidance, and past precedents; (2) identify potential policy issues related to licensing micro-reactors; and (3) describe the staff's approach to facilitate licensing submittals for near-term and future deployment and operation of micro-reactors.

SUMMARY:

As part of a broad spectrum of recent stakeholder engagement on advanced reactors, the U.S. Nuclear Regulatory Commission (NRC) staff has met with individual designers, the U.S. Department of Energy (DOE), and the U.S. Department of Defense (DOD) concerning the licensing and deployment of micro-reactors. Micro-reactors differ significantly from large light-water reactors (LWRs) for which the NRC has developed most of its regulations and guidance. Although no regulatory definition has been established, micro-reactors are small (on the order of tens of megawatts thermal (MWt)), have simpler designs with inherent safety features, and, in the unlikely event of an accident, are anticipated to have lower potential

CONTACTS: Amy E. Cubbage, NRR/DANU
301-415-2875

Boyce W. Travis, NRR/DANU
301-415-4149

radiological consequences with a correspondingly lower impact on public health and safety. Micro-reactors may fulfill nontraditional roles for nuclear power, including service to remotely sited areas, backup power generation, hydrogen production, desalination, process heating, and supporting military and critical national infrastructure facilities. Given the size and design attributes of micro-reactors, portions of the NRC's existing power reactor regulatory framework have limited applicability. For this reason, the staff has identified several licensing topics and potential policy issues related to micro-reactors that warrant Commission awareness. The NRC staff is committed to proactively addressing these issues to support safety-focused, cost-effective and timely regulatory reviews that will enable the safe deployment of these technologies. This paper focuses on stationary micro-reactor concepts being considered for commercial deployment at a fixed location.

This paper discusses various topics that are particular to micro-reactors. Some of these topics are newly identified for micro-reactors, and some have previously been considered in the context of light-water small modular reactors or non-LWRs, in general, but may need revisiting with the attributes of micro-reactors in mind. The staff's efforts to resolve policy issues broadly for non-LWRs may not adequately address the concerns of micro-reactor developers and future applicants.

This paper lays the foundation for a framework to address key topics, as described in Enclosure 1, to provide for an efficient staff review of micro-reactors against standards commensurate with the risks posed by the technology. The staff provides a planned approach to address these topics in the near term and describes plans for longer-term resolution as part of future rulemakings such as the Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors required by Section 103 of the Nuclear Energy Innovation and Modernization Act (NEIMA). The staff's proposed plan for this rulemaking was provided to the Commission in SECY-20-0032, "Rulemaking Plan on Risk Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (RIN-3150-AK31; NRC-2019-0062)," dated April 13, 2020, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19340A056). As additional information becomes available through more detailed engagement with stakeholders and applicants, the NRC staff will keep the Commission informed and prepare future papers to address additional generic micro-reactor policy issues or design-specific issues, as needed. In addition, the staff continues to address advanced reactor policy issues, such as insurance and liability, and will consider any unique micro-reactor issues as these policy issues are resolved.

<u>BACKGROUND</u>:

Micro-reactors are a subset of advanced non-LWR designs, with a variety of intended uses, as discussed above. For the purpose of this paper, they are commercial power reactors licensed under Section 103 of the Atomic Energy Act of 1954, as amended. Micro-reactors are anticipated to be capable of inherent thermal and reactivity control (i.e., an inherent safety characteristic such as the choice of material is a fundamental property of a design) and may be fabricated in a factory and moved to a fixed site for deployment (i.e., may be transportable). The staff has routinely interacted with the DOE Office of Nuclear Energy and with micro-reactor developers such as Oklo, Westinghouse, and X-Energy regarding such reactors.

Over the past several years, the NRC staff has also engaged with DOD personnel on feasibility studies for nuclear power plants to be used at military installations. In 2016, the DOD Defense

Science Board completed a task force report[1] on energy systems for forward/remote operating bases. In 2018, the staff provided input to a study[2] commissioned by the Army Deputy Chief of Staff to analyze the potential benefits and challenges of mobile nuclear power plants with very small modular reactor technology and to address the broader operational and strategic implications of energy delivery and management. On May 10, 2019, the NRC signed a memorandum of understanding with DOD and DOE, which provides "the basis for coordinating NRC, DOE, and DOD technical readiness and sharing of technical expertise and knowledge on micro-reactor technologies to support DOD's research and development." In some cases, the micro-reactors being evaluated by DOD would be "mobile" micro-reactors (i.e., rapidly moved by road, rail, sea, or air and allowing for quick setup and shutdown). Mobile reactors may raise additional policy and licensing considerations beyond those discussed in this paper. However, this paper focuses on stationary micro-reactor concepts being considered for commercial deployment at a fixed location.

On October 14, 2008, the Commission issued its Policy Statement on the Regulation of Advanced Reactors,[3] which included items to be considered in advanced nuclear power reactor designs. This document reinforced and updated the policy statement on advanced reactors previously published in 1986.[4] In the policy statement, the Commission set forth expectations for advanced reactor designs, encouraging early interaction to "contribute towards minimizing complexity and adding stability and predictability in the licensing and regulation of advanced reactors." The Commission also stated that developers of advanced reactors should consider the following:

- highly reliable and less complex shutdown and decay heat removal systems that use inherent or passive means;

- simplified safety systems that, where possible, reduce required operator actions, equipment subjected to severe environmental conditions, and components needed for maintaining safe-shutdown conditions; and

- designs that include considerations for safety and security requirements together in the design process.

In describing their initial concepts for micro-reactors, developers have stated that the designs include many of the above attributes. In the Advanced Reactor Policy Statement, the Commission noted that "incorporating the above attributes may promote more efficient and effective design reviews." The Commission also stated that "the number and nature of the regulatory requirements may depend on the extent to which an individual advanced reactor design incorporates general attributes such as those listed previously." The staff is also mindful of the NRC's Principles of Good Regulation,[5] which state that "regulatory activities should be consistent with the degree of risk reduction they achieve." This paper discusses areas where the staff has found that some existing power reactor regulations, developed under an

---

1 DOD Defense Science Board, Task Force on Energy Systems for Forward/Remote Operating Bases, Final Report, August 1, 2016 (https://apps.dtic.mil/sti/pdfs/AD1087358.pdf).

2 U.S. Army, Deputy Chief of Staff, G-4, Study on the Use of Mobile Nuclear Power Plants for Ground Operations, October 2018 (https://apps.dtic.mil/dtic/tr/fulltext/u2/1064604.pdf).

3 Volume 51 of the *Federal Register,* page 24643 (51 FR 24643) (1986).

4 Volume 73 of the *Federal Register*, page 60612 (73 FR 60612) (2008).

5 Staff Requirements Memorandum—COM-KR-90-1, "Principles of Good Regulation," dated April 6, 1990 (ADAMS Accession No. ML15083A026).

environment focused on regulating large LWR technologies, may not be suitable to apply to smaller, generally simpler and less complex micro-reactor designs.

There is not an agreed-upon definition for what constitutes a micro-reactor. Nevertheless, characteristics shared by the designs referred to as micro-reactors by stakeholders, industry, DOE, and DOD include low potential consequences in terms of radiological releases, small site footprints, and power levels generally on the order of tens of MWt or less, with increased reliance on passive systems and inherent characteristics used to control power and heat removal.

To better risk-inform the regulatory requirements and to more closely reflect the potential consequences associated with the reactor, one approach might be to classify micro-reactors based on demonstrated consequences with other similar low-consequence facilities as part of a future rulemaking. Whatever the process used to define and demonstrate potential radiological consequences, the NRC would establish dose thresholds and applicants would be required to demonstrate that it is unlikely to exceed the established threshold during the life of the facility, similar to the accident dose criterion of 1 rem total effective dose equivalent (TEDE) proposed for research reactors in the Non-Power Production or Utilization Facility License Renewal proposed rule (82 FR 15643). The NRC would then align the requirements and guidance for micro-reactors, where appropriate, with those used in assessing nonpower reactors or other NRC-licensed uses of special nuclear and byproduct materials with comparable risk profiles.

The NRC has experience regulating reactors with low potential consequences such as nonpower reactors; however, several differences between nonpower reactors and micro-reactors should be noted. For example, micro-reactors are designed to operate at full power more frequently and for longer periods than nonpower reactors, to have power conversion systems, to be closed systems that do not perform tests and experiments, and to have inherent or automatic features that may not require human actions for accident response. Therefore, due to the difference in operational characteristics, the suitability of licensing approaches for nonpower reactors would need to be further evaluated before these approached are applied to micro-reactors. However, insights from nonpower reactor approaches, such as provisions for security, emergency preparedness and operator licensing, are useful to consider in developing alternatives for licensing micro-reactors.

Many of the requirements for power reactors under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities,” and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” are not appropriate for micro-reactors considering their unique operational models and anticipated safety characteristics. Some NRC regulations are written as prescriptive requirements independent of the size and potential consequences of the facility and would likely give rise to exemption requests in micro-reactor applications. In particular, prescriptive staffing and operational requirements developed with large LWR facilities in mind may be more extensive than micro-reactors require to operate safely. Provided a micro-reactor applicant can demonstrate the safety and security of its design and show the facility represents a low risk, the staff recognizes that different licensing and regulatory approaches are appropriate for such facilities.

Designers are developing novel micro-reactor designs and identifying potential policy issues and regulatory challenges.[6] The Nuclear Energy Institute (NEI) submitted a white paper on November 13, 2019, on regulatory issues related to micro-reactors (ADAMS Accession No. ML19319C449), including operator requirements for automatic and remote operation, NRC oversight, emergency preparedness, physical protection, and aircraft impact. The discussion of these topics in Enclosure 1 considers the perspectives from NEI's paper along with those of other stakeholders. For most of the topics, NEI advocates developing generic approaches for micro-reactors.

Separately, NEIMA requires the NRC to increase the "use of risk-informed, performance-based licensing evaluation techniques and guidance" for commercial advanced reactors, where appropriate, within the existing regulatory framework and to undertake a rulemaking to establish a technology-inclusive regulatory framework for optional use by applicants for new commercial advanced reactor licenses. NEIMA also requires the NRC to evaluate legal, regulatory, and policy issues that the Commission should address regarding the licensing of commercial advanced nuclear reactor technologies for the purposes of predictable, efficient, and timely reviews. The topics discussed in this paper support these NEIMA requirements.

<u>DISCUSSION</u>:

In concert with ongoing efforts to develop technology-inclusive regulatory infrastructure for advanced reactors, the staff has identified several topics that should be addressed specifically for micro-reactor in parallel to the resolution for advanced reactors more generally:

- security requirements
- emergency preparedness
- staffing, training, and qualification requirements
- autonomous and remote operations
- regulatory oversight
- aircraft impact assessment
- annual fee structure
- manufacturing licenses and transportation
- population-related siting considerations
- environmental considerations

The staff discusses these topics in more detail in Enclosure 1. In the near term, the staff plans to license micro-reactors under the existing regulations for power reactor licenses in 10 CFR Part 50 and 10 CFR Part 52. Because of the significant differences between large LWRs and micro-reactors, the staff is receptive to requests for exemptions from the existing regulations in the areas above and would evaluate such exemptions on a case-by-case basis using existing agency processes. The staff may also incorporate alternate requirements into licenses, certifications, permits, or approvals using regulatory vehicles such as license conditions and hearing orders, or through a rule of particular applicability, as discussed in Enclosure 2. However, the staff recognizes that proposals in some of these areas (such as fully autonomous operation) may encompass policy issues that warrant future Commission interaction.

---

[6] Oklo, Inc. submitted a custom combined license application for the AURORA reactor to the NRC on March 11, 2020 (ADAMS Accession No. ML20075A000). This paper does not address any Oklo-specific matters, which will be addressed separately as they arise.

As a longer-term activity, the staff proposes to take a more holistic, unified approach to licensing and oversight of micro-reactors. The agency could codify such an approach in the rulemaking to establish the technology-inclusive regulatory framework required by NEIMA. The staff plans to address any policy issues that arise during the development of the approach through issue-specific Commission paper(s) as needed. The staff expects this rulemaking to include provisions to address micro-reactors in a manner commensurate with the risks posed by such facilities. The NRC could also address issues such as annual fees in other planned rulemakings (e.g., the annual fee rule).

Stakeholder Engagement

Over the past year, the NRC staff has had extensive public engagement on these topics to inform this paper. Public meetings took place on June 28, October 17, and December 12, 2019. The staff also briefed the Advisory Committee on Reactor Safeguards Future Plants Subcommittee on August 23, 2019. During the December 2019 public meeting, NEI presented its white paper on micro-reactors, including discussions of operator requirements for automatic and remote operation, NRC oversight, emergency preparedness, physical security, and aircraft impact. The discussion of the topics in Enclosure 1 considers perspectives from the NEI white paper along with those of other stakeholders. NEI also discussed in its white paper the NRC's review scope and level of effort for micro-reactor licensing reviews, stating that micro-reactors are expected to achieve high levels of simplicity and safety that would support a more streamlined NRC review. The staff agrees that a more streamlined review is appropriate for advanced reactors, and micro-reactors in particular. As discussed in SECY-20-0010, "Advanced Reactors Program Status," dated January 30, 2020 (ADAMS Accession No. ML19331A034), the staff is developing and implementing transformational approaches to conducting advanced reactor licensing reviews, including the development of staff review strategy guidance, use of limited staffing core review teams, focus on safety-significant design and operational characteristics, preparation of streamlined review documentation, and use of regulatory audits and meetings to reduce the number of requests for additional information.

<u>COORDINATION</u>:

The Office of the General Counsel has reviewed this paper and has no legal objection. The Office of the Chief Financial Officer reviewed this paper and determined that it has no financial impact.

The staff also considered its interactions with the Advisory Committee on Reactor Safeguards in finalizing this paper.

Margaret M. Doane Digitally signed by Margaret M. Doane
Date: 2020.10.06 16:06:52 -04'00'

Margaret M. Doane
Executive Director
for Operations

Enclosures:
1. Technical, Licensing, and Potential Policy Issues for Micro-Reactors
2. Possible Near-Term Licensing Approaches for Micro-Reactors

SUBJECT: POLICY AND LICENSING CONSIDERATIONS RELATED TO MICRO-REACTORS
DATED: October 6, 2020

ADAMS Accession No.: ML20254A363 Package *via e-mail SECY-012

OFFICE	DANU/UARP*	DANU/UART*	DANU/UARP/BC*	QTE*	NRR/DANU/D*	NSIR/DPR/D*
NAME	ACubbage	BTravis	JSegala	JDougherty	JMonninger	KBrock
DATE	5/14/2020	5/14/2020	5/15/2020	5/4/2020	5/20/2020	6/2/2020
OFFICE	NRR/DRO*	NSIR/DPCP/D*	NMSS/REFS/D*	OCFO/DOB*	OGC/NLO*	NRR/D*
NAME	CMiller	RFelts	JTappert	RAllwein	MCarpentier	HNieh
DATE	6/2/2020	6/2/2020	6/16/2020	6/1/2020	7/15/2020	9/8/2020
OFFICE	EDO*					
NAME	MDoane					
DATE	10 /06/2020					

OFFICIAL RECORD COPY