



**UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001**

October 25, 2023

The Honorable Christopher T. Hanson
Chair
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: DRAFT WHITE PAPER, "MICRO-REACTOR LICENSING AND DEPLOYMENT CONSIDERATIONS: FUEL LOADING AND OPERATIONAL TESTING AT A FACTORY"

Dear Chair Hanson:

During the 709th meeting of the Advisory Committee on Reactor Safeguards (ACRS), October 3-5, 2023, we completed our review of the staff draft white paper, "Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory," and the associated enclosure. During this meeting, we had the benefit of discussions with the staff. We also had the benefit of the referenced documents.

CONCLUSIONS AND RECOMMENDATIONS

1. The staff draft white paper identifies near-term options for licensing of factory-fabricated micro-reactors that could be implemented without rulemaking, to enable fuel loading and operational testing of micro-reactors where they are fabricated. We favor the alternative options because the status quo options impose a regulatory burden that does not comport with the anticipated lower hazard level posed by some micro-reactors.
2. Innovative alternative options proposed by the staff for micro-reactors include:
 - a. Redefining when a reactor is considered operational from the initiation of "fuel loading" to "removal of features to preclude criticality," enabling fuel loading prior to transport; and
 - b. Using NUREG-1537 guidance (for licensing of non-power research and test reactors) as a graded review approach for the anticipated lower hazard of operational testing with fuel loaded at the fabrication facility.
3. For completeness and improved clarity, the white paper should:
 - a. Define key terms, such as "micro-reactors" and "features to preclude criticality," and
 - b. Expand the list of topics to address in guidance, such as acceptable attributes for features to preclude criticality, the required safety margin to criticality (especially for first-of-a-kind reactors with little or no operating experience), and the certification required for personnel conducting operational testing at a factory.

BACKGROUND

The staff draft white paper, “Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory,” lays out regulatory options for fuel loading and operational testing of micro-reactors manufactured at a factory (rather than constructed at the intended deployment site). The envisioned deployment model consists of: fabrication, fueling, and possible operational testing at a factory; transportation to the deployment site; power operation at the deployment site; transportation from the deployment site; and decommissioning or refurbishment for redeployment.

The enclosure to the white paper discusses future technical, licensing, and policy considerations for micro-reactors including autonomous and remote operation, decommissioning, siting in densely populated areas¹, maritime and space applications, and commercial mobile micro-reactors. Staff chose to focus on fuel loading and operational testing, because these items have been identified as critical near-term policy issues to be implemented without rulemaking. Our letter also emphasizes these items.

The white paper proposes options for three topics: (1) features to preclude criticality, (2) fuel loading at a factory, and (3) operational testing at a factory. For each topic, status quo and alternative options are presented:

- Under the status quo options (Options 1a, 2a, and 3a), a factory-fabricated module would be considered “in operation” as soon as fuel is loaded, requiring the fabricator to hold a facility operating license under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 or a combined license under 10 CFR Part 52 to load fuel at the factory; or
- Under the alternative options (Options 1b, 2b, and 3b), features to preclude criticality would be credited to allow loading fuel into a factory-fabricated module without the reactor being considered “in operation.” Under these options, the fabricator could be licensed as a manufacturing facility and a 10 CFR Part 70 licensee, followed possibly by operational testing in the factory using a graded review approach (NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors”). 10 CFR Part 71 would then govern transportation of the fueled reactor².

DISCUSSION

Adequate protection of public health and safety is achievable using either the status quo or alternative options. The status quo options involve a regulatory burden for fabricators that may not comport with the hazard from some micro-reactors. In addition, NRC’s current regulatory framework does not provide for transportation of utilization facilities that are “in operation,” without regulatory changes (which may include rulemaking), a factory-fabricated module could not be transported when loaded with fuel.

¹ Current Commission policy and regulations (Title 10 of the *Code of Federal Regulations* Part 100), preclude siting a commercial power reactor, no matter the size or type of reactor, within a population center of 25,000 residents or more.

² If option 1b is not implemented, transportation of a fueled core would be precluded.

The staff proposes innovative options, including a) redefining when a reactor is considered operational from the initiation of “fuel loading” to “removal of features to preclude criticality,” and b) using NUREG-1537 guidance as a graded review approach for the anticipated lower hazard of operational testing with fuel loaded at the fabrication facility.

Changing the definition of when a reactor is considered “in operation” from fuel loading to “removal of features to preclude criticality” (Option 1b) enables fuel loading and subsequent transport and is commensurate with the anticipated lower hazard level of some micro-reactors. This definition would also obviate the need for an operating license to load fuel at a factory. We support this option. Furthermore, the ability to load fuel and conduct operational testing in a factory could have overall safety benefits.

The alternative approach is relatively straightforward for loading fuel at a factory. However, operational testing at a factory is complicated because it would require an operating license or combined operating license, and likely a Type BF package under 10 CFR Part 71 for transportation. The staff proposes that guidance in NUREG-1537 be used for Option 3b. We also support this option because it allows a graded approach for reviewing such applications.

Pursuing either the status quo or alternative options requires careful attention to the exact applicability of any license conditions, exemptions, rules, or other regulatory vehicles. In addition, clarity is needed to support implementation:

- Definitions are needed to determine which reactors are eligible for the proposed alternative options, and if there are any limitations on the extent of fuel irradiation permitted during operational testing before transport. While micro-reactors could be classified based solely on power level, SECY-20-0093, “Policy and Licensing Considerations Related to Micro-Reactors,” emphasizes “demonstrated consequences” (e.g., a threshold of 1 rem total effective dose equivalent).
- The alternative options are predicated on placing a fueled reactor into a condition “incapable of sustaining a nuclear chain reaction under any conditions.” Guidance should address how much shutdown margin would be required. Particularly, uncertainties associated with first-of-a-kind reactor designs should be carefully considered.
- The draft white paper should expand the list of topics to be addressed in guidance to include acceptable criteria for features to preclude criticality (including robustness with respect to possible transportation accidents), and the certification required for personnel conducting operational testing at a factory.

SUMMARY

The staff draft white paper identifies near-term options for licensing of factory-fabricated micro-reactors that could be implemented without rulemaking, to enable fuel loading and operational testing of micro-reactors where they are fabricated. We favor the alternative options because the status quo options impose a regulatory burden that does not comport with the anticipated lower hazard level posed by some micro-reactors.

Sincerely,



Signed by Rempe, Joy
on 10/25/23

Joy L. Rempe
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, "NRC Staff Prepared White Paper - 'Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory – Released to Support ACRS Interaction,'" September 27, 2023 (ML23264A802).
2. U.S. Nuclear Regulatory Commission, "Enclosure to NRC Staff Prepared White Paper - 'Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory – Released to Support ACRS Interaction,'" September 27, 2023 (ML23264A803).
3. U.S. Nuclear Regulatory Commission, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," NUREG-1537, February 28, 1996 (ML14199A740).
4. Title 10 of the *Code of Federal Regulations* Part 50, "Domestic Licensing of Production and Utilization Facilities."
5. Title 10 of the *Code of Federal Regulations* Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."
6. Title 10 of the *Code of Federal Regulations* Part 70, "Domestic Licensing of Special Nuclear Material."
7. Title 10 of the *Code of Federal Regulations* Part 71, "Packaging and Transportation of Radioactive Material."
8. Title 10 of the *Code of Federal Regulations* Part 100, "Reactor Site Criteria."
9. U.S. Nuclear Regulatory Commission, "Policy and Licensing Considerations Related to Micro-Reactors," SECY-20-0093, October 6, 2020 (ML20129J985).

October 25, 2023

SUBJECT: DRAFT WHITE PAPER, "MICRO-REACTOR LICENSING AND DEPLOYMENT CONSIDERATIONS: FUEL LOADING AND OPERATIONAL TESTING AT A FACTORY"

Accession No: ML23289A043 Publicly Available (Y/N): Y Sensitive (Y/N): N
If Sensitive, which category?

Viewing Rights: NRC Users or ACRS only or See restricted distribution

OFFICE	ACRS	SUNSI Review	ACRS	ACRS	ACRS
NAME	DWidmayer	DWidmayer	LBurkhart <i>(MSnodderly for)</i>	SMoore	JRempe
DATE	10/16/23	10/16/23	10/17/23	10/25/23	10/25/23

OFFICIAL RECORD COPY