POLICY ISSUE
NOTATION VOTE

RESPONSE SHEET

TO: Carrie M. Safford, Secretary

FROM: Commissioner Crowell

SUBJECT: SECY-24-0008: Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory

Approved X **Disapproved** ____ **Abstain** ____ **Not Participating** ____

COMMENTS: **Below** ____ **Attached** X **None** ____

Enered in STARS
Yes X
No ____

BRADLEY CROWELL
Digitally signed by BRADLEY CROWELL
Date: 2025.04.09 16:40:31 -04'00'

Signature

Commissioner Crowell's Comments on SECY-24-0008, "Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory"

Micro-reactors represent a potential major change in the nuclear energy landscape. Smaller, standardized reactors produced, potentially in large quantities, at a factory and transported fully built and possibly pre-loaded with fuel to a deployment site have the potential to transform how civilian nuclear power is used and how the NRC approaches our regulatory role. This factory-fabricated deployment model will require innovative thinking on both the part of future applicants and the NRC to realize the efficiencies of such an approach while maintaining an equivalent level of safety to operating reactors. To that end, I commend the staff for developing this paper, which proposes novel thinking on regulatory approaches for micro-reactor licensing and deployment in a timely fashion for potential applicants' use. It is also important to highlight that this paper represents only a subset of regulatory policy issues regarding the safe and efficient licensing of microreactors; the NRC staff will provide the Commission with subsequent papers for our consideration on areas such as operations, deployment, oversight, and end of lifecycle management and transportation.

This paper provides three policy topics for Commission consideration: (Topic 1) features to preclude criticality, (Topic 2) fuel loading at a factory, and (Topic 3) operational testing at a factory. How features to preclude criticality are handled in determining whether a fuel-loaded reactor is considered to be "in operation" underpins many of the policy decisions presented in this paper. At the most fundamental level, treatment of this topic involves considering the level of risk presented by a novel concept and working to ensure the regulatory construct applied is commensurate with the risk and consistent with comparable existing applications.

As stated in the paper,

> [t]he Commission has historically viewed operation as including the loading of fuel into the reactor. It took this view for reasons of safety based on recognition that loading fuel into and initial testing of a reactor involves a nuclear risk that would not otherwise be present.

For a factory-fabricated micro-reactor, the act of loading fuel should not involve the same series of steps that leads to the change in risk profile as would be the case for a traditional large reactor being loaded with fuel. Precluding criticality through design and installed controls represents an important safety distinction between a reactor and manufactured module. Provided features to preclude criticality are installed and correctly implemented, and cannot be removed inadvertently or in an accident, loading fuel into a module in a factory as described in Topic 1 is more akin to loading fuel into a transportation cask than into an operating reactor. These features would need to be robust, capable of holding the fueled module subcritical under all postulated conditions including those addressed as part of transportation, and would require significant and deliberate action both to install and to remove.

As the staff paper describes, features to preclude criticality would mean the module would not be "in operation" during transport, thus allowing transportation of a fueled module under current regulations, and the manufacturing license (ML) would contain provisions allowing for transfer to a licensee authorized to receive and operate the module. For transportation from the factory to the deployment site, the licensee (e.g., the ML holder) would still need to meet the existing, well-established transportation requirements, which are comprehensively addressed in the existing ML regulations, the NRC's transportation regulations, and the U.S. Department of

Transportation regulations. There would also be a thorough review of the design as part of the manufacturing licensing process, which will assess transportation, among other relevant issues, commensurate with the risks of activities currently regulated by the NRC. For Topic 1, I therefore approve option 1b, taking the position that (1) factory-fabricated modules with features to preclude criticality would not be "in operation" when loaded with fuel, (2) operation would begin with removal of those features at the site where the module is licensed to operate, and (3) the removal of those features is the best analogue to "initial loading of fuel" or fuel loading for a reactor without such features.

As mentioned above, Topic 2—fuel loading at the factory—is dependent on the resolution of how to treat features to preclude criticality. In other words, it is necessary to determine whether loading fuel into a factory-fabricated module with features to preclude criticality constitutes "operation" (Topic 1) in order to then decide which type of license for such a module is appropriate (Topic 2). I acknowledge the significance of these issues—loading fuel at the factory is considered essential for commercial-scale deployment by many potential license applicants considering factory-fabricated designs. Based on my rationale for approving option 1b, under Topic 1, it naturally follows that the regulatory construct for loading fuel in a module at the factory should be commensurate with the risks currently understood by the NRC. In option 2b, under Topic 2, the staff has provided an approach which would allow for fuel loading at the factory, provided the manufacturer obtains both an ML for possession of the reactor module and a Part 70 license for possession of special nuclear material in the quantity and form specified in the application (both licenses could be part of the same application, as staff notes in the paper).

Given the novel technical and safety considerations associated with loading fuel into a factory-fabricated module with features to preclude criticality are likely to be similar to a combination of activities already licensed by the NRC (e.g., the process of fuel handing and shipment from a fabrication facility to its eventual destination), a combination ML and special nuclear material license appears to be a reasonable approach for these circumstances. Under this approach, a single entity would apply for two licenses that would work in tandem—the ML would address the design information for the factory-fabricated module, and the material license would address radiological safety at the manufacturing facility. Staff acknowledges additional work remains to determine how to assess aspects of factory operations addressed in the special nuclear material license application that may be different than or in addition to those described in the ML application, as well as how to address the environmental review and financial protection considerations that would likely need to be handled on a case-by-case basis, potentially through license conditions. Given all of these factors, for Topic 2 I approve option 2b as outlined in the paper. Should this option prevail, I would expect the staff to engage the Commission as the specific considerations associated with this license combination approach are developed.

Both Topics 1 and 2 rely heavily on the sufficiency of features to preclude criticality; however, the practical implementation of these features has yet to be contemplated beyond nascent design concepts currently being developed. Because these features are so important and it is not yet clear what "correctly implemented" features will look like, staff should keep the Commission informed as they develop technology-inclusive guidance on the use of features to preclude criticality.

I recognize the constraints the staff imposed on itself in developing this paper—namely, to present policy considerations that did not require new rulemaking to implement. And I understand and appreciate the staff's efforts to get "near-term clarity" on three policy areas likely

to affect any early stage microreactor proposals. In my view, Topic 3 is perhaps the most restricted by this constraint. Regulating operational testing at a factory (i.e., low power testing, not power production) before a reactor unit arrives at its deployment site is a complicated concept, and I agree with the staff's perspective that today, each factory-fabricated module would require an operating license of some form to be safely tested at the manufacturing facility. The conditions for a factory-tested reactor need not be the same as those at the final deployment site. Therefore, these differences would merit different license and review treatment.

Under Topic 3, option 3a would apply the same licensing approach currently used for operating reactors under Part 50 or Part 52, which may not be commensurate with the risk posed by the factory's limited activity. Whereas, option 3b represents an incremental change in review scope through applying, as appropriate, existing regulations in Part 50 for non-power reactors to the factory operating license applicants using appropriate regulatory vehicles, such as license conditions or exemptions, in an effort to scale the safety and environmental reviews to be commensurate with risks associated with the activities conducted at a manufacturing facility. Separately, under option 3b, an ML would also be issued to address the reactor module design.

Provided an appropriate envelope for potential consequences is established such that the risks presented by a reactor module undergoing testing are less than those contemplated for existing non-power reactors, it is not clear to me that, as a matter of policy, Commission approval is needed to use existing requirements and regulatory vehicles on an ad hoc basis for testing micro-reactor modules at factories. Nevertheless, I approve option 3b under the conditions outlined in the paper for the staff to assess the appropriateness of and apply the necessary non-power reactor regulations and guidance for the factory tested module.

As plans for micro-reactors become more fully developed and the concept of factory fabrication of such reactors matures, the staff should continue to contemplate other regulatory approaches for factory testing, even if new ideas would require rulemaking. The staff's consideration of these approaches should include, but not be limited to, adequately addressing applicable public comments received in response to the questions related to MLs and testing presented in the proposed Part 53 rule.

I recognize that manufacturing, fuel loading, and transportation represent just one bucket of issues related to microreactors that must be addressed in the effort to develop a responsible regulatory model, and that additional policy issues will likely need to be addressed and resolved associated with refueling, refurbishment, or redeployment of these reactors after their initial deployment. The paper's enclosure addresses these issues, among others in the lifecycle of a factory-fabricated microreactor (e.g., siting, physical security during transportation, irradiated fuel storage, decommissioning and decommissioning funding assurance)—I appreciate the staff's outlined near-term strategies on these important issues, and I look forward to continued engagement. At present, I believe that the regulatory requirements as they currently exist are robust enough to provide a pathway to license and operate a factory-fabricated micro-reactor, even though additional licenses for each module (whether at the factory or the deployment site) may be required for refurbishment or replacement activities, as well as spent fuel management and decommissioning. Given the novelty of this concept and relative lack of currently available knowledge regarding the full micro-reactor lifecycle, it seems premature to address all possible deployment and refueling plans at this stage. Instead, once a clearer picture emerges, I expect NRC staff will determine whether additional policy issues need to be addressed or if rulemaking

or guidance is needed and will thus raise such issues to the Commission for consideration and feedback (as done well here).

While I approve options 1b, 2b, and 3b, nothing would preclude the use of the regulatory approaches outlined in options 2a or 3a or perhaps the use of other existing regulatory vehicles that may appropriately address activities involved in the licensing of micro-reactors. My approval of the staff's recommended options is in addition to other options that may currently be available, not in place of them. In other words, if an applicant wanted to apply for an operating license for loading fuel into a micro-reactor module, or if a facility performing testing desired a full Part 50 or 52 license for operational testing, I do not wish to preclude them from doing so.

I look forward to the staff's continued work on this novel and evolving portion of the NRC's anticipated future workload.