LICENSING CONSIDERATIONS RELATING TO USE OF NUCLEAR ENERGY FOR NONELECTRIC APPLICATIONS

A Report for the
U.S. Senate Committee on Environment and Public Works and the
U.S. House of Representatives Committee on Energy and Commerce

U.S. Nuclear Regulatory Commission
April 2025

Enclosure

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INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) developed this report as required by Section 203 of the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act) (Ref. 1). Specifically, Section 203 of the ADVANCE Act requires the following:

> (a) IN GENERAL.—Not later than 270 days after the date of enactment of this Act, the Commission shall submit to the appropriate committees of Congress a report addressing any unique licensing issues or requirements relating to—
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> (1) the flexible operation of advanced nuclear reactors, such as ramping power output and switching between electricity generation and nonelectric applications;
> (2) the use of advanced nuclear reactors exclusively for nonelectric applications; and
> (3) the colocation of nuclear reactors with industrial plants or other facilities.
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> (b) STAKEHOLDER INPUT.—In developing the report under subsection (a), the Commission shall seek input from—
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> (1) the Secretary of Energy;
> (2) the nuclear energy industry;
> (3) technology developers;
> (4) the industrial, chemical, and medical sectors;
> (5) nongovernmental organizations; and
> (6) other public stakeholders.
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> (c) CONTENTS.—
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> (1) IN GENERAL.—The report under subsection (a) shall describe—
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> (A) any unique licensing issues or requirements relating to the matters described in paragraphs (1) through (3) of subsection (a), including, with respect to the nonelectric applications referred to in paragraphs (1) and (2) of that subsection, any licensing issues or requirements relating to the use of nuclear energy—
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> (i) for hydrogen or other liquid and gaseous fuel or chemical production;
> (ii) for water desalination and wastewater treatment;
> (iii) for heat used for industrial processes;
> (iv) for district heating;
> (v) in relation to energy storage;
> (vi) for industrial or medical isotope production; and
> (vii) for other applications, as identified by the Commission;
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> (B) options for addressing those issues or requirements—
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> (i) within the existing regulatory framework;
> (ii) as part of the technology-inclusive regulatory framework required under subsection (a)(4) of section 103 of the Nuclear Energy Innovation and Modernization Act (42 U.S.C. 2133 note; Public Law 115–439); or
> (iii) through a new rulemaking; and
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> (C) the extent to which Commission action is needed to implement any matter described in the report.
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> (2) COST ESTIMATES, BUDGETS, AND TIMEFRAMES.—The report shall include cost estimates, proposed budgets, and proposed timeframes for implementing risk-informed and performance-based regulatory guidance in the licensing of nuclear reactors for nonelectric applications.

Implementing the ADVANCE Act is a key priority for the NRC. The agency is working to enhance efficiency in processes, including licensing advanced nuclear reactors for nonelectric applications. The NRC's regulatory framework allows for flexible and efficient licensing processes for these applications, including the consideration of exemptions and license conditions when necessary. In developing this report, the NRC identified overarching considerations for nonelectric applications that can be addressed within the NRC's regulatory framework, including managing and monitoring radioactive materials, controlling radiation exposure, and assessing and protecting the nuclear plant and its operators from potential hazards. The NRC will evaluate these overarching considerations during the application reviews. This report outlines the NRC's completed, ongoing, and potential future actions to add additional flexibility or clarity for nonelectric applications of nuclear reactors. Enclosure 1 includes summary tables of the actions discussed in this report.

The NRC values public input and feedback. As part of its efforts to respond to Section 203 of the ADVANCE Act, the NRC sought input during a public meeting from the U.S. Department of Energy (DOE); the nuclear energy industry; technology developers; the industrial, chemical, and medical sectors; nongovernmental organizations; the public. Additionally, the NRC also received correspondence related to Section 203 of the ADVANCE Act. Enclosure 2 contains details of the meeting and a list of the incoming correspondence. The NRC considered the verbal and written feedback in preparing this report.

LICENSING ISSUES OR REQUIREMENTS RELATING TO THE USE OF NUCLEAR ENERGY FOR NONELECTRIC APPLICATIONS (SECTION 203(a) OF THE ADVANCE ACT)

Section 203(c)(1)(A) of the ADVANCE Act requires that this report describe licensing issues or requirements relating to several potential nonelectric applications for either the flexible operation of advanced nuclear reactors or the use of advanced nuclear reactors exclusively for nonelectric applications. The report is also required to examine licensing issues or requirements relating to colocation of nuclear reactors with industrial plants or other facilities. Each topic is addressed in a separate section in this report.

Flexible Operation of Advanced Nuclear Reactors (Section 203(a)(1))

Flexible operation of advanced nuclear reactors refers to the ability of reactors to adjust their power output or shift their energy production to support a range of applications beyond electrical power generation. All current commercial nuclear power plants can manually adjust output in response to changing grid demand. Expanding this capability to include switching between electric and nonelectric applications, such as hydrogen production, industrial heat, or water desalination, may require additional equipment and infrastructure, depending on the specific energy needs.

The NRC's regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," and Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," accommodate the flexible operation of advanced nuclear reactors. For example, 10 CFR Parts 50 and 52 provide substantial flexibility to applicants to demonstrate that a proposed reactor design can operate safely within its design and licensing basis, which can include ramping power output and switching between electricity generation and nonelectric applications. The NRC's licensing review of these applications evaluates the safety implications of varying load demands. Many studies performed by industry, academia, and government agencies have identified energy storage as a means to mitigate the impact of load fluctuations and reduce the risk of plant disruptions caused by sudden demand

changes. For example, the plant's thermal output could be used to heat energy storage media (e.g., molten salt tanks), which can then be used for electricity generation or to support nonelectric applications. In addition, the NRC published for public comment the proposed rule for 10 CFR Part 53, "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors" (Ref. 2), which, if finalized, would provide an additional licensing pathway for licensing advanced nuclear reactors that are being planned for flexible operations. The NRC is currently addressing the public comments and developing a draft final rule to be provided to the Commission by quarter 3 (Q3) of fiscal year (FY) 2026 for its consideration.

A unique licensing issue that can be addressed within the existing regulatory framework is load following, where a plant's output automatically adjusts in response to externally generated instructions or signals. The NRC's regulatory framework is sufficiently flexible to support applicants pursuing new technologies or operational concepts that request additional flexibility for automatic load following. For example, an exemption from 10 CFR 50.54, "Conditions of Licenses," if granted, would allow the controls of any facility to be performed other than by a licensed operator or senior operator. The NRC's regulations in 10 CFR 50.12, "Specific Exemptions," specify when the NRC may grant an exemption on a case-by-case basis on its own initiative or at the request of an interested person. The NRC has identified the development of guidance for load following as a potential future action to provide additional clarity on flexibility for applicants and licensees under 10 CFR Parts 50 and 52 (Enclosure 1, Table 3). This action, if further pursued, will be addressed through the planning, budgeting, and performance management process, subject to resource availability and prioritization. Additionally, the NRC has included provisions in the proposed rule for 10 CFR Part 53 that would allow for load following with less reliance on human actions, including the ability to switch between applications, provided that appropriate safety measures are in place. The NRC staff plans to provide the 10 CFR Part 53 draft final rule to the Commission by Q3 of FY 2026 for its consideration.

Use of Advanced Nuclear Reactors Exclusively for Nonelectric Applications (Section 203(a)(2))

Advanced nuclear reactors can be used for electrical power generation; exclusively for nonelectric applications, such as providing industrial heat for chemical processes or producing radioactive isotopes for medical and industrial use; or for both electrical power generation and nonelectric applications. The selection of reactor design, power level, and operational characteristics for these applications can affect the complexity of the licensing review.

The NRC's regulations in 10 CFR Parts 50 and 52 provide regulatory flexibility in the licensing process for a nuclear reactor, including advanced reactors, used exclusively for nonelectric applications. For example, the existing regulatory framework provides substantial flexibility to applicants to demonstrate a reactor system's ability to handle transients and accidents that may result from issues with the nuclear plant, the industrial facility, or related activities for the nonelectric applications (Ref. 3). Identifying and analyzing a wide range of potential events within the reactor systems or facilities used for nonelectric applications can affect the complexity of the licensing review. For example, some cases may involve small modular reactors or microreactors with scalable site footprints and boundaries at the site perimeter (Ref. 4). The NRC also published the proposed rule for 10 CFR Part 53, which, if finalized, would provide a more risk-informed and performance-based framework to support a range of nonelectric applications for nuclear reactors, including advanced reactors. The NRC is currently addressing public comments and developing a draft final rule to be provided to the Commission.

The NRC has recent experience in preparing to review license applications for advanced nuclear reactors for nonelectric applications. For example, the NRC issued a construction permit for the SHINE Technologies, LLC. (SHINE) Chrysalis facility in Janesville, Wisconsin for a nonpower utilization facility dedicated to medical isotope production (Ref. 5).[1] The NRC also developed strategies cooperatively with the DOE for the use of power reactors to provide process heat for a hydrogen production facility, which was explored under the Next Generation Nuclear Plant (NGNP) Project (Ref. 6). In addition, national laboratories and reactor vendors prepared various analyses and design studies as part of the activities related to the NGNP Project (Ref. 7). While many of the NGNP Project activities were performed over a decade ago, it remains a pertinent reference for the subject of this report, with its technical contributions continuing to be valid and relevant.

Hydrogen or Other Liquid and Gaseous Fuel or Chemical Production (Section 203(c)(1)(A)(i))

Nuclear reactors can be used to produce hydrogen or other liquid and gaseous fuels or chemicals. Some advanced reactors can supply the high-temperature process heat necessary for various industrial processes, including hydrogen production, as well as the production of chemicals such as ammonia and synthetic fuels. The selection of reactor design, power level, and operational characteristics can affect the complexity of the licensing review.

The existing regulatory framework addresses the licensing considerations for nuclear plants used in hydrogen or fuel/chemical production. Such licensing considerations include examining whether the plant can respond to postulated transients and accidents, and managing potential hazards from nearby fuel or chemical facilities. As part of the licensing process, an applicant or licensee is required to perform analyses and incorporate design features to manage the risks introduced with heat transfer systems connecting the nuclear plant and a nearby industrial facility. Licensees are required to monitor heat transfer fluids to ensure that concentrations of radioactive materials and doses to members of the public, including the workers in the industrial facility, remain below regulatory limits. The regulations in 10 CFR Parts 50 and 52 are sufficiently flexible to address technical issues that may arise from the interconnections of heat transport systems between the nuclear plant and industrial facility, and such issues are addressed as part of the licensing review (Ref. 2). In addition, the NRC has identified the need to develop of additional guidance assessing hazards associated with colocated facilities, including those from hydrogen production, as a potential future action to provide greater clarity in this area (Enclosure 1, Table 3). This action, if further pursued, will be addressed through the planning, budgeting, and performance management process, subject to resource availability and prioritization.

The NRC and its licensees have recent experience using the NRC's existing regulatory framework to enable nuclear reactors to be used for hydrogen production or other fuels or chemicals. For example, in 2023, the Nine Mile Point Nuclear Power Station near Oswego, New York, began producing hydrogen for onsite use in a first-of-its-kind implementation of nuclear energy. The licensee was able to accomplish this hydrogen production without the need for NRC approval consistent with the NRC's regulatory framework (Ref. 8). The use of nuclear reactors to produce hydrogen or other fuels or chemicals has been also evaluated as part of other activities such as the NGNP Project. Although a facility license was ultimately not pursued as part of the NGNP Project, the NRC and the DOE worked cooperatively to evaluate issues

[1] While the SHINE application is for an accelerator-driven subcritical operating assembly rather than a reactor, it is subject to the same regulatory framework in 10 CFR Part 50 as the majority of the current fleet of operating power reactors and all of the operating non-power reactors.

and develop a licensing strategy (Ref. 6) for a possible plant in accordance with the Energy Policy Act of 2005. Insights from those evaluations are proving useful in ongoing interactions with applicants under DOE's Advanced Reactor Demonstration Program (ARDP). For example, the NRC staff participated in pre-application engagement with X-energy, LLC (X-energy) to support the review of a construction permit application for the Long Mott project as part of the ARDP project (Ref. 9). While not required, pre-application engagements can lead to more efficient licensing reviews. X-energy's Long Mott project seeks to provide electrical power and process heat (steam) for use in chemical production to the Dow Chemical Seadrift Site in North Seadrift, Texas. This pre-application engagement and insights from the NGNP project are expected to yield substantial efficiency gains to the NRC and X-energy in the licensing review of a construction permit application (Enclosure 1, Table 2).[2]

Water Desalination and Wastewater Treatment (Section 203(c)(1)(A)(ii))

Nuclear plants can provide energy for desalination and wastewater treatment by providing electricity to power pumps and related equipment and by providing process heat for those facilities (e.g., boiling feedwater). International experience with the design and operation of nuclear plants used for desalination can inform the NRC's licensing reviews and applicants' development of future applications on this topic. For example, the NRC interacts with the International Atomic Energy Agency and other international organizations and through bilateral agreements with various countries to identify and use operating experience related to desalination and other nonelectric uses of nuclear energy. In addition, recent reports prepared by the National Association of Regulatory Utility Commissioners (Ref. 10) and the National Academies of Sciences, Engineering, and Medicine (Ref. 11) provide examples of nuclear plants outside the United States used for desalination. These international experiences help the agency broaden its understanding of these topics, and inform the NRC's licensing review of future applications.

As part of the licensing process, applicants or licensees are required to perform an analysis of the adequacy of radioactive material management, radiation exposure, and the safety of heat transfer systems that may connect the nuclear plant to the desalination or wastewater treatment facility. These considerations will be evaluated during the NRC's licensing review to assess whether the nuclear plant will operate safely within regulatory limits and measures are in place to monitor and control radiation doses to members of the public.

Heat Used for Industrial Processes (Section 203(c)(1)(A)(iii))

Industrial process heat is the use of thermal energy to produce, treat, or alter manufactured goods (Ref. 12). There are many different and distinct uses of process heat in various industrial applications. As described in a recent DOE report (Ref. 13), this range of possible uses could involve different reactor technologies and coolant (e.g., light water, gas, liquid metal, and molten salt) for different applications.

The NRC staff previously examined and determined that using small modular reactors to generate process heat can be addressed within the NRC's existing regulatory framework (Ref. 14). The NRC is prepared to leverage prior licensing experience and other initiatives, such as interactions with DOE on the NGNP Project, to inform future licensing reviews for industrial

[2] Long Mott Energy, LLC, a wholly owned subsidiary of The Dow Chemical Company (TDCC) via TDCC's subsidiary GWN Holding, LLC, submitted a construction permit application for Project Long Mott on March 31, 2025. At the time of this report, the NRC staff is performing an acceptance review of the application to determine if it is acceptable for docketing.

process heat plants. As evidence that the possible use of process heat from nuclear plants is not a recent development, the Atomic Energy Commission (AEC), the predecessor agency to the NRC, approved an application involving the proposed use of a nuclear power plant for the production of process heat. In particular, the AEC issued a construction permit to Consumers Power Company's Midland Plant in Midland, Michigan to generate both electricity and process heat for sale to a third party, Dow Chemical Company (Ref. 15). Although the Midland experience was decades ago and the NRC would apply more risk-informed and performance-based techniques to future reviews, some insights from that application and the related licensing proceedings remain relevant today due to fundamental similarities in the applicable regulatory framework.

District Heating (Section 203(c)(1)(A)(iv))

Nuclear plants can provide energy for district heating. A National Association of Regulatory Utility Commissioners report (Ref. 10) provides several examples of nuclear plants outside of the United States being used for such applications. The system configurations for district heating applications would be similar to waste heat systems of existing nuclear plants, using open- or closed-cycle circulating water systems.

The NRC's existing regulatory framework also includes provisions for routinely monitoring cooling systems for radioactive effluents. For example, 10 CFR Part 20, "Standards for Protection Against Radiation," contains applicable regulations, and Regulatory Guide (RG) 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste" (Ref. 16), describes acceptable methods that can be adapted for monitoring applications using thermal energy from a nuclear plant for district heating applications to ensure that concentrations of radioactive effluents and doses to members of the public remain below regulatory limits.

Energy Storage (Section 203(c)(1)(A)(v))

Energy storage can involve a variety of technologies that could be supported by nuclear reactors. Some examples include pumped hydroelectric systems, compressed air systems, thermal systems using molten salts, and battery systems.

The NRC is aware of several technologies that reactor designers are considering for various energy storage systems, that may use electricity generated from nuclear plants to operate pumps or compressors for moving water or air or for charging batteries at a variety of possible locations and sizes. The use of thermal systems such as tanks of molten salts that could be heated and subsequently used for generating electricity or for process heat applications could be provided by a nonelectric application of some nuclear power plant technologies. For example, the NRC staff is currently reviewing a construction permit application for Kemmerer Power Station, Unit 1, which includes a form of a thermal storage system and a TerraPower reactor design as part of the ARDP project in Kemmerer, Wyoming (Ref. 17) (Enclosure 1, Table 2). The NRC staff expects to complete its review and issue a decision on this application by Q3 of FY 2026.

Industrial or Medical Isotope Production (Section 203(c)(1)(A)(vi))

Isotopes for industrial or medical applications are produced using a variety of reactors, including research and test reactors, commercial nonpower utilization facilities, and nuclear reactors used

for electricity generation. The regulations in 10 CFR Parts 50 and 52 can address the production of isotopes within power reactors and related safety issues introduced during reactor operation, and the 10 CFR Part 53 proposed rule includes provisions that, if finalized, could also address this topic. In addition, the regulations in 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material," address the needed precautions for handling radioactive isotopes following the removal of capsules from the reactor and their transport to other facilities.

The NRC has experience in licensing for industrial or medical isotope production. For example, the NRC approved a license amendment for the Tennessee Valley Authority at the Watts Bar Nuclear Plant in Spring City, Tennessee to produce tritium in support of the national defense (Ref. 18). Additionally, the potential for production of isotopes for use in cancer treatments is being explored by the holders of operating licenses for commercial nuclear power reactors.

Other Applications, as Identified by the Commission (Section 203(c)(1)(A)(vii))

The NRC is aware of other potential nonelectric applications for nuclear reactors that are being studied and, in some cases, still being developed or being evaluated to determine feasibility. These applications include providing dedicated power to data centers, which could rely on electricity or heat generated by nuclear power plants. Another potential application of some reactor designs is for resource extraction, such as remote mining operations. While the NRC's existing regulatory framework can address the unique licensing considerations related to these other potential nonelectric applications, the reactor design, power level, site, and operational characteristics can affect the complexity of the licensing review. The use of nuclear reactors for remote mining operations and some other nonelectric applications are expected to involve the use of microreactors. The NRC plans to consider this topic in more detail as part of implementing Section 208, "Regulatory Requirements for Micro-reactors," of the ADVANCE Act.

In addition, the NRC is aware that some companies and DOE are exploring nuclear propulsion and industrial heat applications for commercial maritime applications. For example, DOE participates in the Maritime Nuclear Applications Group, which is co-led by DOE's National Reactor Innovation Center (NRIC), and is identifying possible regulatory gaps for using nuclear reactors in commercial maritime applications (Ref. 19). The NRC staff routinely interacts with NRIC, DOE, and other organizations to share information and coordinate activities consistent with the Memorandum of Understanding established pursuant to the Nuclear Energy Innovation Capabilities Act of 2017 (Ref. 20). The NRC staff plans to leverage such interactions, as well as continued monitoring, to determine if and when potential future actions would be appropriate and justifiable for commercial maritime applications.

Colocation of Nuclear Reactors with Industrial Plants or Other Facilities (Section 203(a)(3))

Nuclear reactors can, under appropriate circumstances, be colocated with industrial plants or other facilities. The specific siting proposals, reactor design, interconnections between the nuclear plant and the industrial facility, and hazards posed by the industrial facility can affect the complexity of the licensing review.

The NRC's existing regulatory framework can support efficient reviews of applications related to the colocation of nuclear reactors with industrial plants or other facilities. The NRC staff's review of an application involving the proposed colocation of a nuclear reactor with industrial plants or other facilities begins with determining whether the proposed site meets the siting criteria of a

nuclear plant in 10 CFR Part 100, “Reactor Site Criteria,” and applicable criteria established by other federal, state, and local agencies, such as the U.S. Environmental Protection Agency and state historical preservation offices. The NRC has issued regulatory guidance that can be applied to nonelectric applications to support such determinations[3], including RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations” (Ref. 4); RG 4.2, “Preparation of Environmental Reports for Nuclear Power Stations” (Ref. 21), and other RGs addressing specific natural hazards (e.g., seismic events and flooding) and nearby industrial, military, and transportation facilities. These issues are also addressed within RG 1.253, which endorsed, with clarifications and additions, a methodology prepared under a cost-shared initiative led by nuclear utilities and supported by DOE (Ref. 22).

Many proposals for colocating a nuclear plant and industrial facility involve the two plants being close to each other but having the industrial facility outside of the nuclear plant’s boundaries, which are established for reasons of plant safety and security. However, there may be cases in which the scale or complexity of the nonelectric application would allow it to be incorporated within the site boundary of a nuclear plant. In either case, an applicant or licensee is required to demonstrate that the proposed reactor design and any colocated facility using process or waste heat from the nuclear plant are designed to mitigate interactions and interferences with the nuclear plant’s operation during both routine activities and possible emergencies. The regulations in 10 CFR Parts 50 and 52, as well as the proposed rule for 10 CFR Part 53, include provisions that can support the possible colocation of nuclear reactors with industrial plants or other facilities. The placement of nonelectric applications within the safety- and security-related boundaries of a nuclear plant can affect the complexity of the licensing review and introduce design limitations, programmatic controls, and interface requirements for both the nuclear plant and nonelectric application. However, the NRC’s regulations in 10 CFR Parts 50 and 52 allow for the scale and complexity of a nonelectric application to be considered when deciding if it can be incorporated within the site boundary of a nuclear plant. For example, the hydrogen production facility at the Nine Mile Point Nuclear Station demonstrates how a hydrogen production facility can be incorporated into a nuclear plant site using the existing regulatory framework.

As discussed in previous sections of this report on specific nonelectric applications, an applicant or licensee is required to consider any colocated facility within the analyses of the frequency and consequences of reactor transients and accidents, the monitoring and control of radioactive effluents, the development of procedures and programs (e.g., emergency preparedness), and siting evaluations (e.g., population-related considerations). The NRC’s regulations in 10 CFR Parts 50 and 52 address potential risks from hazardous chemicals and explosive gases from any colocated facility. In addition, international experience can inform the NRC’s licensing reviews and applicants’ development of future applications involving colocation of nuclear plants with industrial or other facilities. For example, a report prepared by the International Atomic Energy Agency provides useful insights related to the design and operation of nuclear plants colocated with industrial facilities, including the consideration of potential external hazards

[3] These RGs, although developed for nuclear power stations used for electrical production provide useful insights, such as the actual physical, environmental, and demographic features of the proposed site and how they relate to the safety analysis, for an applicant or licensee in implementing the site-related requirements of 10 CFR Parts 50 and Part 52, as well as the proposed rule for Part 53. Most of the requirements and guidance focuses on the nuclear reactor and not the end use (i.e., electricity or non-electric applications) and therefore are applicable to providing electricity or process heat to a colocated facility. The NRC maintains a webpage that provides guidance and other information for applicants and licensees on these issues as well as for other entities that are currently in the development process of a nuclear reactor design or reactor-related projects (see https://www.nrc.gov/reactors/new-reactors/advanced/new-app.html). The NRC will continue look for opportunities to clarify the applicability of guidance documents that can be technology-inclusive, including the use of nuclear energy for nonelectric applications.

(Ref. 23). These operational experiences help the agency broaden its understanding of these issues and inform the NRC's licensing review of future applications.

The NRC staff is working with DOE, national laboratories, and other organizations to evaluate potential risks posed by the colocation of nuclear plants and hydrogen production facilities. For example, in June 2024, the NRC issued a report on safety and regulatory considerations for hydrogen production (Ref. 24), which is expected to have a moderate impact on both the NRC and external entities by providing updated insights into technical issues related to nonelectrical applications. The NRC has identified the development of additional guidance for assessing hazards from colocated facilities as a potential future action to provide greater clarity in this area (Enclosure 1, Table 3). This action, if further pursued, will be addressed through the planning, budgeting, and performance management process, subject to resource availability and prioritization. In addition, the NRC has an ongoing action, where the agency has funded research by Sandia National Laboratories and interacts with the Electric Power Research Institute, to develop a probabilistic risk assessment framework to address fire hazards associated with hydrogen generation facilities colocated with nuclear plants (Enclosure 1, Table 2). This ongoing action is expected to be completed by Q3 of FY 2026.

OPTIONS FOR ADDRESSING THOSE ISSUES OR REQUIREMENTS (SECTION 203(c)(1)(B) OF THE ADVANCE ACT)

This section and Enclosure 1 summarize the completed, ongoing, and potential future actions that the NRC has identified for addressing issues and requirements examined in the report.

Within the Existing Regulatory Framework (Section 203(c)(1)(B)(i))

The existing regulatory framework is sufficiently flexible and capable of addressing the issues and requirements examined in this report. For example, Tables 1 and 2 in Enclosure 1 outline three completed and ongoing NRC activities where this framework has been applied in the licensing process for reactors used for nonelectric applications. These activities include the construction permit application review for TerraPower Kemmerer Power Station, Unit 1 (using molten salt storage), and pre-application engagement for a construction permit application for X-energy's Project Long Mott. The NRC plans to measure the effectiveness of the licensing process for reactors used for nonelectric applications as the NRC completes application reviews, and to seek process improvements that would benefit the NRC and external entities. In addition, the NRC has issued regulatory guidance to provide clarity for designers of nuclear reactors that are most likely to be used for nonelectric applications, such as those that require high process heat temperatures (Ref. 22). The existing regulatory framework also allows for the consideration of exemptions, when necessary, and license conditions for specific reactor technologies or applications.

Table 3 in Enclosure 1 includes two future actions that the NRC will explore within the existing regulatory framework, if warranted. These actions will be considered based on NRC regulatory needs, lessons learned from application reviews, and stakeholder interest—and subject to resource availability and prioritization. These potential future actions include guidance to provide additional clarity on flexibility for load following under 10 CFR Parts 50 and 52 and additional clarity for assessing hazards from colocated facilities.

As Part of the Technology-Inclusive Regulatory Framework Required Under the Nuclear Energy Innovation and Modernization Act (NEIMA) (Section 203(c)(1)(B)(ii))

The NRC is currently working to establish the technology-inclusive regulatory framework required by NEIMA ahead of the December 31, 2027, statutory deadline. The proposed rule for 10 CFR Part 53 would provide an alternative approach to the existing regulatory framework for commercial nuclear plants (10 CFR Parts 50 and 52). The proposed rule includes provisions that address the need to consider potential hazards to a nuclear plant colocated with an industrial plant or other facility and the need to protect the public, including workers in the colocated facility, from radiation doses from routine operations and postulated accidents. These provisions are expected to allow more risk-informed, performance-based approaches as compared to 10 CFR Parts 50 and 52. The proposed rule would accommodate factory fabrication (including fueling) of microreactors, which is expected to yield substantial efficiency gains to the licensing and regulation of microreactors that are being considered for colocation with an industrial plant or other facility. In addition, the proposed rule includes provisions that would allow for load following with less reliance on human actions, supporting the ability to ramp power output and switch between electricity generation and nonelectric applications.

The NRC received public comments on how 10 CFR Part 53 could be revised to address the topics in Section 203 of the ADVANCE Act during the public comment period for the 10 CFR Part 53 proposed rule. This input will be addressed in the 10 CFR Part 53 rulemaking process.

Through a New Rulemaking (Section 203(c)(1)(B)(iii))

The NRC has not identified any actions related to the subject of this report requiring new rulemaking. The NRC is already working to establish the regulatory framework required by NEIMA as part of the 10 CFR Part 53 rulemaking, which addresses many of the topics in Section 203 of the ADVANCE Act. The NRC may consider whether further rulemaking related to these topics would be appropriate and justifiable based on lessons learned from 10 CFR Part 53 or ongoing application reviews. For example, the future integration of reactor systems with nonelectrical applications, such as providing process heat to molten salt storage systems and nearby chemical facilities, may benefit from a new rulemaking that incorporates lessons learned from the ongoing application reviews. The NRC staff would propose this approach to the Commission if developing such a regulation appeared both feasible and justifiable.

EXTENT TO WHICH COMMISSION ACTION IS NEEDED TO IMPLEMENT THIS REPORT (SECTION 203(c)(1)(C) OF THE ADVANCE ACT)

The NRC has not identified any Commission action needed to implement and address the issues and requirements examined in this report within the existing regulatory framework. Table 2 in Enclosure 1 includes two ongoing actions where Commission action will be needed: (1) the construction permit application review for Kemmerer Power Station, Unit 1; and (2) the ongoing 10 CFR Part 53 rulemaking. Table 3 in Enclosure 1 identifies potential future NRC actions that could improve clarity and flexibility associated with the use of nuclear energy for

nonelectric applications. The NRC does not anticipate that Commission direction would be needed for the potential future actions identified in Table 3.

COST ESTIMATES, PROPOSED BUDGETS, AND PROPOSED TIMEFRAMES (SECTION 203(c)(2) OF THE ADVANCE ACT)

Table 3 in Enclosure 1 includes two potential future actions for development of additional risk-informed and performance-based regulatory guidance in the licensing of nuclear reactors for nonelectric applications. These actions, if further pursued, will be addressed through the planning, budgeting, and performance management process, subject to resource availability and prioritization.

CONCLUSION

The NRC's existing regulatory framework provides flexibility and enables the use of efficient processes in licensing nonelectric applications of nuclear energy. The effectiveness and agility of the existing regulatory framework to address nonelectric applications of nuclear energy have been demonstrated in recent years, by projects such as the hydrogen production facility at the Nine Mile Point Nuclear Station. The NRC staff solicited input from stakeholders in accordance with Section 203(b) of the ADVANCE Act in the development of this report and related actions. The NRC will continue to engage stakeholders in the future as potential nonelectric applications evolve. The NRC continues to focus on efficiency, timeliness, and predictability in the licensing process consistent with the ADVANCE Act while monitoring the impacts of these actions and seeking innovative ways to enhance the licensing process for nuclear reactors used in nonelectric applications.

ACRONYMS

10 CFR	Title 10 of the *Code of Federal Regulations*
ADAMS	Agencywide Documents Access and Management System
ADVANCE Act	Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024
ARDP	Advanced Reactor Demonstration Program
C	Celsius
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
F	Fahrenheit
FY	Fiscal Year
NEIMA	Nuclear Energy Innovation and Modernization Act
NGNP	Next Generation Nuclear Plant
NRC	U.S. Nuclear Regulatory Commission
NRIC	National Reactor Innovation Center
Q	Quarter
RG	Regulatory Guide
SHINE	SHINE Technologies, LLC
X-energy	X-energy, LLC

REFERENCES

1. Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024, Pub. L. No. 118-67, div. B, § 506, 138 Stat. 1447, __ (2024).
2. "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors," *Federal Register*, Vol. 89, No. 211, October 31, 2024, pp. 86918–87128.
3. NUREG/CR-6944, "Next Generation Nuclear Plant Phenomena Identification and Ranking Tables (PIRTs)," Volume 6, "Process Heat and Hydrogen Co-Generation PIRTs," March 2008 (Agencywide Documents Access and Management System Accession No. ML081140464).
4. Regulatory Guide 4.7, Revision 4, "General Site Suitability Criteria for Nuclear Power Stations," February 2024 (ML23348A082).
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14. SECY-11-0112, “Staff Assessment of Selected Small Modular Reactor Issues Identified in SECY-10-0034,” August 12, 2011 (ML110460434).
15. “Midland Plant Unit 1: Construction Permit No. CPPR-81,” Docket 50-329, December 15, 1972 (ML19326D347).
16. Regulatory Guide 1.21, Revision 3, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste.” (ML21139A224).
17. “Submittal of the Construction Permit Application for the Natrium Reactor Plant, Kemmerer Power Station Unit 1,” March 28, 2024 (ML24088A060).
18. “Amendment 40 to Facility Operating License No. NPF-90 to Irradiate Tritium-Producing Burnable Absorber Rods in the Reactor Core,” Watts Bar Nuclear Plant, Unit 1, September 23, 2002 (ML022540925).
19. National Reactor Innovation Center, “Maritime Nuclear Energy.” Available: https://nric.inl.gov/maritime. [Accessed February 2025].
20. “Memorandum of Understanding Between U.S. Department of Energy and U.S. Nuclear Regulatory Commission on Nuclear Energy Innovation,” October 2019 (ML19263C976).
21. Regulatory Guide 4.2, Revision 3, “Preparation of Environmental Reports for Nuclear Power Stations.” (ML18071A400).
22. Regulatory Guide 1.253, Revision 0, “Guidance for a Technology-Inclusive Content-of-Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors,” (ML23269A222).
23. IAEA-TECDOC-1682, “Advances in Nuclear Power Process Heat Applications,” International Atomic Energy Agency, May 2012.
24. TLR-RES/DE/REB-2024-11, “Safety and Regulatory Considerations for On-Site Hydrogen Production Facilities Co-located with Nuclear Power Plants,” June 2024 (ML24207A174).

ENCLOSURE 1

SUMMARY OF ACTIONS RELATED TO THE ACCELERATING DEPLOYMENT OF VERSATILE, ADVANCED NUCLEAR FOR CLEAN ENERGY ACT OF 2024 (ADVANCE ACT) SECTION 203

Actions described in this Enclosure include completed, ongoing, and potential new actions related to Section 203 of the ADVANCE Act. These tables are not exhaustive, but highlight actions of particular relevance to this report. The NRC will monitor the licensing process efficiencies realized by these actions. The term “external entities” as used in the “Impact” column in the tables refers to the nuclear energy industry; technology developers; the industrial, chemical, and medical sectors; nongovernmental organizations; and other public stakeholders expected to be directly affected by these actions.

Table 1 – Completed NRC Program Actions Related to ADVANCE Act Section 203

Action	Primary ADVANCE Act Section 203 Provision	Impact	Status/ Timeframe
Issue the Next Generation Nuclear Plant Licensing Strategy	203(a)(2)	Moderate impact to the NRC and external entities by documenting foundational concepts on the use of nuclear energy for nonelectric applications.	Completed
Issue NUREG/CR-6944, "Next Generation Nuclear Plant Phenomena Identification and Ranking Tables (PIRTs), Volume 6: Process Heat and Hydrogen Co-Generation PIRTs"	203(a)(2)	Moderate impact to the NRC and external entities by documenting foundational concepts on the use of nuclear energy for nonelectric applications.	Completed
Issue NRC/Idaho National Laboratories report, "Safety and Regulatory Considerations for On-Site Hydrogen Production Facilities Co-located with Nuclear Power Plants"	203(a)(2)	Moderate impact to the NRC and external entities by documenting updates to the evaluation of technical issues related to nonelectrical applications for hydrogen production.	Completed
Issue Regulatory Guide (RG) 1.253, Revision 0, "Guidance for a Technology-Inclusive Content-of-Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors"	203(a)(2)	Substantial impact to the NRC and external entities by providing guidance on the preparation and review of applications for licenses, certifications, and approvals for nuclear reactor designs often proposed for use in nonelectric applications.	Completed

Table 2 – Ongoing NRC Program Actions Related to ADVANCE Act Section 203

Action	Primary ADVANCE Act Section 203 Provision	Commission Action Needed?	Impact	Status/ Timeframe
Publishing final rule on risk-informed, technology-inclusive regulatory framework for advanced reactors (10 CFR Part 53)	203(c)(1)(B)(ii)	Yes	Expected to yield substantial efficiency gains to the NRC and external entities by providing a risk-informed, technology-inclusive licensing pathway, providing flexibility in areas such as plant designs, staffing, and load following. The final rule package will include responses to public comments, including those referenced in Enclosure 2.	Reviewing comments on proposed rule; Q3 FY 2026 for draft final rule to be provided to the Commission
Working with Sandia National Laboratories and the Electric Power Research Institute to develop a probabilistic risk assessment framework for addressing fire hazards associated with hydrogen generation facilities colocated with nuclear plants	203(a)(3)	No	Expected to yield substantial efficiency gains to the NRC and external entities by providing additional tools to address technical issues (e.g., risk assessments) in colocating a nuclear plant with a hydrogen production facility.	Ongoing; Q2 FY 2026
Reviewing construction permit application for Kemmerer Power Station, Unit 1 (using molten salt storage)	203(c)(1)(A)(v)	Yes	Ongoing review of a construction permit application involving energy storage and using the recently issued RG 1.253. As the first-of-a-kind application, this review is expected to provide substantial benefit for future applications and application reviews.	Ongoing; Q3 FY 2026

Action	Primary ADVANCE Act Section 203 Provision	Commission Action Needed?	Impact	Status/ Timeframe
Participating in pre-application engagement on a construction permit application for Project Long Mott. Dow and X-energy submitted a construction permit application for Project Long Mott on March 31, 2025. At the time of this report, the NRC staff is performing an acceptance review for the application to determine if it is acceptable for docketing.	203(c)(1)(A)(i)	No	Pre-application engagement is expected to support an efficient review of a construction permit application with use of process heat for a colocated chemical plant and using the recently issued RG 1.253. As the first-of-a- kind application, this review will provide substantial benefit for future applications and application reviews.	Ongoing; pending acceptance of application for docketing

Note: 10 CFR = Title 10 of the *Code of Federal Regulations*; Q = quarter; FY = fiscal year.

Table 3 – Potential New NRC Program Actions Related to ADVANCE Act Section 203[4]

Action	Primary ADVANCE Act Section 203 Provision	Commission Action Needed?	Impact
Develop guidance to provide additional clarity on flexibility for load following under 10 CFR Parts 50 and 52	203(a)(1)	No	Improvements in design, analysis, and application criteria for load following operations to provide greater flexibility for applicants and licensees under 10 CFR Parts 50 and 52 are expected to yield moderate efficiency gains for the NRC and external entities.
Develop additional guidance for assessing hazards from colocated facilities	203(a)(3)	No	Improvements in application quality, established review criteria, and consistency of review are expected to yield moderate efficiency gains to the NRC and external entities.

[4] These potential future actions, if further pursued, will be addressed through the planning, budgeting, and performance management process, subject to resource availability and prioritization.

ENCLOSURE 2

STAKEHOLDER ENGAGEMENT

Public Meeting

In the preparation of this report, the U.S. Nuclear Regulatory Commission (NRC) solicited input from a broad range of external stakeholders, consistent with the requirements in Section 203(b) of the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act). Specifically, the NRC sought input from the U.S. Department of Energy (DOE); the nuclear energy industry; technology developers; the industrial, chemical, and medical sectors; nongovernmental organizations; and other public stakeholders.

The NRC received input from external stakeholders during a public meeting on December 12, 2024, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML24365A121). The meeting included a presentation by the National Technical Director of DOE's Integrated Energy Systems Program (ADAMS Accession No. ML24347A247). This DOE program maximizes the use of nuclear energy by developing technologies to support chemical, thermal, and electrical energy pathways that deliver nuclear energy to the industrial, transportation, and commercial sectors. The NRC considered the verbal and written feedback received during and after the meeting when preparing this report.

Correspondence

The NRC received written input related to Section 203 of the ADVANCE Act from the following individual:

Incoming Correspondence	ADAMS Accession No.
January 17, 2025, email from M. Keller, Hybrid Power Technologies LLC	ML25045A071

The NRC received public comments on how 10 CFR Part 53 could be revised to address the topics in Section 203 of the ADVANCE Act during the public comment period for the 10 CFR Part 53 proposed rule. This input will be addressed in the 10 CFR Part 53 rulemaking process.