Accelerating Modern Nuclear Fission Deployment through Data Access

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Abstract

Small Modular Reactors (SMRs) are a proven technology with decades of operational success in the U.S. Navy, yet their deployment in the U.S. power grid is stalled by financial uncertainty. Current insurance frameworks designed for large-scale reactors do not account for the modular nature of SMRs, creating prohibitive costs for private developers and preventing reinsurers from accurately pricing risk. To bridge this gap, this paper proposes a publicly accessible SMR data registry that leverages existing infrastructure and data streams to minimize cost. This framework incorporates safety data mandated under 10 CFR Parts 50 and 52 as well as the risk-informed, performance-based data required by Parts 53 and 57 into a digital dashboard accessible to manufacturers and insurers. Opening these data streams to private ventures avoids new digital infrastructure costs while providing the transparency needed to lower insurance premiums and meet unprecedented energy demands.

Overview

The global transition to a decarbonized, reliable baseload energy future is being slowed by the delayed deployment of Small Modular Reactors (SMRs). While the engineering has been proven through decades of success in the U.S. Navy, the transition to private construction has revealed a fundamental mismatch between reactor design and insurance structures (Nuclear Harmonization and Standardization Initiative [NHSI], 2024). Current insurance and reinsurance frameworks were designed for 20th-century large-scale fission reactors and do not account for the modular, factory-fabricated nature of SMRs (International Atomic Energy Agency [IAEA], 2018). As a result, private developers face prohibitive financial risks due to a scarcity of data (Hidayat, 2026). This paper evaluates how an SMR digital twin registry can utilize existing DOE electronic systems and NRC technical repositories that are currently consolidated by the DOE's Nuclear Reactor Innovation Center (NRIC) to provide the repeatable safety data required by private markets. By reconfiguring existing maintenance and quality assurance records into a digital dashboard, the U.S. can transition from static regulatory reporting to dynamic risk assessment. This approach leverages the legal authorities of the 2019 memorandum of understanding between the DOE and NRC to harmonize data streams across 10 CFR Parts 50, 52, 53, and 57 (DOE & NRC, 2019). The deployment of SMRs is currently stalled by a lack of visibility into standardized risk data, and the DOE NRIC should modify data streams to establish a semi-public SMR data registry to provide the transparency required for private insurance and rapid commercial deployment.

Problem

The global transition to a decarbonized, reliable baseload energy future is being slowed by the delayed deployment of SMRs. Proposals for new SMR projects are moving forward slowly because public and private ventures are unwilling to take on the distinct financial risks tied to deployment (IAEA, 2018). While the engineering has been proven through decades of success in the U.S. Navy, the transition to private construction has revealed a fundamental mismatch between reactor design and insurance structures (NHSI, 2024).

Insurers typically price risk based on decades of historical data, yet there are currently zero commercial SMRs operating in the United States. This creates a premium gap where the insurance premium is written based on excess caution. Because reinsurers cannot look back at a track record of commercial SMR performance, they default to the highest possible risk ratings. This financial hurdle means that the lack of data introduces additional costs for the first unit of any new fleet of SMRs (NEI, 2024).

Current insurance frameworks were designed for large-scale reactors where risk was calculated based on site-specific civil engineering projects (IAEA, 2018). This legacy model creates a liability trap because it treats the nuclear reactor and the construction site as a single risk. Under the Price-Anderson Act, the process for qualifying for protections remains tethered to slow NRC licensing (Allen et al., 2025). This site-centric approach does not account for the modular nature of SMRs.

The underlying causes of deployment stagnation include the absence of harmonized liability requirements and limited standardized risk data (NHSI, 2024). This lack of clarity prevents reinsurers from pricing risk accurately (IAEA, 2018). While previous arguments focused on production efficiency, these are secondary to the immediate problem of financial de-risking. An SMR fleet cannot be built if the first unit is uninsurable (NEI, 2024). Establishing a publicly SMR data registry is essential to providing the repeatable safety data required to lower insurance premiums and enable commercial scaling.

Empirical Analysis

I. U.S. Navy Nuclear Fleet

The transition of nuclear technology to a private sector solution has been hindered by a failure to adapt insurance models to a modular scale. Contrary to the perception of SMRs as an unproven technology, the U.S. Navy's Nuclear Propulsion Program has safely operated over 100 small-scale reactors for more than 70 years, amassing over 7,600 reactor years of safe operation (NNPP, 2025). This safety record indicates that technical risks are well understood and that the primary barrier is the commercial insurability of new reactors. The Navy uses identical methods for construction, inspection, and operation across its fleet to ensure every reactor is built to the same specifications, providing the repeatable data sets that private insurers require to move beyond third generation reactor risk pricing (NNPP, 2025).

II. Legacy Fission (3rd Generation Reactors)

The construction of Vogtle Units 3 and 4 provide a clear example of the financial burden inherent in large-scale reactors (Durand et al., 2024). Originally estimated at $14 billion, total costs exceeded $35 billion by 2024 (Schlissel, 2022). This failure was partially driven by a technical flaw. The AP1000 reactors were too large for transport, forcing on-site construction rather than on-site installation (Schlissel, 2022). The risk-informed manufacturing pathways of Part 53 enable the shift toward factory-made SMRs by separating hardware certification from site-specific licensing used by Vogtle. Utilizing a publicly accessible data registry on top of existing digital infrastructure further optimizes this process, providing the real-time transparency manufacturers need to secure private insurance and accelerate commercial deployment.

III. SMR Growth

Reusing a proven technical design is the most effective way to lower SMR risk. A collaboration between regulators in the United States, Canada, and the United Kingdom allowed Ontario Power Generation to proceed with construction using the GE-Hitachi BWRX-300 standardized design. Because the design was pre-vetted for both Canadian and U.S. safety standards, the project avoided redundant engineering reviews (Lynch, 2026). This shows that treating a reactor as a pre-certified product drops the cost associated with repeated per-site reactor applications (NHSI, 2024). Virginia is one of several states at the forefront of the shift to SMRs, with a $500 million joint venture between Dominion Energy and Amazon to explore a 300 MW SMR project (Collins, 2025). Shifting the burden to design-level verification moves SMRs from speculative projects to predictable infrastructure assets, a process that will be strengthened by increased transparency of existing nuclear data streams.

Implementation Considerations

Two major considerations for implementing a public-facing dashboard for small modular reactor safety data are intellectual property and national security.

Intellectual property represents a primary concern for manufacturers who rely on proprietary engineering data to maintain a competitive advantage. Providing access to data that reveals proprietary design characteristics may allow competitors to exploit intellectual property. To mitigate this risk, commercially sensitive information should be redacted while reliability and safety data is made available to manufacturers and insurers. This approach of selectively available information is in alignment with the NRIC’s current practices of providing reactor siting data for advanced reactor companies to plan for ideal deployment locations, where the information provided levels the playing field and encourages competition.

National security is an even more critical consideration, as the centralization of operational data creates a high-value target for state actors or industrial espionage. Data currently passed on to the NRIC is related to reactor design performance. The DOE, NRC, and U.S. national security agencies should continue to ensure that only data that is beneficial to the health and safety of citizens is accessible to innovation teams like the NRIC, manufacturers, and insurers. Lowering risk of data held behind a public access point will allow lower friction for users requesting access, therefore increasing the use of the information made available.

Metrics of Success

The following metrics would assess the success of data accessibility for the national reactor innovation center:

1) Reduction in average insurance premium costs for small modular reactor projects over a five year period. Accurate prices for insurance would depend on reliability data that companies use to judge risk. Better data from a registry would help lower the high costs of insuring new nuclear projects as insurers become convinced of the design of fourth generation nuclear reactors.

2) An increase in the number of new reactor applications per fiscal year, which would indicate lower barriers to investment by private small modular reactor developers. More applications would show that problems like high startup costs and confusing rules are being fixed. This growth would show developers are getting more support from private investors and large tech companies.

3) A sharp increase in component-related reports followed by a decrease. An early jump in reports would show that matching technical rules is helping builders share information. A drop would suggest that building methods have improved after several years of progress, leading to fewer parts breaking and an established supply chain.

4) An increase in the testing and design data received by the NRIC from the DOE and NRC. Success would depend on different government groups easily sharing expertise and computer models. More data moving between groups would prove that more research, development, and testing is occurring from the SMR developers submitting data.

Recommendation

Based on recent strategic shifts and federal policy developments, the DOE's NRIC should focus on three factors when expanding SMR data access to address the financial and technical barriers currently facing the nuclear private sector.

The NRIC should allow public and private organizations to apply for access to applicable SMR databases. Making safety and reliability data accessible to insurers and manufacturers is critical for commercial scaling. By providing transparent records of reactor hours in laboratory settings and across multiple deployed locations, reinsurers can more accurately price risk for SMRs. This transparency addresses the financial and temporal benefits of SMRs, which rely on lower capital investments and shorter build times compared to traditional gigawatt-scale plants.

While the goal is to increase the ease with which interested parties access data, the NRIC must maintain its role in ensuring that released information does not compromise national security or proprietary interests. The NRIC should deepen its collaboration with the DOE, the NRC, and U.S. national security offices to refine these protections. This coordination is essential for de-risking technology for private backers who require accurate safety data without exposing intellectual property.

Rather than creating redundant data pathways, the NRIC should utilize the framework established by the 2019 Memorandum of Understanding between the DOE and NRC. This memo was specifically designed to coordinate technical readiness and the sharing of expertise regarding advanced nuclear reactor technologies. By leveraging existing facilities and software codes already used to model physical reactor behavior, the NRIC can streamline the testing and demonstration of reactor concepts funded by the private sector.

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