U.S. DEPARTMENT OF ENERGY (DOE)
NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA)
DEFENSE NUCLEAR NONPROLIFERATION (DNN)

DNN Sentinel

DENY, DETECT, DEFEAT.

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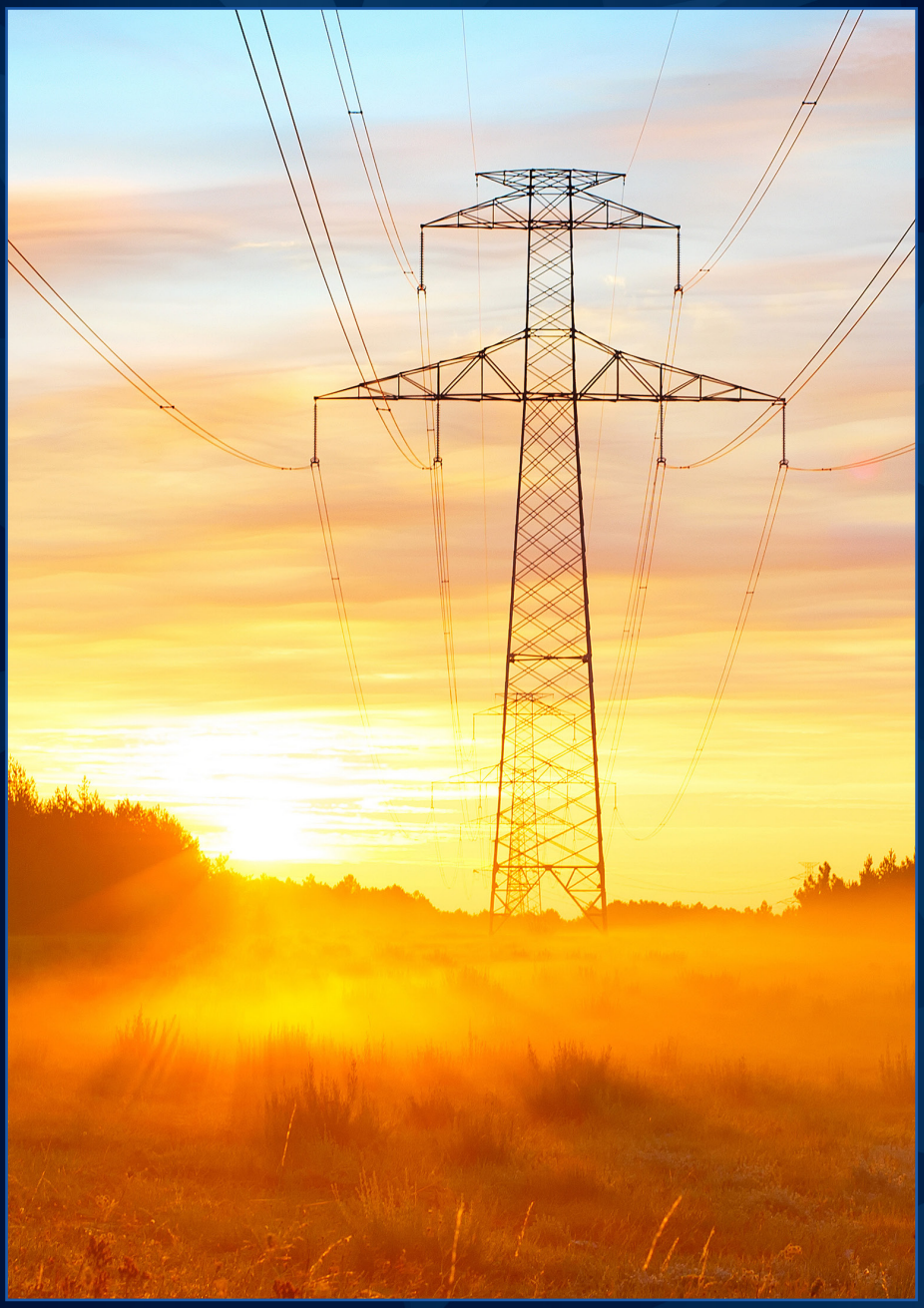

How DNN Supports Energy Dominance and American Prosperity

DNN SENTINEL:
DENY, DETECT, DEFEAT

VOL. XII, NO. 1

https://www.energy.gov/nnsa/missions/nonproliferation

From the Deputy Administrator

The mission of the Office of Defense Nuclear Nonproliferation is to deny, detect, and defeat nuclear and radiological threats and keep America strong, safe, and prosperous. As Deputy Administrator, I am committed to keeping Congress, the interagency, and the public informed about our vital work.

The DNN Sentinel provides a valuable deep-dive into how we execute our mission, with each issue dedicated to a different theme. The Summer 2026 edition is focused on how DNN advances energy dominance and implements President Trump's May 2025 nuclear energy executive orders.

In addition to executing our primary mission of nuclear nonproliferation, DNN uses our tools, technology, and expertise to accelerate the American commercial nuclear industry. We downblend highly enriched uranium (HEU) that is excess to defense needs to high-assay low-enriched uranium (HALEU) for use by industry; help U.S. companies integrate safeguards, security, and proliferation resistance into the design of nuclear facilities; and play a key role in negotiating agreements for nuclear cooperation that enable U.S. exports. In turn, a strong and healthy U.S. commercial nuclear industry enhances national security and is a force multiplier for NNSA's work on nuclear nonproliferation globally.

This issue of the DNN Sentinel provides a valuable overview of these programs, including partnerships with U.S. nuclear industry on safeguards, security, and proliferation resistance-by-design; domestic radiological security; HALEU supply; and export controls.

As Deputy Administrator, I have had the privilege of seeing this work firsthand. I've visited foreign partners that are partnering with DNN to deploy U.S. nuclear technology based on the highest standards of safeguards and security; toured the one-of-a-kind facilities where we downblend HEU to produce HALEU for the U.S. nuclear industry; and helped advance agreements for peaceful nuclear cooperation that open new markets to U.S. industry.

I am proud of the work this team does to shield the homeland from nuclear and radiological threats while helping to unleash American energy dominance, and I am pleased to share this work with you through this issue of the DNN Sentinel.

Matthew C. Napoli

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DNN Partners with the U.S. Nuclear Industry to Advance Energy Dominance and National Security

By Ruth Smith, Bego Aranguren, Logan Scott, Sean Toole

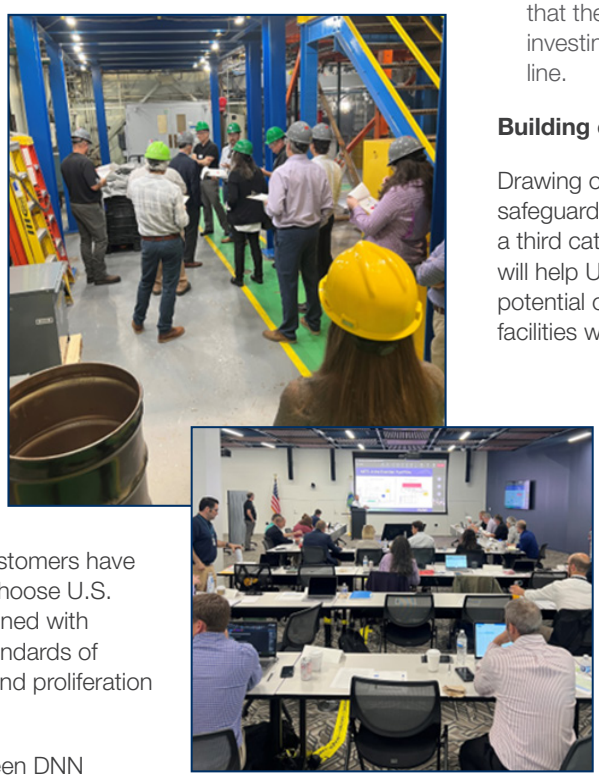
A Win-Win for American Prosperity and National Security

The National Nuclear Security Administration's Office of Defense Nuclear Nonproliferation (DNN) is partnering with U.S. companies to make advanced and small modular reactors (A/SMRs) and associated nuclear fuel cycle facilities more secure, easier to safeguard, and more resistant to nuclear proliferation. This work directly advances President Trump's nuclear energy executive orders, especially Executive Order 14299 – Deploying Advanced Nuclear Reactor Technologies for National Security and Executive Order 14302 - Reinvigorating the Nuclear Industrial Base. U.S. companies can contact DNN to request assistance via DNN's Nuclear Nexus website.

DNN is uniquely positioned to prepare U.S. companies for the international market through its deep understanding of international nuclear security, safeguards, and nonproliferation requirements, as well as its longstanding partnerships with nuclear partners around the world. Collaborating with DNN early can save time and money for American nuclear developers by reducing the likelihood that costly and time-consuming retrofits will be needed to meet safeguards and security requirements when reactors are exported to international markets. For example, drilling a hole in a wall of a nuclear facility to accommodate an IAEA camera could cost over $100,000; it pays to address safeguards and security early in the design process.

DNN's work also gives U.S. industry an edge over foreign competitors on the export market. For countries launching new civil nuclear programs, establishing safeguards and security infrastructure can be a significant challenge. International customers have a strong incentive to choose U.S. reactors that are designed with the world's highest standards of safeguards, security, and proliferation resistance.

The partnership between DNN and the U.S. nuclear industry also makes America stronger and safer. Improved facility designs reduce the risk that terrorists or hostile nations could steal or divert nuclear material from a U.S.-developed reactor for use in a weapon, regardless of where that facility might be located.



DNN Safeguards and Security by Design Workshop at Argonne National Laboratory in September 2025.

Delivering Results for U.S. Industry

To date, DNN has helped ten U.S. companies integrate robust security and safeguards into the designs of advanced nuclear reactor concepts and associated fuel cycle facilities. These engagements yield significant benefits, as illustrated in the following examples:

- DNN helped a U.S. partner company develop a more cost-effective security system for their planned facility that reduces the required number of full-time security staff without compromising security principles, saving millions of dollars over the lifetime of the facility.
- DNN provided analysis to a U.S. partner company on security vulnerabilities of their design that resulted in the partner moving the location of non-core systems outside the secure space that saved millions in facility design and security retrofits.
- Multiple partners have hired dedicated safeguards and security teams at their own companies to help with facility design following their engagements with DNN, which demonstrates that the engagements are helping companies understand that investing early in these areas yields significant returns down the line.

Building on Success

Drawing on the success of its work with U.S. industry on nuclear safeguards and security, DNN is expanding its offerings to include a third category: proliferation resistance. Under this initiative, DNN will help U.S. companies minimize the production and diversion potential of weapons-usable nuclear material in advanced nuclear facilities while maintaining or even improving reactor performance.

For example, DNN could partner with A/SMR developers to help them optimize the design of the nuclear reactor's core in order to minimize the amount of plutonium that is generated during reactor operations. This reduces the complexity of spent nuclear fuel management while also reducing proliferation risks.

As the American nuclear renaissance gets underway, DNN is expanding its critical work to make A/SMRs and associated fuel cycle facilities more secure, easier to safeguard, and more resistant to nuclear proliferation. This work saves time and money for American nuclear developers, makes American designs more competitive on the global market, and makes America stronger and safer.

In Partnership with Japan, DNN Completes Largest-Ever HALEU Shipment to Power American Nuclear Industry

By Alexa R. Erickson

Fuel will Advance U.S. Nuclear Innovation and American Energy Dominance

A Historic Shipment

In a significant stride for global nuclear security and advanced energy development, DNN's Office of Material Management and Minimization (M3), in partnership with Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Japan Atomic Energy Agency (JAEA), successfully transferred 1.7 metric tons of HALEU from Japan's Fast Critical Assembly to the United States in late March 2026. This undertaking marks the largest single international shipment of uranium in M3's history and represents a pivotal advancement in fortifying America's nuclear energy future.

The material was transported on a Nuclear Transport Solutions vessel specially made and dedicated for nuclear material transport.

Operators from JAEA package the HALEU coupons at the Fast Critical Assembly.

The receipt of the material, comprised of over 18,000 individual Teflon-coated "coupons" packaged in 75 casks, fulfills a Statement of Intent signed in November 2023. A UK-flagged maritime vessel owned by Nuclear Transport Solutions transported the HALEU from Japan to the United States with security provided by the UK's Civil Nuclear Constabulary. Upon arrival, the unirradiated HALEU was trucked to the Y-12 National Security Complex (Y-12), where it will be processed and made available to DOE's Office of Nuclear Energy. The shipment also contained irradiated low-enriched uranium from JAEA's Japan Materials Testing Reactor and Japan Research Reactor 3, which was transported to the Savannah River Site for disposition

The Critical Role of HALEU

HALEU is an indispensable component for cutting-edge nuclear fuels. Its application spans from advanced reactor designs to fueling research reactors and producing medical isotopes. Crucially, HALEU contributes to nuclear security and nonproliferation objectives by mitigating global dependence on weapons-grade highly enriched uranium and plutonium.

Many advanced nuclear reactor designers intend to use HALEU fuel to achieve smaller designs, longer operating cycles, and increased efficiencies over current technologies. The transferred HALEU material—once processed by Y-12—will be instrumental to the DOE Office of Nuclear Energy's HALEU Availability Program. This program aims to bridge the gap between supply and demand, enabling the continued rapid progress of advanced reactor demonstrations and laying a robust foundation for the next century of U.S. nuclear leadership.

The transferred HALEU, which became available following the shutdown of Japan's Fast Critical Assembly, directly supports the U.S. strategy to cultivate a robust domestic nuclear fuel supply chain and advances President Trump's May 2025 Executive Order on Deploying Advanced Nuclear Reactor Technologies for National Security.

Strengthening International Partnerships

This recent transfer is a testament to the enduring legacy of nuclear security and nonproliferation cooperation between the United States and Japan. For over three decades, NNSA, MEXT, JAEA, and Japanese universities have collaborated to convert research reactors from HEU to HALEU fuel and return inventories of uranium and plutonium no longer needed by Japan after fulfilling its research purposes.

Securing the Nuclear Renaissance: Protecting Radioactive Material on America's Highways

By Shea Cotton, Danae Gonzales, and Samuel Meyer

As the United States embarks on an ambitious nuclear renaissance, a critical challenge looms: how to securely and wisely manage an increased number of nuclear and radioactive material shipments across thousands of miles of American highways. From nuclear fuel for power reactors, to radioactive sources used for medical and industrial applications, the need is wide and varied. A single security incident anywhere in the nation could significantly impede this national priority. Transportation security is therefore more than a regulatory requirement—it is fundamental to American energy dominance.

The U.S. trucking industry makes thousands of radioactive material shipments across the country each year and faces an evolving security landscape that increasingly challenges its ability to protect this material. The Department of Homeland Security estimates that cargo theft accounts for up to $35 billion in losses annually, and thefts involving deceptive tactics such as cyberattacks and GPS spoofing have surged in recent years.[1] These thefts highlight the increased vulnerability of radioactive material in transit and could serve as a potential blueprint for malicious actors.

The Transport Security Tracking and Reporting (T-STAR) system is a DNN-developed technology that helps keep radiological material secure while in transit.

In response, the Office of Radiological Security (ORS) part of the Office of Global Material Security (GMS) is developing security technologies and conducting training and outreach to empower American industry. These initiatives aim to enhance the American trucking industry's ability to securely transport radioactive material. The expertise and best practices gained are broadly applicable, as the same carriers often transport nuclear materials and other critical equipment, thus benefiting the entire nuclear sector.

Last year, an ORS-sponsored event at Oak Ridge National Laboratory (ORNL) brought together executives from every major U.S. commercial carrier of radioactive material. Participants engaged in exercises and demonstrations of ORS-developed transportation security technologies. By sharing national laboratory expertise, ORS aims to strengthen the security of America's transportation infrastructure. Randy Dillon of the Georgia-based Bennett Family of Companies, the leading shipper of nuclear and radioactive materials in the United States, noted that "These have been two of the best, most informative days I have spent in my nearly 40 years in transportation." A follow-on event was held in May 2026 at ORNL to build on this success, including high-ranking representatives from across the U.S. radioactive source supply chain.

> ***"These have been two of the best, most informative days I have spent in my nearly 40 years in transportation."***
>
> Randy Dillon, Bennett Family of Companies, the leading shipper of nuclear and radioactive materials in the United States

Preventing terrorists from acquiring radioactive materials in transit, a point when they are particularly vulnerable, is a shared priority for both ORS and the transportation sector. Recognizing this, ORS cultivates relationships with key members of both the nuclear and transportation industries to protect the U.S. energy sector from radiological theft. Previously, no dedicated forum existed for industry to collaborate on these critical security challenges. To bridge this gap, ORNL established the Transportation Security Unified Stakeholders Group, which convenes voluntary partners from industry (including trucking and source suppliers), state and federal agencies, and other professional associations to enhance the security and safety of radioactive shipments.

Uniting diverse stakeholders, the stakeholders group fosters a collaborative partnership that tackles critical transport security challenges, mitigates threats, and shares expertise. It empowers industry to develop best practices for the secure transportation of radioactive materials.

By collaborating with industry and providing technical resources, technologies, and operational tools, ORS enhances public safety and national security. This enables the U.S. nuclear sector to unleash energy dominance.

[1] *American Transportation Research Institute. "The Fight Against Cargo Theft: Insights from the Trucking Industry." October 2025. Accessed at* https://truckingresearch.org/2025/10/the-fight-against-cargo-theft-insights-from-the-trucking-industry/

Keeping America Safe: How Export Controls Protect American Innovation

By Kaley Walker

DNN's Office of Nonproliferation and Arms Control (NPAC) is safeguarding and protecting American innovation and competitiveness in the realm of emerging technologies.

Leveraging its unique partnership with DOE labs, plants, and sites, NPAC accesses insights from leading subject matter experts and works at the cutting edge of critical and emerging technologies. It plays a crucial role in inter-agency initiatives to develop robust export controls and maintain American technological dominance. NPAC can share nuanced, thorough, and contextualized analyses of technologies with partners at the Department of Commerce, Department of War, and Department of State to inform their review of export license applications.

NPAC's partnership with the National Laboratories enables it to fulfil DOE's statutory mission to review dual-use licenses for weapons of mass destruction (WMD) proliferation concerns as designated by the Export Control Reform Act of 2018 and the Nuclear Nonproliferation Act. While this partnership has traditionally focused on identifying concerns related to nuclear, chemical, and biological weapons and their delivery systems, NPAC and the National Laboratories are expanding focus on protecting technologies crucial to national security, such as microelectronics.

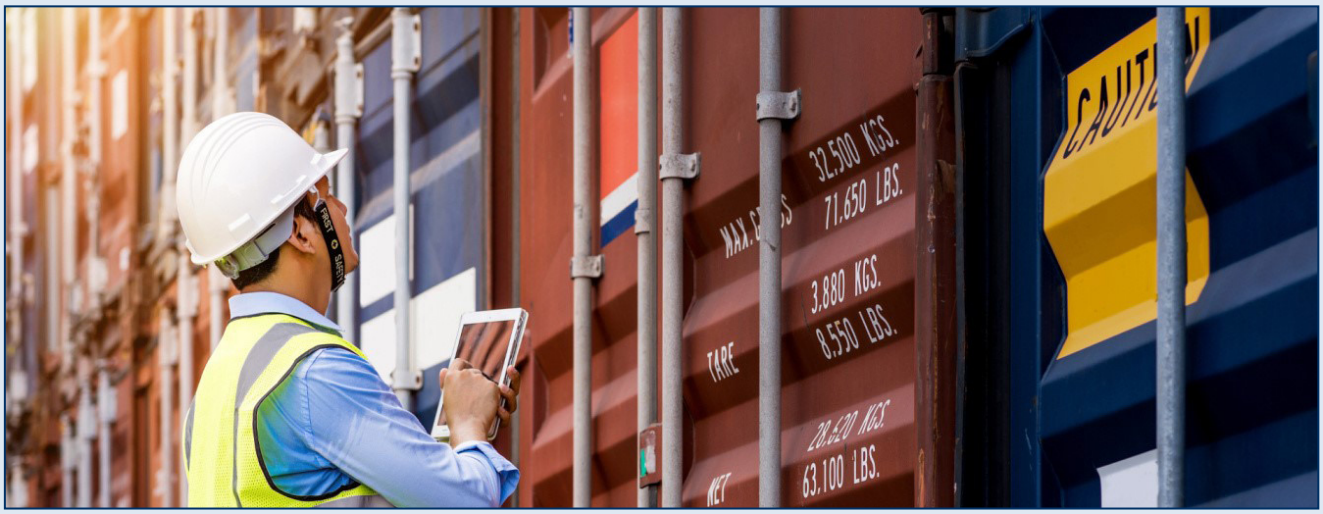
The advantage that makes American commodities the leading edge of modern innovation also makes them prime targets for adversaries. Export control regulations are designed to enable the legitimate flow of trade while ensuring items that could support WMD procurement are denied to bad actors. By licensing these dual-use items and working to align strategic trade policies with our allies, commodities that are subject to export controls may safely and expeditiously cross borders.

NPAC is focused on protecting the technological advantages of the United States. The Administration's America First Trade Trade First Policy views export controls as a key tool for leveling the playing field for U.S. businesses and protect our national expertise in emerging technologies from being exploited by our foes.

First, NPAC is spearheading a novel microelectronics analysis capability to establish the Microelectronics Export Controls Lab (MEC Lab). MEC helps the U.S. government stay ahead of state-of-the-art advances in semiconductors. The National Laboratories will proactively identify microelectronics and related technologies that are crucial for national security and share findings with counterparts in the export licensing system so that it may consider new and updated controls.

Second, NPAC is setting up a program to help write rules that keep critical U.S. technologies like quantum comput-ing, hypersonic systems, and advanced manufacturing and materials out of foreign hands. NPAC will employ a multi-lab approach designed to leverage expertise across multiple technologies. The National Lab complex is uniquely capable of modeling, prototyping, and predicting how proliferators may use these technologies.

With insights from microelectronics and advanced technol-ogy analysis, NPAC and its partners at the DOE National Laboratories will protect national security and promote American technological dominance.



Export controls are critical tools for NNSA's nonproliferation mission.

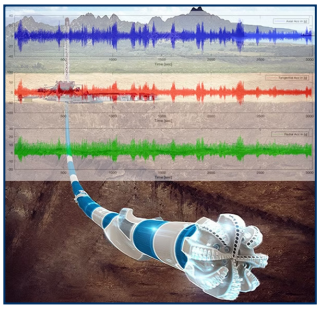
Innovation in Oil and Gas Exploration: How NNSA Research is Leading the Way to Safer, More Secure Energy

By Evan Thompson, Hank Zhu, and Kurt Housh

Fossil fuels are a critical pillar of the U.S economy, supporting millions of jobs and contributing to national energy security. This industry has historically required the use of high-activity radioactive sources to discover new reserves, and the use of those radioactive materials has generated safety and security concerns. DNN has taken on this security challenge to reduce radioactive risks and to enable continued American energy dominance.

The 2021 National Academies of Sciences (NAS) report, *Radioactive Sources: Applications and Alternative Technologies*, recommended prioritizing funding for research and development of alternatives to radioactive sources where no viable non-radioisotopic technologies currently exist, such as well logging. Well logging is the process of creating a detailed record of the geologic formations encountered in a borehole, typically for oil and gas exploration. It helps identify the physical properties of subsurface formations and locate valuable resources like fossil fuels and minerals. Traditionally, this process has relied on americium-beryllium (AmBe) neutron sources, with over 1,700 AmBe devices currently in use in the United States. The NAS report noted the lack of viable alternatives.

To address this gap, the DNN Research and Development (R&D) Office and DNN Global Material Security Office have invested in innovative technologies that aim to eliminate the need for radioactive materials in well logging, thereby creating a safer and more efficient method for subsurface characterization. Two such technologies—developed by Starfire Industries and Teverra LLC—represent promising alternatives to AmBe-based tools, offering equal or superior data quality while significantly reducing risks.



Teverra's Drilling Dynamics Geomechanics technology. Image credit: Teverra

Starfire Industries, with support from the DNN Small Business Innovation Research (SBIR) program, developed the QL40-nGen-CNL Compensated Neutron Logger. This tool uses a compact deuterium-deuterium (D-D) neutron generator instead of radioactive sources. In fiscal year 2025, follow-on funding from GMS helped Starfire reach a commercialization milestone in partnership with Mount Sopris Instruments based in Denver, Colorado.

D-D neutron sources offer a safer alternative due to the absence of radioactive materials, reducing both risk and liability. Although D-D neutrons differ in energy from traditional AmBe sources, simulations have shown that they can provide improved sensitivity to porosity changes. Starfire's patented design enabled optimization of neutron detectors, resulting in a tool with strong porosity response despite the lower neutron flux of D-D sources, essentially doing "more with less."

The D-D Compensated Neutron Log tool has been deployed in wells maintained by the U.S. Geological Survey and other clients. Results have been benchmarked against AmBe-based porosity data, demonstrating comparable performance with higher resolution due to the increased sensitivity of D-D neutrons. With continued support from NNSA, this tool offers independent well loggers a viable, non-radioactive alternative to AmBe. Future applications in gamma-spectral and pulsed neutron logging such as in uranium mining are also under exploration.

Teverra LLC is pioneering a different but equally transformative approach to well logging. Their technology replaces radioactive sources with a system that analyzes drill-bit vibration data using advanced signal processing and physics-informed machine learning. This method estimates key formation properties such as density, porosity, and clay content without the need for radioactive materials.

Also funded by DNN R&D though the SBIR program, Teverra's system leverages data already collected during drilling operations. It delivers high-resolution property profiles across a variety of wellbores, enabling superior reservoir characterization while eliminating risks. Field trials have demonstrated over 90% prediction accuracy, validated against conventional logging tools.

Teverra is currently transitioning its software from prototype to commercial product, with plans for real-time deployment. The project transitioned from R&D to GMS in fiscal year 2026 to complete commercialization efforts. "Our technology shows that we can achieve or exceed the performance of traditional well logging while removing radioactive hazards entirely," said Dr. Hamed Soroush, CEO of Teverra and principal investigator of the SBIR project. "It's a safer, smarter, and more sustainable path for the industry."

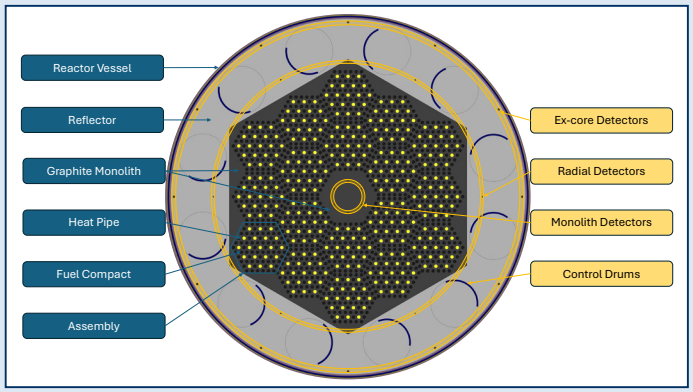
Together, the innovations from Starfire and Teverra represent a major step forward in the evolution of well logging. By eliminating the need for radioactive sources, these technologies not only enhance safety and reduce regulatory burdens but also improve data quality and operational efficiency. Their complementary approaches, one based on advanced neutron generation, and the other based on machine learning and vibration analysis are reshaping subsurface exploration and contributing to a more secure and profitable energy future for the United States.

Digital Twins Strengthen Safeguards and Security for Advanced Reactor Designs

By Julie Gostic, Luis Ocampo Giraldo and Michelle Goff

Digital twins of nuclear reactors—virtual replicas that combine near real-time data, machine learning, and simulation—are emerging as a powerful tool for evaluating nuclear safeguards, security, and reactor design.

Idaho National Laboratory (INL) is leading a project to fully integrate a digital twin framework with an advanced reactor design from an American company slated for deployment at the laboratory. The project is supported by DNN's Research and Development Office (DNN R&D).



Digital rendering of a generic heat-pipe microreactor for assessing diversion pathway analysis.

The project's goal is to develop digital twins to enhance monitoring capabilities and strengthen nuclear safeguards techniques. In 2023, INL developed the first digital twin of a nuclear reactor in collaboration with Idaho State University using the Aerojet-General Nucleonics 201 reactor. Since then, with support from DNN R&D, the team has been scaling the technology to progressively larger systems, including the Neutron Radiography Reactor at INL and a microreactor prototype.

One of the digital twin's primary functions is to support nuclear nonproliferation by identifying "proliferation pathways," or ways in which nuclear material could be removed for illicit purposes. The system uses machine learning to detect anomalies that may signal such activities. Additionally, these digital twins could allow operators to remotely monitor reactor safety, reducing operational costs and minimizing the potential for human error across the U.S. nuclear fleet.

The digital twin framework is meant to be integrated into the reactor design process from the beginning, rather than after construction. "This approach allows for the early identification of monitoring needs and the strategic placement of sensors and detectors," said Ryan Stewart, an INL researcher and principal investigator of the project. "It avoids costly retrofitting and ensures that safeguards are embedded in the reactor's architecture, supporting both domestic and international regulatory compliance."

The digital twin framework lays the groundwork for remote and potentially autonomous reactor operations, which will be especially valuable for microreactors in remote or distributed grids. By centralizing data and enabling remote diagnostics, the system reduces the need for on-site personnel and enhances safety. These capabilities could eventually support fleets of reactors managed from centralized control centers.

The digital twin capability can be adapted to evolving reactor technologies and monitoring needs—laying the groundwork for future autonomous operations across the U.S. nuclear fleet. INL Researchers are scaling the framework from a 5-watt research reactor to a 5-megawatt prototype, with plans towards even larger systems and supporting other reactor designs.

This effort will establish the foundation for future digital twin frameworks that can be leveraged to monitor reactors, analyze designs and evaluate operational processes. Ultimately, this work supports the continued development of advanced reactor technologies and reinforces U.S. leadership in nuclear energy innovation, promoting American energy dominance.