U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Prevent, Counter, and Respond—NNSA's Plan to Reduce Global Nuclear Threats

FY 2023-FY 2027

Report to Congress
August 2023

National Nuclear Security Administration
United States Department of Energy
Washington, DC 20585

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Message from the Administrator

The Department of Energy's National Nuclear Security Administration (DOE/NNSA) is pleased to submit *Prevent, Counter, and Respond—A Strategic Plan to Reduce Global Nuclear Threats (FY 2023–FY 2027).* This report, along with the DOE/NNSA *Stockpile Stewardship and Management Plan*, outlines DOE/NNSA planning and programmatic activities to provide comprehensive nuclear security solutions that protect the American people, our allies, and our partners in a dynamic world. As outlined in the 2022 *National Security Strategy*, the United States is committed to addressing the "existential threat of nuclear weapons" working "shoulder-to-shoulder" with our partners and allies. In a September 2021 speech to the United Nations General Assembly, President Biden heralded a "new era of relentless diplomacy," noting "the United States is ready to work with any nation that steps up and pursues peaceful resolution to shared challenges…to address urgent threats like COVID-19 and climate change or enduring threats like nuclear proliferation."

Through our *Innovate, Collaborate, and Deliver* approach and as articulated in the *NNSA Strategic Vision* and its four mission priorities, DOE/NNSA works to forge solutions that enable global security and stability as well as maintain the country's nuclear deterrence, provide nuclear propulsion, and leverage transformative technologies to address emerging challenges. DOE/NNSA uses an integrated strategy to prevent, counter, and respond to nuclear threats; and draws on its strong technical and policy expertise to accelerate its efforts to strengthen nonproliferation and enhance nuclear and radiological security worldwide expanding on our existing partnerships with more than 100 agencies and 100 countries.

These combined efforts to mitigate global nuclear threats are paramount to strengthening U.S. national security while also supporting U.S. efforts to address climate change. President Biden has outlined a plan to achieve net-zero carbon emissions by 2050 by advancing cutting-edge clean energy technologies and building an equitable clean energy future. Nuclear energy is central to achieving these clean energy goals, and DOE/NNSA is dedicated to promoting the safe, secure, and peaceful expansion of nuclear energy worldwide while adhering to the highest nonproliferation and nuclear security standards.

DOE/NNSA works in close collaboration with its national laboratories, plants, and sites as well as with other federal agencies to anticipate tomorrow's nuclear and national security challenges and deliver timely, innovative solutions. In an era of rapidly evolving global threats and a changing technological landscape, DOE/NNSA focuses on investing in a world-class workforce, robust infrastructure, and cutting-edge technological solutions to address current and future challenges. DOE/NNSA's most important asset is its people, and we place the highest priority on recruiting and retaining a world-class workforce.

This report will outline NNSA's cross-cutting capabilities for carrying out its mission to protect the Nation, our allies, and our partners by providing a resilient and responsive Nuclear Security Enterprise.

This report is provided to:

- **The Honorable Jack Reed**
  Chairman, Senate Committee on Armed Services
- **The Honorable Roger Wicker**
  Ranking Member, Senate Committee on Armed Services
- **The Honorable Angus King**
  Chairman, Subcommittee on Strategic Forces
  Senate Committee on Armed Services
- **The Honorable Deb Fischer**
  Ranking Member, Subcommittee on Strategic Forces
  Senate Committee on Armed Services
- **The Honorable Mike Rogers**
  Chairman, House Committee on Armed Services
- **The Honorable Adam Smith**
  Ranking Member, House Committee on Armed Services
- **The Honorable Doug Lamborn**
  Chairman, Subcommittee on Strategic Forces
  House Committee on Armed Services
- **The Honorable Seth Moulton**
  Ranking Member, Subcommittee on Strategic Forces
  House Committee on Armed Services
- **The Honorable Patty Murray**
  Chair, Senate Committee on Appropriations
- **The Honorable Susan Collins**
  Vice Chair, Senate Committee on Appropriations
- **The Honorable Dianne Feinstein**
  Chair, Subcommittee on Energy and Water Development
  Senate Committee on Appropriations
- **The Honorable John Kennedy**
  Ranking Member, Subcommittee on Energy and Water Development
  Senate Committee on Appropriations
- **The Honorable Kay Granger**
  Chairwoman, House Committee on Appropriations
- **The Honorable Rosa L. DeLauro**
  Ranking Member, House Committee on Appropriations
- **The Honorable Chuck Fleischmann**
  Chairman, Subcommittee on Energy and Water Development, and Related Agencies
  House Committee on Appropriations

- **The Honorable Marcy Kaptur**
  Ranking Member, Subcommittee on Energy and Water Development, and Related Agencies
  House Committee on Appropriations

Should you have any questions or need additional information, please contact Dr. Benn Tannenbaum, Associate Administrator for Congressional and Intergovernmental Affairs, at (202) 586-7332.

Sincerely,

Jill Hruby
Under Secretary for Nuclear Security
Administrator, NNSA

Message from the Secretary

The Nation is confronted by a range of global challenges, including Russia's full-scale invasion of Ukraine, China and Russia's pursuit of novel weapons systems, ongoing concerns about Iran's and North Korea's nuclear activities, and the rapid pace of technological developments that have the potential to lower the barrier to nuclear proliferation. The Department of Energy's National Nuclear Security Administration (DOE/NNSA) has made important strides in strengthening nonproliferation and arms control regimes and in securing nuclear and radioactive material worldwide to prevent its misuse by malign actors. To respond to the advent of game-changing technologies and stay ahead of our adversaries, DOE/NNSA continues to invest in the future workforce and cutting-edge science and technologies.

At the same time, the global community is experiencing the worsening impacts of climate change. Today more than ever, we need to make progress toward building a clean energy future. DOE is a central contributor to this effort. In November 2021, we launched our Net-Zero World initiative at the United Nations Climate Change Conference, which will advance partnerships between our national laboratories and philanthropies to help partner countries achieve their climate-related pledges and support a transition to a net-zero energy future.

Nuclear power is a critical part of our decarbonization efforts. DOE/NNSA has consistently played a key role in underpinning the safe, secure, and peaceful expansion of nuclear energy worldwide, working in close collaboration with partners and allies to strengthen nonproliferation and nuclear security norms and best practices. DOE is ramping up efforts to support advanced reactor technologies domestically and internationally as a means to bolster safe and secure nuclear energy as a reliable source of base power, and DOE/NNSA is committed to promoting the strongest nonproliferation and nuclear security standards as we pursue our clean energy goals.

Sincerely,

Jennifer Granholm

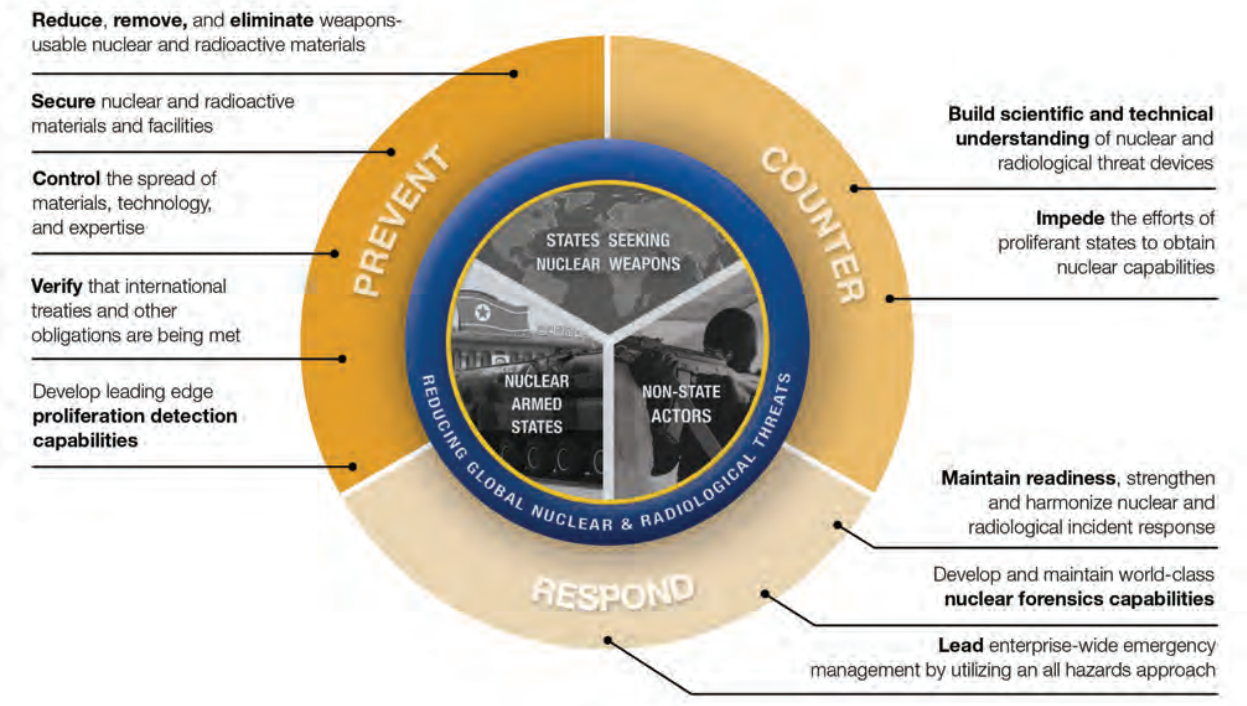
Executive Summary

Prevent, Counter, and Respond—NNSA's Plan to Reduce Global Nuclear Threats (FY 2023-FY 2027), outlines the Department of Energy's National Nuclear Security Administration (DOE/NNSA) activities to address the risk of nuclear terrorism and proliferation, its updated priorities and plans for FY 2023-FY 2027, and its key accomplishments from FY 2022. By limiting the number of and further nuclear expansion by nuclear-capable states and preventing terrorist access to materials and technology, DOE/NNSA plays a critical role in enhancing global security and stability and constrains the range of potential threats facing the Nation, its allies, and partners.

President Biden, in the *2022 National Security Strategy,* called for the United States to address the "existential threat posed by the proliferation of nuclear weapons through renewed arms control and nonproliferation leadership," noting that the United States will "work with allies and partners, civil society, and international organizations" to "prevent the spread of weapons of mass destruction and fissile material, their means of delivery, and enabling technologies." DOE/NNSA nuclear threat reduction activities strengthen U.S. national security by:

- ***Preventing*** adversaries from acquiring nuclear weapons or weapons-usable materials, technology, and expertise.
- ***Countering*** efforts to acquire such weapons or materials.
- ***Responding*** to nuclear or radiological incidents and accidents domestically and abroad.

This report describes DOE/NNSA nuclear and radiological threat reduction activities within the prevent, counter, and respond strategic framework, highlighting these ten key objectives:



As DOE/NNSA implements the ten objectives above, the following set of activities are also increasingly important to respond to the evolving threat environment and to align with U.S. Government nuclear policy:

- Integrating nonproliferation and nuclear security in advanced nuclear designs to support the clean energy transition
- Strengthening U.S. Government technical nuclear forensics capabilities
- Leveraging the benefits of emerging technologies while minimizing the risks
- Achieving permanent threat reduction through new and alternative technologies
- Strengthening U.S. Government counterproliferation capabilities
- Developing technology and approaches for future arms control agreements

Consistent with the updated *NNSA Strategic Vision*, DOE/NNSA leverages the following key enablers to underpin all of its activities to prevent, counter, and respond to nuclear threats:

- Investing in a long-term strategy to prepare for future nonproliferation challenges
- Developing a world-class science, technology, and, engineering workforce
- Revitalizing infrastructure
- Strengthening DOE/NNSA resilience and applying lessons-learned from COVID-19

DOE/NNSA relies on innovative solutions from the world-class science, technology, policy expertise, and infrastructure of the Department and its laboratories, plants, and sites.

DOE/NNSA partnerships maximize the impact and effectiveness of threat reduction activities.

Legislative Language

Section 2575 of Title 50 of United States Code (50 U.S.C. § 2575), requires that:

> The [NNSA] Administrator shall develop and annually update a five-year management plan for activities associated with the defense nuclear nonproliferation programs of the Administration to prevent and counter the proliferation of materials, technology, equipment, and expertise related to nuclear and radiological weapons in order to minimize and address the risk of nuclear terrorism and the proliferation of such weapons.

The specific requirements for the plan, and the location of the corresponding information within this document, are described in Appendix B.

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CHAPTER 1

Strategic Framework for Reducing Global Nuclear Threats

Consistent with national guidance, DOE/NNSA is positioned to meet present and future challenges through its enduring missions to prevent nuclear weapons proliferation and reduce the threat of nuclear and radiological terrorism around the world.

1.0 Strategic Framework for Reducing Global Nuclear Threats

Prevent, Counter, and Respond – NNSA's Plan to Reduce Global Nuclear Threats fulfills the requirement in 50 U.S.C. § 2575 and outlines the DOE/NNSA integrated strategy to meet present and future challenges through its enduring missions to prevent nuclear weapons proliferation and reduce the threat of nuclear and radiological terrorism around the world. The United States will continue collaborating with partners and allies to mitigate risks caused by state and non-state proliferation of nuclear and radioactive materials, technology, and expertise.

1.1 Mandate, Authority, and Policy Drivers

The Department of Energy's National Nuclear Security Administration (DOE/NNSA) draws its mission and authorities from the *Atomic Energy Act,* as amended, (codified at Title 42 United States Code [U.S.C] § 2011 et seq.), the *National Nuclear Security Administration Act,* as amended (50 U.S.C. § 2401 et seq), and the *Atomic Energy Defense Act*, as amended (50 U.S.C. § 2501 *et seq.*). Consistent with NNSA's Strategic Vision, DOE/NNSA advances the security and safety of the United States through four enduring mission priorities: (1) designing and delivering the Nation's nuclear stockpile; (2) forging solutions that enable global security and stability; (3) harnessing the atom to power a global nuclear fleet; and (4) leveraging transformative technologies to address emerging challenges. This report, *Prevent, Counter and Respond – NNSA's Plan to Reduce Global Nuclear Threats*, focuses on DOE/NNSA's strategy to implement the second mission priority: forging solutions that enable global security and stability.

DOE/NNSA reduces global nuclear threats to keep the United States safe by preventing adversaries from acquiring nuclear weapons or weapons-usable materials, technology, and expertise; countering efforts to acquire such weapons or materials; and responding to nuclear or radiological incidents and accidents domestically and abroad.

The vision from President Biden's *National Security Strategy* calls for strong U.S. leadership on nonproliferation and collaboration with partners and allies to address the existential threat posed by nuclear weapons. Presidential and DOE strategy documents, including the *2022 Nuclear Posture Review*, flow from this guiding document and inform DOE/NNSA's nuclear threat reduction missions. Additional guidance from the *2022 National Defense Strategy* outlines the complex geopolitical landscape, including strategic competition from China, acute threats posed by Russia as evident in its aggression against Ukraine, and other persistent threats including those posed by Iran, North Korea, and violent extremist organizations.

1.2 The Environment for Nuclear and Radiological Proliferation and Terrorism

As part of a comprehensive U.S. Government approach, DOE/NNSA aligns its program activities to address the current and emerging nuclear and radiological threat environment and the likely events or conditions that could negatively affect the safety and security of the United States and its allies. Reports from U.S. Government agencies and international organizations inform DOE/NNSA's understanding of the threat environment. Such reports include the Intelligence Community's annual worldwide threat assessment and periodic "Global Trends" reports, the Department of Defense's (DOD) assessments and military power reports, the Department of State's annual reports on compliance with and adherence to arms control, nonproliferation, and disarmament agreements and commitments, and relevant reports from the International Atomic Energy Agency (IAEA) and United Nations Security Council (UNSC) bodies. National guidance from the 2022 National Security Strategy, the 2022 National Defense Strategy, along with the nested Nuclear Posture Review, and relevant Executive Orders on addressing nuclear terrorism, relevant emerging technologies, and the impacts of climate change also add context to threat environment.

Russia's further invasion of Ukraine has significant negative implications for the nonproliferation regime and raises possible risk of horizontal proliferation. Moreover, Russia's reckless military actions in Chernobyl and Zaporizhzhia introduce expanded nuclear security risks in Ukraine. China's rapid nuclear weapons build-up and platform modernization are also of immediate concern. Meanwhile, the complex nuclear threats posed by Iran and North Korea also demand U.S. Government and DOE/NNSA attention. All the while, enduring proliferation and terrorism concerns remain.

Nuclear-armed states, states seeking nuclear weapons or associated capabilities, those with evolving nuclear capabilities, and non-state actors pose different risks that frame the threat environment. Both horizontal and vertical proliferation as well as over-the-horizon threats of nuclear proliferation are of concern. In addition, the threat environment includes the risks posed by emerging, converging, and disruptive technologies, as well as other hazards.

FIGURE 1: THREAT ASSESSMENT REPORTS

See Appendix G for report references.

Nuclear Armed States: Modernization, Expansion, Platform Diversification

States with existing nuclear weapons capabilities, such as Russia and China, are continuing to modernize and selectively expand and diversify their arsenals, which poses nuclear monitoring challenges and threatens strategic stability. Russia is developing novel nuclear weapons systems, including a nuclear-powered, nuclear-armed cruise missile ("Burevestnik"), and an unmanned nuclear-powered, nuclear-armed underwater drone ("Poseidon"), and recently deployed an air-launched ballistic missile ("Kinzhal"). None of these new systems, or Russia's sizeable existing non-strategic nuclear weapons stockpile, are captured by the Treaty between the United States and the Russian Federation on Measures for Further Reduction and Limitation of Strategic Offensive Weapons (New START) regime. Russia's nuclear "saber-rattling" and "escalate-to-deescalate" strategies have increased NATO member states' and regional allies' concerns, particularly as we have seen these threats dangerously applied in Ukraine.

Russia's full-scale invasion of Ukraine has degraded U.S.-Russian bilateral relations and cooperation in multilateral forums that focus on nuclear risk reduction, creating substantial uncertainty on the path forward for global arms control and strategic stability talks. Moreover, Russia's past activities have raised concerns with regard to its adherence to and compliance with a number of arms control agreements and arrangements. Notably, in January 2023, the United States determined that Russia is not in compliance with its New START obligations to facilitate inspection activities on its territory and to convene a session of the Bilateral Consultative Commission within the timelines specified in the Treaty. On February 28, 2023, Russia notified the United States of its purported suspension of the New START Treaty. Since then, Russia has not provided any required New START notifications. Russia's claimed suspension of the New START Treaty is invalid.

China is shifting away from its longstanding minimalist nuclear force posture in its continued pursuit of a survivable nuclear triad and its accelerating expansion of its nuclear stockpile, from an estimated low-200s in 2020 to potentially 1,000 warheads by 2030. China's continued development and fielding of a variety of delivery systems (e.g., the DF-17 hypersonic glide vehicle-capable medium-range ballistic missile and nuclear-capable H-6N bomber), infrastructure developments to increase fissile material production, and movement towards a launch-on-warning posture continue to raise concerns. China has resisted proposals to engage in nuclear transparency and arms control negotiations. Moreover, as Russia and China grow strategically closer, both economically and militarily, the United States will need to contend with additional challenges that may further complicate United States' goals of strengthening strategic stability.

Arms race pressures and threats of nuclear escalation pose additional risks. Russia and China both continue expanding their nuclear arsenals, which poses challenges for mutual and verifiable arms control. Moreover, tensions between other nuclear-armed states such as periodic crises between India and Pakistan, and additional tensions on the contested border between China and India create additional nuclear risk While the United States and Russia had engaged in strategic stability talks in June 2021 aimed at addressing some of these risks, Russia's February 2022 invasion of Ukraine and its subsequent announcement that it had placed its nuclear forces on high alert against Western targets have halted any potential progress.

Ongoing developments continue to erode the international nonproliferation regime and hamper nuclear security best practices. Although DOE/NNSA and other U.S. Government agencies worked with Russia for many years on cooperative threat reduction programs to secure nuclear weapons, materials, facilities, and expertise, there remains a concern about Russia's sustainment of those nuclear security efforts as diplomacy has declined. Russian and Chinese state-owned enterprises have also adopted a competitive posture toward nuclear reactor exports to the developing world, which might threaten international efforts on nuclear security and nonproliferation. The Treaty on the Non-proliferation of Nuclear Weapons

(NPT), the cornerstone of the nonproliferation regime for over 50 years, is under increased strain as Russia has repeatedly contravened international nuclear norms during its invasion of Ukraine, and as increased dissatisfaction on disarmament progress has led to the Treaty on the Prohibition of Nuclear Weapons (TPNW) entering into force in early 2021. Russia's decision to break consensus on the draft Final Document at the 2022 NPT Review Conference demonstrates further deterioration in the geopolitical climate facing nonproliferation regimes. Despite these challenges, the United States and its allies will continue to engage the international community to maintain a global commitment to nonproliferation and nuclear security.

States of Concern: Emerging & Latent Proliferant Programs, and Those Over-the-Horizon

States with evolving nuclear capabilities pose a persistent threat and a different set of challenges. This includes North Korea and Iran respectively. Despite a series of high-level summits held in 2018 and 2019 and a halt to nuclear testing, North Korea continues to expand its nuclear and ballistic missile-related capabilities as key components of its national strategy to preserve the long-term security of the Kim regime by operating material production facilities, continuing construction of a light-water reactor, seeking relevant technical information and illicit commodity transfers, as well as testing and diversifying its delivery vehicle platforms. In addition, North Korea passed a new law in September 2022 declaring itself a nuclear weapons state. Emphasizing its irreversibility, North Korean leader Kim Jong Un announced that North Korea would "never give up" its nuclear weapons, narrowing the gap for negotiations on denuclearization.

FIGURE 2: SECRETARY GRANHOLM AT THE 65TH IAEA GENERAL CONFERENCE

U.S. Secretary of Energy Jennifer Granholm delivers the U.S. National Statement to the 65th IAEA General Conference, Vienna, Austria, September 20, 2021. (USUNVIE/ Colin Peters)

Iran has expanded its uranium enrichment capabilities, failed to provide sufficient substantive cooperation on the IAEA's outstanding safeguards investigations, exceeded limits of the Joint Comprehensive Plan of Action (JCPOA), and shortened its potential breakout time.

It is also possible that unanticipated state actors, including those with latent nuclear capabilities, could pursue new weapons programs by evading international detection and nuclear safeguards. States with increasing security concerns might consider this path. In this environment, the risk of illicit transfers of sensitive nuclear materials, technology, and expertise may increase. Monitoring for such over-the-horizon possibilities makes robust proliferation detection capabilities more vital and reinforces the need for the United States to maintain nuclear fuel cycle expertise to detect novel signatures of weapons development.

Finally, several states are embarking on civil nuclear power programs with foreign suppliers. Russia and China, in particular, are using civil nuclear reactor exports as a means of exerting soft power and long-

term influence. It is critical that these new civil nuclear programs meet international standards for safeguards, security, and proliferation-resistance in order to minimize potential risks.

Non-State Actors: The Potential for Nuclear and Radiological Terrorism

The potential for nuclear and radiological terrorism continues to pose a serious and enduring threat to the United States and to international security and stability. Vulnerable nuclear or radioactive materials could potentially be acquired for use in a radiological dispersal device (RDD), radiological exposure device (RED), or improvised nuclear device (IND). DOE/NNSA must continue to be prepared in the event that motivated and capable non-state actors gain access to nuclear or radioactive materials, technology, or expertise due to enabling conditions including weakened security posture, the support of insiders, the presence of violent extremists, cyber security vulnerabilities, the availability of sophisticated exploitation tools, or loss of state control of territory.

Terrorist organizations have consistently sought nuclear and radioactive materials, underscoring the importance of material security. In line with the recent National Security Memorandum on Countering WMD Terrorism and Advancing Nuclear and Radioactive Material Security, DOE/NNSA proactively reduces the risk of non-state actors acquiring nuclear material by working with partner nations and international organizations to minimize the need for, presence of, and production of weapons-usable nuclear material (highly enriched uranium or separated plutonium) around the world, and to implement sustainable global material security efforts and address the potential of illicit trafficking.

Emerging, Converging, and Disruptive Technologies: Rapid Evolution and Spread, Uncertain Impacts

The rapid development and global dispersion of emerging and disruptive technologies–such as additive manufacturing, artificial intelligence/machine learning, quantum computing, 5G/6G networking, the Internet of Things, autonomous systems and vehicles, commercial satellite imagery constellations–and their combination with existing technologies, could improve U.S. capabilities to detect and respond to proliferation. Alternatively, adversaries could use these emerging technologies to lower the barriers to proliferation or enable new proliferation pathways. For example, additive manufacturing can offer significant benefits in rapid prototyping and design optimization for detection systems, but these tools could also become capable of manufacturing proliferation-sensitive items, challenging the multilateral export control regime's efforts to keep pace as these technologies becomes globally ubiquitous.

The convergence of multiple technologies may produce new or enhanced proliferation risks that are difficult to predict. Furthermore, most of these emerging and disruptive technologies are being competitively developed for commercial applications, hindering attempts to impose strict government controls. China is the primary strategic competitor to the United States as it has a comprehensive strategy to acquire and use technology to advance its national goals, including through its Military-Civil Fusion Policy and National Intelligence Law that require Chinese entities to share technology and information with military, intelligence, and security services. China is focused on a range of enabling technologies, including biotechnology, advanced computing, and artificial intelligence. Both China and Russia have expressed plans to be world leaders in artificial intelligence and other emerging technologies in pursuit of military and geostrategic superiority. DOE/NNSA maintains and is expanding a proactive, analytic posture to continuously identify emerging technology developments, characterize the risks and opportunities presented, and prepare solutions in response.

An All-Hazards Approach: Climate Change, COVID-19, Cyber, and Other Factors

In addition to the potential impacts that new technologies may have on the nuclear and radiological threat environment, other natural or manmade factors may also impact DOE/NNSA mission execution and thus warrant consideration. Such all-hazards emergencies include natural disasters (e.g., severe weather events, earthquakes, pandemics, and wildfires) and manmade disasters (e.g., transportation accidents,

industrial and engineering failures, cyber intrusions, and terrorist events). These emergencies can vary in frequency, duration, range of disruptions, and motive.

FIGURE 3: AN "ALL-HAZARDS" APPROACH

Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad", raised the importance of climate change to U.S. national security and mandated the IC produce intelligence assessments on the impact of climate change to help decision makers better understand the threat and subsequent implications. Climate change has aggravated existing natural hazard vulnerabilities by increasing risk and consequences. In recent years, powerful weather events have become more common, further intensifying the potential for disruptions to DOE/NNSA operations. Furthermore, as additional nations look to civil nuclear power programs as a means to limit or reduce climate change, the possibility for nuclear and radiological proliferation and terrorism could expand if it is not managed carefully with safeguards and security efforts.

Recent experience with the COVID-19 pandemic showed that DOE/NNSA has adapted to simultaneously maintain onsite security, personnel safety, and mission execution. Continuous adjustments will be required to further adapt to a hybrid work environment with a geographically dispersed workforce. Telework and other geographic dispersion measures intended to protect staff and further mission resilience could present new cyber security vulnerabilities.

Russia's Invasion of Ukraine

As President Biden stated, Russia's unjustified full-scale invasion of Ukraine is "a direct challenge to the rule-based international order established since the end of World War II." Russia's dangerous and irresponsible seizure of, and military attacks in the vicinity of Ukraine's nuclear facilities created immediate concerns about their safe and secure operations and underscored the urgency needed for support from the IAEA and Ukrainian partners to mitigate the risk of a nuclear incident.

DOE/NNSA has worked in close collaboration with Ukrainian partners on a wide range of nonproliferation and nuclear security topics since the early 1990s, including eliminating weapons-usable nuclear material, strengthening nuclear and radiological security, and implementing nuclear safeguards. In 2012, DOE/NNSA completed the removal of over 234 kilograms of highly enriched uranium (HEU) from Ukraine. In doing so, Ukraine voluntarily and verifiably eliminated nearly all its HEU. The small quantities of HEU that remain are for specific and appropriate scientific purposes. In exchange for eliminating its HEU inventory, DOE/NNSA provided Ukraine with low enriched uranium (LEU) fuel for the research reactor at the Kyiv Institute for Nuclear Research and supported the development and construction of the Neutron Source Facility at the Kharkiv Institute of Physics and Technology.

DOE/NNSA worked with Ukraine to consolidate disused radioactive sources from 11 radiological sites in secure storage facilities throughout the country and replaced radioactive sources at three sites with non-radioisotopic alternative technologies for permanent risk reduction. DOE/NNSA installed radiation detection equipment at roughly 90 points of entry and equipped five checkpoints on administrative lines in eastern Ukraine and Crimea with radiation detection equipment, inspection equipment, and green border security equipment. This equipment has provided key insights on what is happening on the ground during this crisis.

Since Russia's full-scale invasion of Ukraine, DOE/NNSA has deployed additional radiation detection and monitoring capabilities to Ukrainian partners and in neighboring countries. These sensors provide the U.S. Government and its international partners with real-time data in the event of a radiation release from a Ukrainian nuclear facility or other potential nuclear-related scenarios in the region, which would be used to inform decisions to protect public health and safety. This equipment would also help Ukrainian authorities detect movement of nuclear and radioactive material and provide continuity of counter smuggling capabilities during this crisis.

1.3 Strategic Implementation Framework

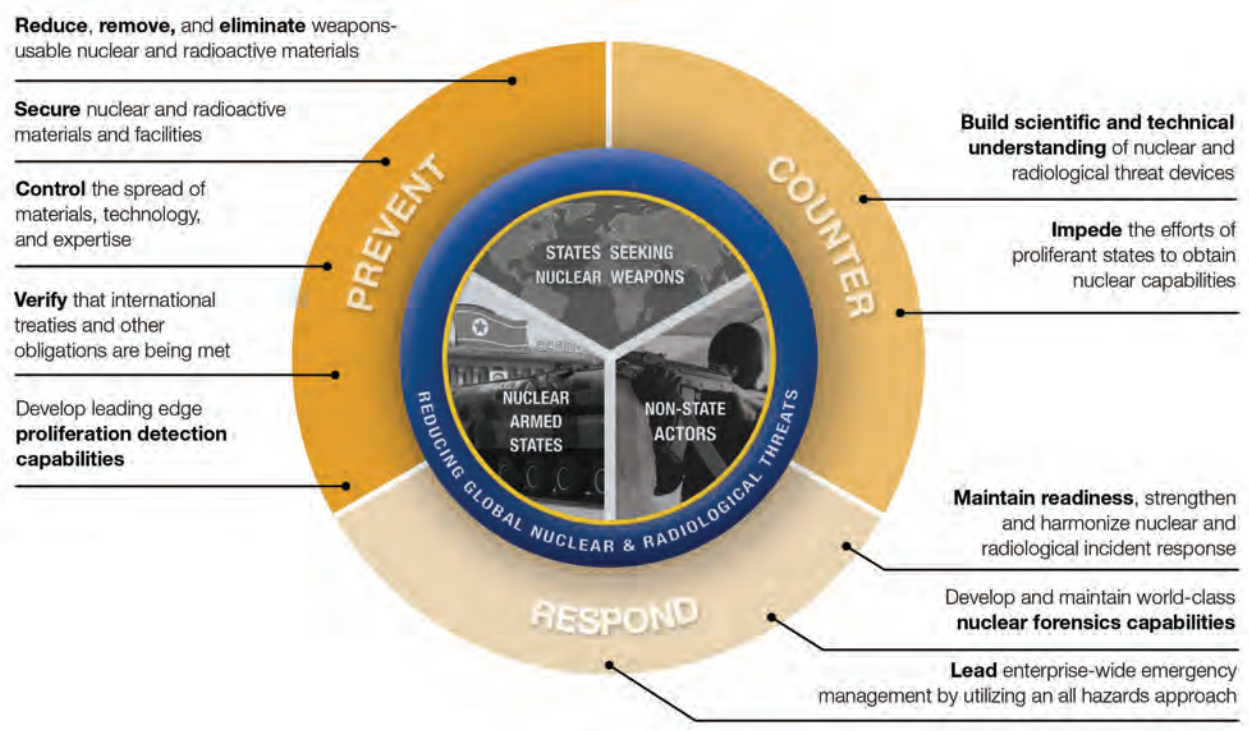
To address its mission and policy mandate to reduce global nuclear and radiological threats posed by nuclear armed states, states seeking nuclear weapons, and non-state actors, DOE/NNSA conceptualizes its approach using a strategic implementation framework (see Figure 4) focused on three areas:

1. ***Prevent*** proliferant states from developing nuclear weapons or acquiring weapons-usable nuclear materials, equipment, technology, and expertise, and prevent non-state actors from acquiring nuclear and radioactive materials that can be used for malicious purposes.

2. ***Counter*** the efforts of both proliferant states and non-state actors to acquire, develop, disseminate, deliver, or use the materials, expertise, or components of a nuclear or radiological device.

3. ***Respond*** to the full spectrum of nuclear and radiological emergencies at home or abroad, including deliberate attacks and accidents, to minimize the damage from such incidents.

FIGURE 4: PREVENT, COUNTER, AND RESPOND STRATEGIC IMPLEMENTATION FRAMEWORK



DOE/NNSA's cross-cutting activities to prevent, counter, and respond to nuclear threat areas are part of a broader U.S Government approach and are informed by threat assessment information; catalyzed by rigorous research, development, test, and evaluation efforts; and enhanced by strong collaborations with its many interagency and international partners.

This report describes DOE/NNSA's nuclear and radiological threat reduction activities within the prevent, counter, and respond strategic framework, highlighting these ten key objectives:

Prevent:

- Reduce, remove, and eliminate weapons-usable nuclear and radioactive materials
- Secure nuclear and radioactive materials and facilities
- Control the spread of materials, technology, and expertise
- Verify that international treaty and other obligations are being met
- Develop leading edge proliferation detection capabilities

Counter:

- Build scientific and technical understanding of nuclear and radiological threat devices
- Support efforts to impede proliferant states' ability to obtain nuclear capabilities

Respond:

- Maintain readiness, strengthen and harmonize nuclear and radiological incident response
- Develop and maintain world-class nuclear forensics capabilities
- Lead enterprise-wide emergency management by utilizing an all-hazards approach

Supplementing these objectives, a set of priorities are increasing in importance as DOE/NNSA responds to the evolving threat environment and aligns its support to the U.S. Government's nuclear policy agenda:

- Promoting secure, proliferation-resistant nuclear technology to address climate change
- Strengthening U.S. Government technical nuclear forensics capabilities
- Leveraging the benefits of emerging technologies while minimizing the risks
- Achieving permanent threat reduction through new and alternative technologies
- Strengthening U.S. Government counterproliferation capabilities
- Developing technology and approaches for future arms control agreements

To address the ten objectives of this strategic framework and the areas of increasing priority, DOE/NNSA leverages four key mission enablers, which include:

- Investing in a long-term strategy to prepare for future nonproliferation challenges
- Developing a world-class science, technology, and, engineering workforce
- Revitalizing infrastructure
- Strengthening DOE/NNSA resilience and applying lessons-learned from COVID-19

DOE/NNSA relies on the world-class science, technology, policy expertise, and infrastructure of the Department and its laboratories, plants, and sites to provide innovative solutions to successfully execute its nuclear threat reduction activities. Supplementing this continuous innovation, DOE/NNSA fosters strong interagency and international partnerships to extend the global reach of its nonproliferation and nuclear security activities, to deliver sustainable and impactful solutions against current and emerging threats in the United States and in more than 100 countries worldwide.

CHAPTER 2

Preventing, Countering, and Responding to Nuclear and Radiological Terrorism and Proliferation

DOE/NNSA works globally to develop and execute programs designed to prevent, counter, and respond to nuclear and radiological proliferation and terrorism.

2.0 Preventing, Countering, and Responding to Nuclear and Radiological Terrorism and Proliferation

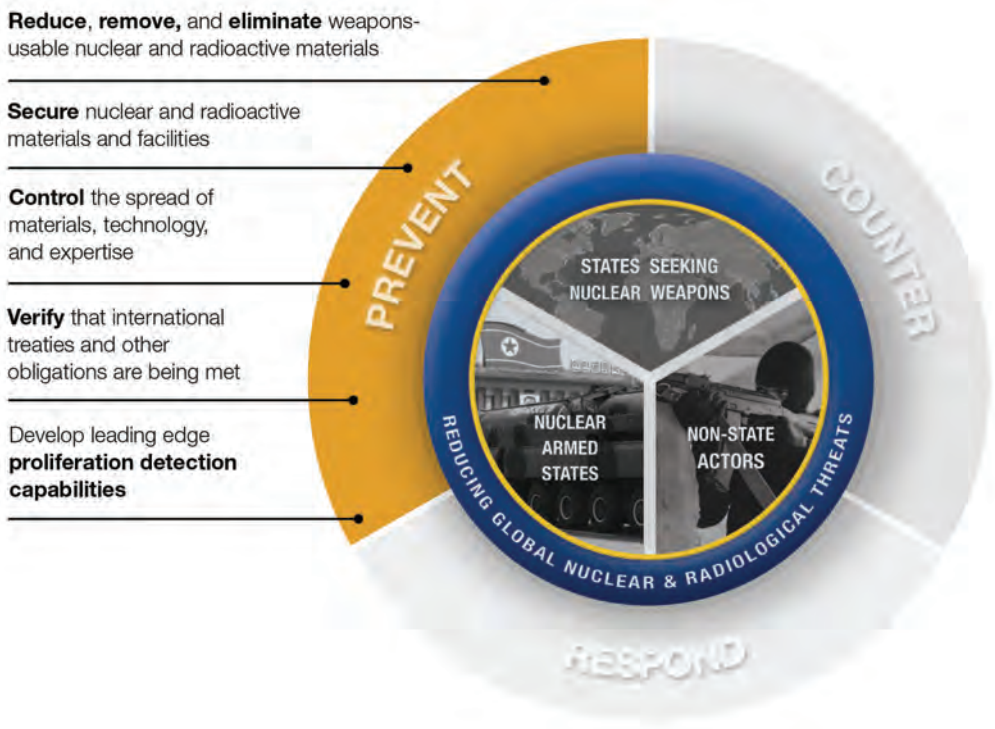
As the United States faces new and evolving national security challenges, the Department of Energy's National Nuclear Security Administration (DOE/NNSA) is working with the interagency to pursue a robust nonproliferation, nuclear security, and arms control agenda to keep the United States safe by:

- **Preventing** adversaries from acquiring nuclear weapons or weapons-usable materials, technology, or expertise.
- **Countering** efforts to acquire such weapons or materials.
- **Responding** to nuclear or radiological incidents and accidents domestically and abroad.

This chapter details how DOE/NNSA develops and executes programs designed to prevent, counter, and respond to nuclear or radiological proliferation and terrorism.

2.1 Prevent

Under the **Prevent** portion of its mission, DOE/NNSA pursues five key objectives to mitigate the risks posed by three main categories of threat actors. DOE/NNSA's work is supported by robust threat assessments, research and development, and a variety of domestic and international partnerships.



2.1.1 Reduce, Remove, and Eliminate Weapons-Usable Nuclear and Radioactive Materials

DOE/NNSA implements programs that reduce, remove, and eliminate the civilian use and production of weapons-usable nuclear and radioactive materials to achieve permanent threat reduction. In doing so, DOE/NNSA directly reduces the likelihood that terrorists could acquire sufficient materials to build a nuclear weapon, improvised nuclear device (IND), radiological exposure device (RED), or radiological dispersal device (RDD).

DOE/NNSA is continuing its efforts to minimize the civilian use of, and when possible, eliminate weapons-usable nuclear materials and promote sound management principles for materials that remain. In pursuit of this objective, DOE/NNSA:

- Works with international partners to remove, consolidate, and dispose of weapons-usable nuclear material from civilian facilities around the world and develops and maintains mobile packaging capabilities that can rapidly deploy to characterize, stabilize, package, and remove nuclear material globally.
- Continues its efforts to convert research reactors and isotope production facilities into use non-weapons usable nuclear material, verifies the shutdown of HEU-using facilities worldwide, and

works with partners around the world to improve proliferation resistance in the design of new research reactors and associated facilities.

- Partners with U.S. industry to establish a reliable non-HEU based domestic supply of molybdenum-99 (Mo-99), a critical isotope for medical procedures.
- Disposes of HEU and U.S. inventories of weapons-usable plutonium declared surplus to defense needs.
- Removes and disposes of disused radioactive sources in coordination with the U.S. Nuclear Regulatory Commission and Agreement State regulators.
- Promotes the use of non-radioisotopic alternative technologies.

FIGURE 5: HEU REMOVAL FROM JAPAN

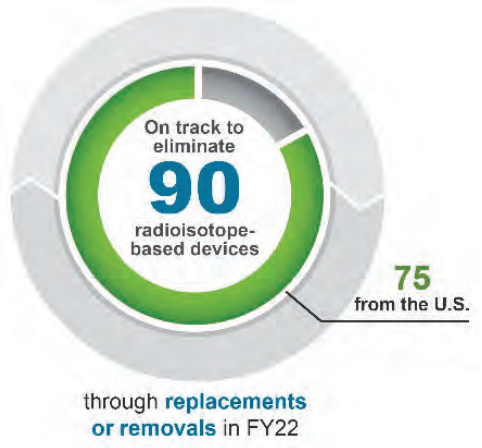
U.S. and Japanese technical experts prepare HEU shipping containers for transportation

Fiscal Year (FY) 2023 Priorities

- Support DOE/NNSA's high-assay low-enriched uranium (HALEU) supply initiatives for research reactors, medical isotope production, and U.S. advanced reactor demonstrations.
- Lead efforts to qualify new high-density HALEU fuels to convert research reactors that cannot use currently licensed HALEU fuels.
- Complete the National Environmental Policy Act (NEPA) work for the Surplus Plutonium Disposition Program's 34 metric tons disposition mission, with a draft Environmental Impact Statement (EIS) to be released in FY 2023 and a final EIS to follow in due course.
- Deploy the Mobile Melt Consolidate system to Norway in preparation for the in-country downblending of its HEU to LEU.
- Continue to support the transition from high-activity radioactive sources to non-radioisotopic alternative innovative technologies by replacing 85 radioisotope-based devices in the United States and internationally with alternative technologies.

FY 2022 Accomplishments

- Signed the first contracts as part of the Department's Uranium Lease and Take-back Program in collaboration with SHINE Technologies, LLC, a milestone in the effort to increase domestic production of Mo-99 without the use of HEU.
- Converted the IVG.1M reactor in Kazakhstan to LEU fuel.
- Removed or confirmed the disposition of a cumulative 7,270 kilograms of weapons-usable nuclear material from partner countries around the world.
- Removed all HEU from four partner facilities in Japan—fulfilling commitments made at the 2016 Nuclear Security Summit and 2018 U.S.-Japan Bilateral Commission meeting.



- Executed Exercise Dark Sleeper, the first large-scale international exercise involving both the Mobile Uranium Facility and the Mobile Plutonium Facility.
- Eliminated 119 radioisotope-based devices through replacements or removals in FY 2022, including 101 eliminated in the United States.
- Recovered and disposed of more than 500 excess and unwanted sealed sources from locations throughout the United States and 200 disused or orphaned radioactive sources in other countries.

Landmark Certification of Sufficient U.S. Supply of Mo-99 for Medical Procedures Without the Use of HEU

On December 20, 2021, the U.S. Secretary of Energy and the U.S. Secretary of Health and Human Services jointly certified that there is a sufficient supply of Mo-99 made without the use of HEU to meet the needs of medical patients in the United States. Mo-99 is an isotope used in more than 40,000 medical diagnostic procedures every day across the United States. This certification is a major success for DOE/NNSA's programs that provided financial and technical assistance to convert global producers of Mo-99 from using HEU to LEU targets, as well as its efforts to establish a domestic production capability for Mo-99 without the use of HEU.

The certification triggered a congressionally mandated ban on U.S. exports of HEU for medical isotope production. "Doctors and patients around the globe can be confident that the critical medical isotope Mo-99 will be there when they need it," said Secretary of Energy Jennifer Granholm, "and we can provide that assurance without making any further exports of highly enriched uranium."

Hot cells used by the Dutch company Curium to produce Mo-99 using LEU targets. DOE/NNSA provided financial and technical support for Curium's conversion from HEU to LEU in 2018.

2.1.2 Secure Nuclear and Radioactive Materials and Facilities

For the past three decades, DOE/NNSA has collaborated with domestic and foreign partners to improve the security of vulnerable nuclear and radioactive materials. However, evolving adversary capabilities, emerging technologies, expanding global nuclear fuel cycle, and growing demand for peaceful nuclear applications present significant challenges for global nuclear security.

DOE/NNSA is developing and implementing innovative approaches to adapt its nuclear security efforts to the changing landscape of emerging risks, seeking to build long-term sustainability of its capacity-building support by working with partners to indigenize regulations and inspection processes, training infrastructure, maintenance approaches, exercise and performance testing programs, life-cycle planning, and nuclear security culture. To do so, DOE/NNSA:

- Works with partner countries to strengthen security of weapons-usable nuclear material, nuclear power plants, fuel cycle capabilities, research and non-power reactors, and materials in transit.
- Works domestically and internationally to protect radioactive sources used in medical, research, and commercial applications.
- Collaborates with U.S. nuclear industry partners on Security-by-Design (SeBD) activities to enhance security of advanced reactor designs and works with radiological device manufacturers on SeBD activities to add security measures into devices to prevent theft.
- Supports safe and secure access to peaceful uses of nuclear energy and technology.

The Mission Never Sleeps: DOE/NNSA Resiliency and Adaptability Under COVID-19 Restrictions

Despite unprecedented restrictions prompted by the COVID-19 pandemic, DOE/NNSA demonstrated resilience and adaptability in its nuclear and radiological security mission in FY 2022 by:

- Conducting more than 1,000 virtual exchanges with more than 100 partners.
- Expanding nuclear security cooperation from 29 to 58 countries.
- Conducting nuclear security outreach to six countries embarking on new nuclear power programs.
- Securing a total of 90 buildings both in the United States and internationally with high-activity radioactive sources.

Tajikistan remote MDS training

In FY 2023, DOE/NNSA will continue to develop innovative solutions and partnerships to cultivate resilience and adaptability to respond to evolving challenges such as emerging technologies, cyber security, and global disruptions such as COVID-19.

FY 2023 Priorities

- Engage up to nine nuclear newcomers to promote early and comprehensive incorporation of nuclear security concepts at the national and site levels based on particular threat environments and requirements.
- Promote nuclear security as an integral part of peaceful uses of nuclear science and technology and of the sustainable development and climate change agenda.
- Bolster the international nuclear security regime by promoting the universalization and strengthened implementation of the Amendment to the Convention on the Physical Protection of Nuclear Materials, International Convention for the Suppression of Acts of Nuclear Terrorism, and Code of Conduct for the Safety and Security of Radioactive Sources, and reinforcing the importance of the International Atomic Energy Agency (IAEA) Nuclear Security Series guidance documents, security related information circulars, and Nuclear Security Support Centers.

FY 2022 Accomplishments

- Expanded bilateral cooperation on a wide range of nuclear security topics to nearly 60 countries, several of which are embarking on new nuclear energy infrastructure.
- Continued implementing upgrades at nuclear facilities in key countries to reduce risks of sabotage and theft, while helping sustain previous upgrades in countries such as Malaysia, Romania, and the Czech Republic.

- Started new upgrades at nuclear facilities in Morocco and Jordan based on assessments of risks and potential vulnerabilities.
- Developed a sabotage mitigation initiative with key partners whose nuclear power plants are critical to energy security.
- Launched the RadSecure 100 Initiative, which focuses on removing radioactive material from licensed facilities where feasible and improving security at the remaining facilities located in 100 metropolitan areas throughout the United States.

2.1.3 Control the Spread of Materials, Technology, and Expertise

In conjunction with U.S. interagency partners, DOE/NNSA seeks to control the spread of materials, technology, and expertise through innovative nonproliferation and arms control policy and by building the sustainable capacity of partner countries to deter, detect, disrupt, and investigate smuggling of nuclear and radioactive materials that could be used in acts of terrorism:

FIGURE 6: ENDURING RELATIONSHIPS ON COUNTER NUCLEAR SMUGGLING

NNSA's Office of Nuclear Smuggling Detection and Deterrence celebrated its long-standing relationship with Uzbekistan State Customs Committee in countering nuclear smuggling during an equipment handover ceremony.

- Supports the IAEA and partner countries' efforts to implement and strengthen international nuclear safeguards.
- Builds domestic and international capacity to implement export control obligations and conduct technical analysis and end-user evaluations of U.S. export license applications for proliferation concerns.
- Supports the negotiation and implementation of arms control agreements and develops monitoring and verification regimes to verifiably reduce nuclear weapons and nuclear programs.
- Develops approaches and strategies to address emerging nonproliferation challenges and opportunities.
- Addresses remaining gaps in global counter nuclear smuggling capabilities by cooperating with partner countries to establish and sustain defense-in-depth detection strategies at high-priority points of entry, along frontier areas, working with border and maritime security agencies at green and blue borders, and within the interior of states.

FY 2023 Priorities

- Promote IAEA safeguards to the U.S. advanced reactor community and partner states and strengthen the IAEA's ability to detect and deter undeclared nuclear activities, including by developing a multilateral, nonproliferation enrichment and training platform for training IAEA inspectors.
- DOE/NNSA will continue to collaborate with the interagency to support the AUKUS (Australia, the United Kingdom, and the United States) partnership in finding the optimal pathway for Australia to acquire conventionally-armed, nuclear-powered submarines while upholding the highest nonproliferation standards. DOE/NNSA will work closely with the IAEA to implement strong safeguards measures and strengthen the nonproliferation regime while reaffirming Australia's long-standing commitment not to pursue nuclear weapons, consistent with its obligations under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).
- Strengthen radiation detection and interdiction capabilities in high-risk frontier areas through Green Border Security Initiative (GBSI) projects in up to nine countries including Azerbaijan, Estonia, Georgia, Kazakhstan, Kosovo, Lithuania, Moldova, North Macedonia, and Tajikistan.

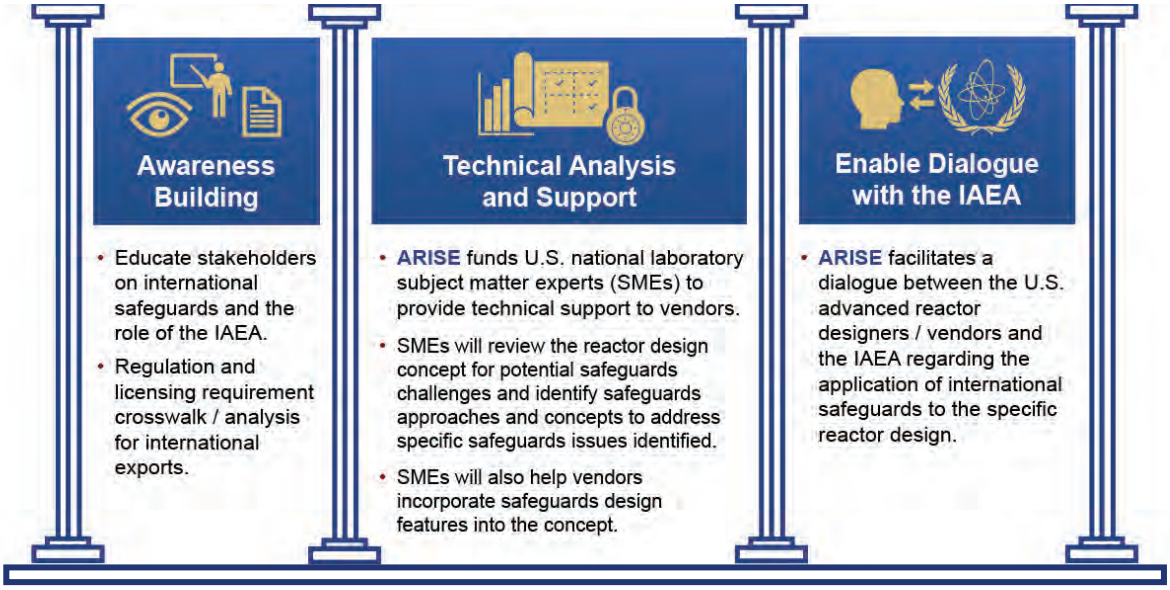
- Strengthen interdiction and inspection capabilities of internal security and law enforcement units making intelligence-driven decisions to patrol and protect internal checkpoints, major public events, and possible adversary targets of interest such as critical infrastructure.

FY 2022 Accomplishments

- Conducted more than 50 export control training events to strengthen U.S. enforcement agencies and foreign partners' ability to prevent the illicit transfer of dual-use commodities related to weapons of mass destruction (WMD).

- Transferred seven safeguards tools and technologies to the IAEA and partners including chemical and particle reference standards, containment and surveillance techniques, and software methodologies.
- Developed and tested IAEA safeguards tools for nondestructive analysis, destructive analysis, containment and surveillance, and cyber security. Provided innovated research and development support for the IAEA Network of Analytical Laboratories.

FIGURE 7: ADVANCED REACTOR INTERNATIONAL SAFEGUARDS ENGAGEMENT (ARISE) PROGRAM



- Launched the ARISE program to support the implementation and delivery of Safeguards by Design (SBD) in advanced reactor designs and improve the safeguard ability of future reactor exports.
- Deployed counter nuclear smuggling capabilities at 25 official crossing points in ten countries.
- Deployed counter nuclear smuggling capabilities to 16 internal law enforcement units in eight countries.
- Continued deployment of counter nuclear smuggling capabilities to three countries along frontier areas and/or administrative lines as part of the Green Border Security Initiative (GBSI).

DOE/NNSA Addresses Gaps in Counter-Nuclear Smuggling Through its Green Border Security Initiative (GBSI) Projects

The threat of illicit trafficking of nuclear and radioactive materials is not confined to official ports of entry. Many foreign partners face the challenge of countering nuclear smuggling along green border areas and administrative lines. ***Green borders*** are areas between official border crossings that are controlled by border guards or similar law enforcement organizations. ***Administrative lines*** are areas where official government control ends—often near ungoverned areas or areas temporarily not under the control of the government —and are typically monitored by law enforcement agencies through security checkpoints to address threats of smuggling or other illegal activities.

To effectively counter nuclear smuggling threats in such areas around the world, DOE/NNSA developed and implemented the GBSI. GBSI projects provide sustainable technical and non-technical solutions to equip partner countries to address counter-smuggling gaps in priority sections of green border areas and other sensitive locations.

2.1.4 Verify International Treaty and Other Obligations Are Being Met

DOE/NNSA reduces proliferation concerns by supporting the negotiation and implementation of agreements and associated monitoring regimes to verifiably reduce nuclear weapons and dismantle nuclear programs. DOE/NNSA:

- Supports several nonproliferation and arms control agreements including New START, the Chemical Weapons Convention, the Plutonium Production Reactor Agreement, the Threshold Nuclear Test Ban Treaty, and the Comprehensive Nuclear-Test-Ban Treaty.
- Conducts applied technology development, testing, evaluation, maintenance, and deployment of innovative monitoring technologies and develops monitoring and verification approaches.
- Contributes to policy development, formulation, and support to U.S. participation in multilateral nonproliferation regimes, including the NPT, Nuclear Suppliers Group, and Zangger Committee, among others.
- Enables the development and maintenance of a nuclear Test Site Verification Team and continues development of advanced monitoring and verification capabilities for future nuclear weapons arms control initiatives.

The Tenth Review Conference (RevCon) of the Parties to the NPT

The NPT is the cornerstone of the international nonproliferation regime, playing an essential role in preventing the spread of nuclear weapons and weapons technology, promoting cooperation on the peaceful uses of nuclear energy, and furthering the goal of achieving nuclear disarmament and general and complete disarmament.

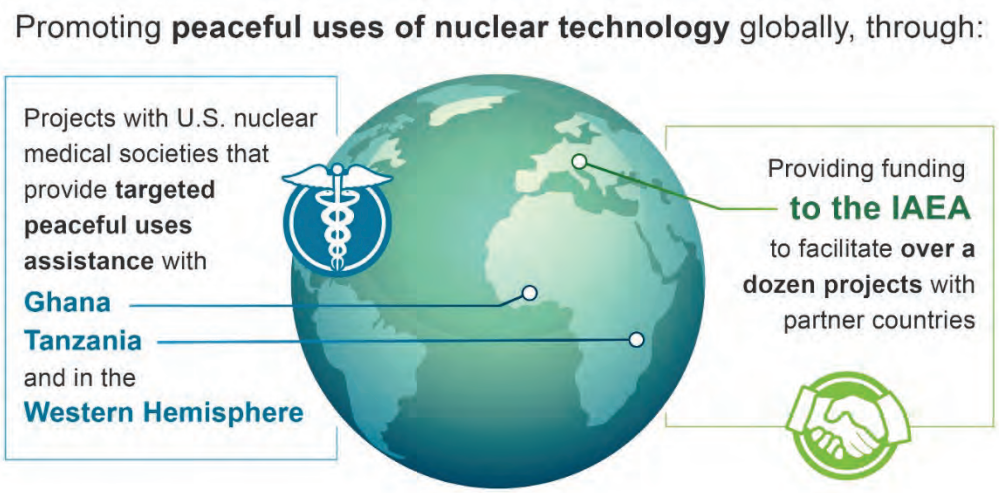
The 10th NPT RevCon took place in August 2022 in a challenging international security environment. DOE/NNSA supported U.S. Government efforts to achieve positive outcomes from this meeting, including demonstrating U.S. progress on disarmament, promoting strong nonproliferation standards and the universalization of the Additional Protocol, and expanding access to the peaceful uses of nuclear energy as a core benefit of the NPT. However, State Parties to the NPT were unable to reach consensus on a Final Document due to Russia's decision to break consensus because of the document's references to Russia's irresponsible behavior in Ukraine, including nuclear saber rattling and Russia's actions with respect to Ukraine's nuclear power plants.

FY 2023 Priorities

- Develop, test, and evaluate verification and monitoring procedures and technologies; train and exercise specialized U.S. verification teams; and conduct operations planning to maintain short-notice readiness for U.S.-led monitoring and verification of nuclear weapons material production programs and associated denuclearization efforts around the world.
- Support U.S. Government efforts to develop future arms control agreements and potential strategic dialogue initiatives.
- Promote the peaceful uses benefits of the nonproliferation regime through targeted peaceful uses projects, including in sub-Saharan Africa and South and Central America.

FY 2022 Accomplishments

- DOE/NNSA collaborated with the interagency in the DOD-led Nuclear Posture Review (NPR) process. The 2022 NPR affirms U.S. commitments to the NPT and the IAEA and highlights U.S. support for the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The NPR also highlights the importance of arms control as a critical tool in our overall U.S. deterrent and national security strategy.
- Established, trained, and exercised a Test-Site Verification Team to expand technical and manpower readiness for future U.S.-led monitoring and verification of denuclearization activities.
- Supported U.S. Government efforts to develop future arms control agreements and strategic dialogue initiatives with Russia and possibly others.
- Continued to promote peaceful uses of nuclear technology globally, including through projects with U.S. nuclear medical societies to provide targeted peaceful uses assistance with Tanzania and Ghana and in the Western Hemisphere, and provided funding to the IAEA to facilitate more than a dozen projects with partner countries.



2.1.5 Develop Leading Edge Proliferation Detection Capabilities

DOE/NNSA provides crosscutting research and development that drives the innovation of U.S. technical capabilities to detect nuclear detonations; foreign nuclear weapons program activities; and the presence, movement, or diversion of special nuclear material. DOE/NNSA:

- Develops and sustains foundational nonproliferation and technical competencies that provide the technical agility needed to support a broad spectrum of U.S. nonproliferation mission and anticipated threat reduction and response.
- Advances the scientific understanding of nuclear proliferation signatures and observables.
- Works through university consortia to conduct research and development in nuclear science, engineering, nuclear forensics, and other disciplines and train the next generation of experts to support nuclear nonproliferation, nuclear security, and treaty compliance monitoring.

FY 2023 Priorities

- Provide a broad, underlying set of technical capabilities that support nuclear nonproliferation and nuclear security, continuing to expand current technical frameworks and research and development efforts focusing on arms control and warhead verification and monitoring.
- Fabricate space-based Global Burst Detector nuclear detonation detection payloads and test assets for Global Positioning System Block IIIF satellites in accordance with the negotiated schedule with the U.S. Air Force.
- Continue testbed development for the Low Yield Nuclear Monitoring effort, designed to improve U.S. capabilities to detect and characterize low-yield, and evasively conducted underground nuclear explosions.
- Support facility upgrades and equipment procurements to create a comprehensive, physics-based computational model that can predict the output of an entire uranium enrichment system based on the specific design of a single machine.
- Support four university consortia to address basic gaps in nuclear nonproliferation, treaty compliance monitoring, and forensics.

FY 2022 Accomplishments

- Supported the successful launch of the U.S. Space Force (USSF) Space Test Program satellite that contained two payloads for global nuclear detonation detection monitoring; one payload is the Space and Atmospheric Burst Reporting System (SABRS) that will detect nuclear explosions as part of the U.S. Nuclear Detonation Detection System (USNDS), and the second will test the performance of technologies planned for use in future sensor designs.
- Completed a field experiment at the Nevada National Security Site to detect electromagnetic signals emanating from an underground explosion and improve U.S. capabilities to detect and characterize low-yield and evasively conducted underground nuclear explosions.
- Completed upgrades to the first four laboratories of the Uranium Science and Technology Center at Oak Ridge National Laboratory, which will allow for development of scientific capabilities and expertise focused on uranium chemistry in the context of nuclear proliferation.
- Conducted a high-explosive hydrodynamic testing campaign to understand signatures associated with such events with the goal to enhance U.S. modeling and simulation capabilities that support the detection of nuclear weapons development.

Space-based Nuclear Detonation Detection

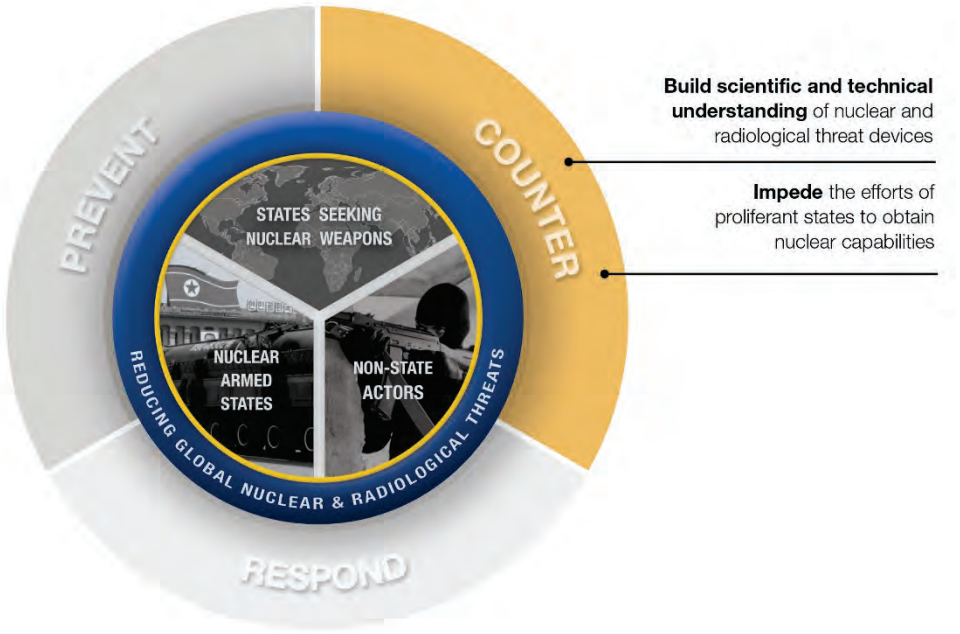
Global Nuclear Monitoring: DOE/NNSA develops and builds the United States' space-based operational sensors to monitor and report nuclear detonations from the earth's surface out to exoatmospheric space. DOE/NNSA delivers these satellite payloads to meet interagency

performance and schedule commitments and provides launch and on-orbit operational support for the U.S. Nuclear Detonation Detection System (USNDS). The USNDS provides critical information for five mission areas from peace-time treaty monitoring to military applications.

DOE/NNSA supported the successful December 2021 launch of the U.S. Space Force (USSF) Space Test Program satellite, STPSat-6, which contained two NNSA-provided payloads for global nuclear detonation detection monitoring. SABRS is the primary mission payload and will detect nuclear explosions as part of the USNDS, and the second will test the performance in space environments of technologies planned for use in future sensor designs. Next-generation USNDS payload development and production is ongoing at Sandia National Laboratories (SNL) and Los Alamos National Laboratory (LANL) for future delivery to the USSF.

2.2 Counter

Under the **Counter** portion of its agenda, DOE/NNSA pursues two key objectives to advance the Nation's technical capabilities to understand and defeat nuclear threat devices, including improvised nuclear devices (INDs) and lost or stolen nuclear weapons.



2.2.1 Build Scientific and Technical Understanding of Nuclear and Radiological Threat Devices

DOE/NNSA provides technical expertise to advise and enable all aspects of U.S. Government nuclear counterproliferation and nuclear counterterrorism missions.

DOE/NNSA uses nuclear weapons design and materials expertise to analyze nuclear threat device concepts and develop plans and countermeasures against a wide range of nuclear threats and devices. This knowledge informs U.S. Government policies, regulations, and key DOD mission partners on terrorist and proliferant state nuclear threats and related contingency planning. DOE/NNSA:

- Advances scientific and technical understanding of nuclear and radiological threat devices, including INDs and lost or stolen foreign nuclear weapons.
- Advises on protection requirements for nuclear materials.
- Conducts exchanges with international partners to prevent and counter nuclear terrorism and nuclear proliferation.

FY 2023 Priorities

- Execute a major validation experiment to increase confidence in disablement techniques and improve accuracy in predictive modeling capabilities in support of the counter-weapons of mass destruction (C-WMD) mission.

- Evaluate performance of tool suites that were recently transitioned to private industry production partners.
- Continue procurement of mission critical equipment to recapitalize equipment that has exceeded its useful life, including handheld and vehicle-borne radiation detection equipment, high resolution spectroscopic identification systems, correlated neutron detectors, high-energy radiography equipment, and contamination survey meters.

FY 2022 Accomplishments

- Conducted more than 10 experiments to increase DOE/NNSA's confidence and accuracy in predictive modeling capabilities and new disablement tools in support of the nuclear device defeat mission.
- Completed a multi-year integrated experimental validation campaign, as well as uncertainty quantification studies, to qualify 3-D predictive modeling and simulation capabilities for specific disablement techniques.

- Executed two major integrated experiments in support of nuclear materials characterization assessments.
- Executed multiple fully diagnosed experiments in support of its integrated experimental series. Various experiments supporting nuclear materials characterization were executed at LANL, Lawrence Livermore National Laboratory, and SNL.
- Continued to support the development of new tools that support WMD device defeat, nuclear search, detection, and remediation.
- Completed three demonstration projects for innovative technologies to address emerging proliferation threats.

2.2.2 Support Efforts to Impede Proliferant States' Ability to Obtain Nuclear Capabilities

DOE/NNSA delivers expert analysis and technical solutions to support U.S. Government efforts to impede proliferant states' efforts to obtain nuclear weapons capabilities. DOE/NNSA:

- Applies its science-based understanding of nuclear threat devices to provide risk-informed support for a variety of counterproliferation missions. These technical capabilities and expertise, bolstered by collaboration with interagency partners, allow the U.S. Government to achieve counterproliferation objectives and increase confidence in mission effectiveness.
- Administers a substantial portfolio to enable U.S. Government export control and interdiction activities, working closely with foreign governments and multilateral organizations to curb the spread of proliferation-relevant technology and equipment.

FY 2023 Priorities

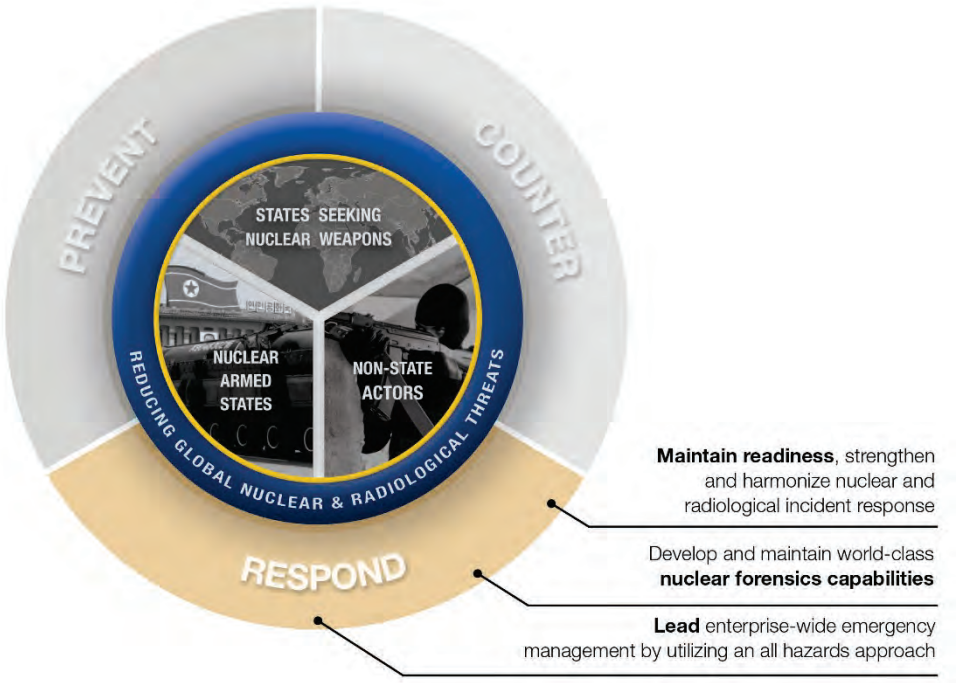
- Deliver expert analysis and technical solutions to support U.S. Government efforts to delay, degrade, deny, or deter proliferant states' nuclear weapons programs.
- Apply science-based understanding of nuclear threat devices and provide risk-informed support for a variety of counterproliferation missions.
- Integrate DOE/NNSA's specialized and unique counterproliferation capability (technology, expertise, infrastructure) and strategic policy development to support emergency response and the U.S. counterproliferation apparatus.
- Collaborate with mission partners, including foreign governments, multilateral organizations, and U.S. law enforcement, to curb the spread of proliferation-relevant technology and equipment worldwide and to support U.S. Government export control and interdiction activities.

FY 2022 Accomplishments

- Contributed to the interagency policy planning process and development of interagency strategic counterproliferation initiatives.
- Developed intra-agency coordination leveraging multiple counterproliferation efforts across the organization.
- Supported DOD operational planning requirements through the execution of more than ten threat-relevant experiments to increase confidence in technical assessments.

2.3 Respond

Under the **Respond** portion of its agenda, DOE/NNSA pursues three key objectives to execute nuclear and radiological crisis response and consequence management missions worldwide, while also administering and directing the implementation and integration of emergency management programs.



2.3.1 Maintain Readiness, Strengthen and Harmonize Nuclear and Radiological Incident Response

DOE/NNSA's Nuclear Emergency Support Team (NEST) serves as the Nation's last line of defense against a nuclear or radiological incident or accident. NEST provides a flexible, scalable, and tailorable capability to maintain readiness against nuclear or radiological incidents, both domestic and foreign. DOE/NNSA maintains a robust infrastructure for command, control, coordination, and communication of NEST's nuclear incident response assets, and maintains response personnel who are equipped for rapid deployment in response to an incident or accident anywhere in the world. Specialized response teams are prepared to support a variety of national security and public health and safety efforts, ranging from threat-based nuclear search to providing preventive nuclear and radiological detection support to public safety organizations at major public events.

Beyond maintaining readiness, DOE/NNSA strengthens preparedness for all nuclear and radiological incidents, accidents, and terror threats posing a threat to the U.S. national security interests. DOE/NNSA:

- Partners domestically with federal, state, and local officials to bolster their capabilities to respond to a nuclear or radiological threat or incident.
- Cooperates with partner countries and international organizations worldwide to strengthen their capacity to effectively address nuclear or radiological threats in their regions.

- Executes capacity building programs to strengthens domestic and international preparedness, as part of the robust strategy to respond to nuclear and/or radiological incidents and accidents, whether due to malicious acts, accidents, or natural disasters.
- Develops and delivers training, workshops, exercises, and peer-to-peer collaborations with partner countries supporting the technical elements associated with the investigation and prosecution of nuclear smuggling incidents.

FY 2023 Priorities

- Enhance DOE/NNSA facilities to accommodate increased training requirements, including hazards associated with enhanced toolsets to defeat WMD, and integrating toolsets more effectively with Federal Bureau of Investigation (FBI) field team training.
- Continue DOE/NNSA equipment recapitalization, innovation, and delivery of equipment to responders while assessing potential gaps and improvement options with the NSC and interagency mission partners.
- Continue to support the development of innovative capabilities that support WMD device defeat, nuclear search, detection, and remediation.
- Advance U.S. nuclear threat reduction and emergency preparedness policy objectives through engagements with international organizations and foreign partners, bolstering global response capabilities and reinforcing mechanisms for cooperation.
- Further develop the DOE/NNSA Reserve Corps initiative to increase existing capacity to respond to nuclear/radiological incidents requiring sustained operations for several weeks to months.
- Develop an exercise implementation plan in coordination with operational partners to align NEST technical assistance and capability with National Security Presidential Memorandum 36 direction and objectives.
- Expand and deepen existing relationships with partner country agencies to enhance the partner investigation support capabilities to include capacity building focused on isotopic identification and analysis of detected material.

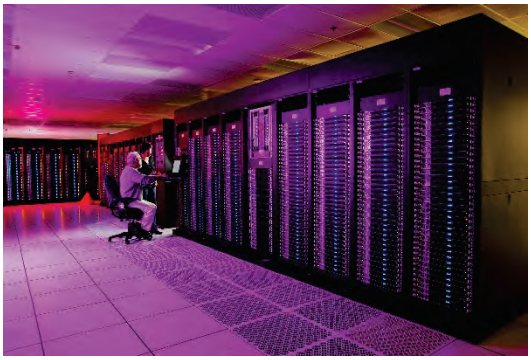
FY 2022 Accomplishments

- Trained partners on schedule and within budget to support the “Capability Forward” initiative, providing training, equipment, and technical support to enhance the FBI’s regional C-WMD teams capabilities, accelerating life-saving responses to nuclear threats.
- Advanced radiological/nuclear emergency preparedness response domestically and internationally by collaborating with domestic and international partners to conduct 50 virtual or in-person training events on topics including crisis communication, nuclear incident response, medical response, and security of major public events.
- Conducted 23 engagements with foreign partners and international organizations, including Israel, Taiwan, Japan, Canada, the Arctic Council, and the IAEA, to advance U.S. nuclear threat reduction and emergency preparedness objectives.
- Improved and integrated Public Health and Safety programs to provide an agile and interoperable capability that is mutually supportive across all mission areas, including mission partner engagement, anomaly detection, analysis, and assessment.

2.3.2 Develop and Maintain World-class Nuclear Forensics Capabilities

DOE/NNSA develops and maintains world-class nuclear forensic capabilities that can be used to determine the origin of nuclear materials interdicted outside of regulatory control or used in a nuclear device in coordination with the interagency and international partners. DOE/NNSA's technical ability to conduct highly sophisticated nuclear forensics assessments aids attribution of illicit nuclear material sources and constitutes an essential element of the U.S. Government's strategy to reinforce nuclear security norms, deter state support for nuclear terrorism, and hold adversaries accountable for nuclear incidents. DOE/NNSA:

FIGURE 8: NUCLEAR FORENSICS



Use of supercomputers is integral for nuclear forensics data evaluation.

- Shares leadership and supports capability development, assessment, strategic planning, and interagency coordination of the U.S. Government National Technical Nuclear Forensics (NTNF) Program, which provides a well-integrated program that supports the characterization and attribution of nuclear material, device, accident, or attack.
- Maintains nuclear forensics technical and operational capabilities that support the U.S. Government nuclear forensics core mission areas of pre-detonation device, post-detonation, and pre-detonation materials analysis.
- Provides capabilities for response to nuclear/radiological incidents, including identifying and assessing high value samples; device disassembly/disposition; device assessment; and analysis of interdicted nuclear material and improving international partnerships and training capacity.
- Maintains the National Nuclear Material Archive (NNMA), which identifies, prioritizes, analyzes, and characterizes high-value historical nuclear material samples, a critical tool allowing for comparative analysis of material characteristics, which significantly aids assessment of interdicted materials.

FY 2023 Priorities

- Develop national laboratories' operational and scientific capabilities to provide whole-of-government nuclear forensics response activities and support to attribution and expand national security work relevant to nuclear forensics at the laboratories to reinforce essential nuclear forensics expertise.
- Contribute to a new Concept of Operations for post-detonation forensic ground collection to enhance operational and technical capabilities across a broader spectrum of scenarios. Explore options to mitigate or eliminate risk to the pre-detonation device mission from increasing and competing demands on aging facilities and infrastructure.
- Plan and deliver measures to improve U.S. nuclear forensics operations and infrastructure to strategically meet new deterrence, collection, analysis, and evaluation requirements for nuclear incidents.
- Plan for improved interfaces between exercises with nuclear forensics equities.

FY 2022 Accomplishments

- Developed comprehensive updates to nuclear forensics collection, analysis, and evaluation of technical and operational requirements.
- Completed the initial identification of high-value nuclear forensics specimens needed for the NNMA and improved analytical capacity.
- Developed innovative techniques applicable to nuclear forensics through modern analyses of legacy nuclear test fallout debris samples and irradiation experiments at the Nuclear Criticality Experiments Research Center.
- Completed construction and occupation of a consolidated deployment facility for DOE Forensics Operations that will enhance the maintenance and deployment of equipment in direct support of the Ground Collection Task Force.
- Began, and partially completed, infrastructure improvements for the Disposition and Forensic Evidence Analysis Team to mitigate risk from aging tunnel facilities and rail equipment.
- Resumed normal schedule of in-person operational forensics exercises and training events, following a long period of conducting multi-site virtual work sessions and tabletop exercises.

FIGURE 9: BUILDING INTERNATIONAL NUCLEAR FORENSICS CAPACITY

Nuclear forensics course participants working on an investigation scenario in a mock laboratory setup at the Department of Energy's HAMMER facility.

2.3.3 Lead Enterprise-Wide Emergency Management by Utilizing an All-Hazards Approach

DOE/NNSA's Emergency Operations administers and directs the implementation and integration of emergency management programs across the DOE and DOE/NNSA enterprise to prevent, prepare for, protect from, respond to, recover from, and mitigate all-hazard emergencies that threaten life, property, and the environment.

The Office of Emergency Operations prepares DOE, including NNSA, to respond promptly, efficiently, and effectively to any emergency involving or affecting DOE and NNSA sites, facilities, and activities, or any emergency in which DOE and NNSA equities can assist. Emergency Operations' role in a nuclear event is to support the responding elements of DOE/NNSA while coordinating with those elements and senior leadership, providing secure, reliable communications throughout the event. These actions and resources provide the same support across the DOE/NNSA enterprise, in collaboration with the Department of Homeland Security, the Federal Emergency Management Agency, and other partner agencies, for any type of emergency or continuity event that adversely impacts the Department's ability to successfully accomplish its Mission Essential Functions.

DOE/NNSA's Office of Emergency Operations is designed to provide an integrated planning approach and operational support throughout DOE/NNSA as well as a link to the wider emergency management community. The office is the central point in the collaboration among Federal, state, local, Tribal, and territorial partners. Covering all phases of incidents and events, the office is responsible for:

- Developing and administering all DOE/NNSA emergency management policies, technical guidance, and support.
- Implementing, managing, and coordination of readiness assurance, training, and exercise programs to prepare the Department to respond to and recover from all-hazards emergencies at Headquarters and at every lab, plant, and site.
- Providing 24/7/365 operations and communications support for the NNSA Emergency Management Enterprise and Senior Leadership. This is accomplished through the Consolidated Emergency Operations Center (CEOC) for daily monitoring and the unified coordination across the Emergency Management Enterprise during escalated operations.
- Managing and leading the various Departmental continuity programs and provide interoperability and modernization of the continuity communications systems and infrastructure across DOE/NNSA and with interagency partners.

- Guiding continuous improvement efforts to achieve a higher level of performance in all emergency and continuity operations.

FY 2023 Priorities

- Institutionalize Executive Order 13961, "Governance and Integration of Federal Mission Resilience", and the related Federal Mission Resilience Strategy to promote viable mission assurance capabilities.
- Align the new Office of Emergency Management strategic plan with DOE/NNSA priorities and resources.
- Incorporate validated emergency management and continuity procedures for DOE/NNSA leadership.
- Lead the design and development of DOE's participation in continuity exercises, Eagle Horizon, and the interagency National Level Exercise program 2022.
- Integrate the Secretary of Energy's CEOC with internal and external partners.
- Mature the Emergency Management Readiness Assurance Reporting Program.
- Institutionalize the tenets of the Assess, Distribute, and Sustain model into departmental day-to-day operations.
- Develop Generation 2 Emergency Readiness Assurance Reporting Dashboard.

FY 2022 Accomplishments

- Planned and executed the annual Eagle Horizon exercise which included participation from senior leadership, DOE headquarters offices, laboratories, plants, and sites.
- Led Federal Mission Resilience efforts across DOE and the interagency prepare the Federal Executive Branch to perform essential functions regardless of threats or conditions.
- Secured Secretarial approval of DOE Order 150.1B, Continuity Programs, which instructs all headquarters offices and field laboratories, plants, and sites of what must be addressed in their continuity programs and in their Continuity of Operations plans.
- Implemented the FY 2022-FY 2024 Emergency Operations Strategic Plan.
- Developed and conducted continuity succession briefings with DOE/NNSA senior leadership participation.

CHAPTER 3

Cross-cutting Priorities and Key Enablers

DOE/NNSA's cross-cutting priorities and key enablers are increasingly important to respond to the evolving threat environment and its support to the U.S. Government's nuclear policy agenda.

3.0 Cross-cutting Priorities and Key Enablers

3.1 Cross-cutting Priorities and Responses

As the Department of Energy, National Nuclear Security Administration (DOE/NNSA) implements the ten objectives of its strategic framework detailed above, the following set of activities are increasingly important as the DOE/NNSA responds to the evolving threat environment in alignment with the Administration's nuclear policy agenda. This section outlines DOE/NNSA priorities and responses, which include:

- Integrating nonproliferation and nuclear security in advanced nuclear designs in support of the clean energy transition
- Strengthening U.S. Government technical nuclear forensics capabilities
- Leveraging the benefits of emerging technologies while minimizing the risks
- Achieving permanent threat reduction through new and alternative technologies
- Strengthening U.S. Government counterproliferation capabilities
- Developing technology and approaches for future arms control agreements

FIGURE 10: DOE/NNSA RESPONDS TO AN EVOLVING THREAT ENVIRONMENT

3.1.1 Addressing Climate Change Through Clean Energy Technologies and Advanced Nuclear Designs

On January 27, 2021, President Biden stated that addressing the climate crisis "is more necessary and urgent than ever." In his Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad", President Biden set a goal to achieve net-zero emissions no later than 2050 and outlined the DOE's role in "intensifying international collaboration to drive innovation and deployment of clean energy technologies, which are critical for climate protection."

DOE is pursuing several new initiatives to maximize the full potential of nuclear energy as a key technology for meeting U.S. climate goals and reducing emissions globally. The Department is investing heavily in nuclear technology research and development to enable the development and deployment of a broad set of advanced nuclear reactor designs over the next 15 years, and expanding the breadth and scope of international collaborations to advance U.S. climate goals so countries have the necessary nonproliferation measures in place to maintain a nuclear energy program. One such example is the Net Zero World Initiative, which Secretary of Energy Granholm announced at the 26th United Nations Climate Change Conference of the Parties in November 2021. The Net Zero World Initiative expresses DOE's commitment to partnering with specific countries to develop tailored, actionable technology road maps and investment strategies that would "accelerate global energy system decarbonization" and enable countries to achieve net zero emissions.

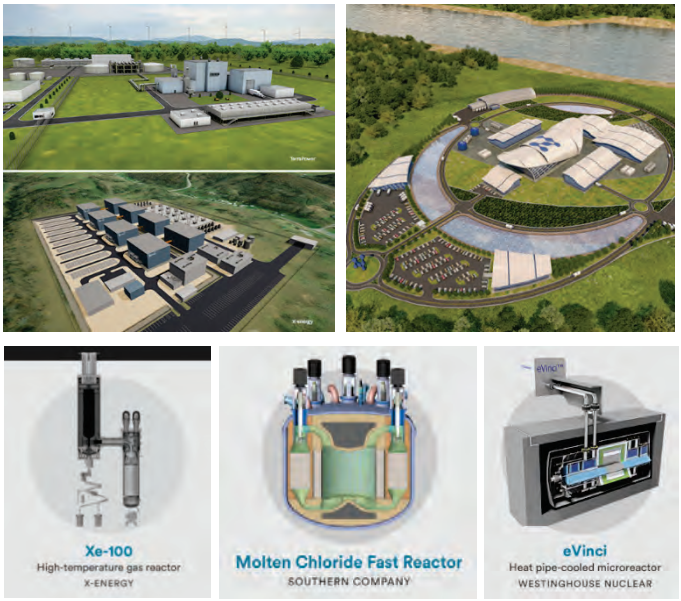
DOE/NNSA plays a pivotal role in supporting the safe, peaceful use of nuclear energy as a clean energy source and will strengthen public-private and international partnerships to aid in the adoption of next generation nuclear power. DOE/NNSA works with U.S. industry, multilateral institutions, and partner countries so that nonproliferation measures, including safeguards, security, and proliferation resistance are integrated as early as possible in nuclear power plant designs and national systems.

Leveraging its unique technical capabilities and policy expertise, DOE/NNSA pursues a multi-pronged strategy to support partner countries' access to the peaceful uses of nuclear energy. This strategy includes:

- Partnering with the International Atomic Energy Agency (IAEA) and its Member States to encourage adherence to international legal instruments and frameworks to confirm the safe, secure, and peaceful use of nuclear energy, including adoption of the Additional Protocol as the universal standard for promoting peaceful uses of nuclear energy and the Amendment to the Convention on the Physical Protection of Nuclear Material as the legally binding instrument on security of nuclear material.

- Working with the U.S. Nuclear Regulatory Commission and U.S. industry on voluntary Safeguards by Design (SBD) and Security by Design (SeBD) efforts to address nonproliferation challenges and risks posed by advanced reactor and small modular reactor designs.
- Implementing 10 CFR Part 810 (Part 810) regulations for U.S. nuclear exporters, 123 agreements for peaceful nuclear cooperation, and dual-use license reviews to enable U.S. leadership in nuclear technology while mitigating proliferation risk and continuing to evolve U.S. regulatory frameworks to consider proliferation-sensitive emerging technologies.

FIGURE 11: ADVANCED NUCLEAR ENERGY SYSTEMS



Advanced nuclear energy systems are a key part of DOE's goal to develop safe, clean, and affordable nuclear power options. The advanced SMRs currently under development represent a variety of sizes, technology options, capabilities, and deployment scenarios. DOE/NNSA is committed to address nonproliferation challenges and risks posed by the new advanced nuclear.

- Working bilaterally and multilaterally to assist partner countries—particularly nuclear newcomers—in the development of robust nuclear regulatory frameworks, policies, and practices, and providing relevant training for those responsible for the development, oversight, and operation of new or expanded nuclear facilities or other nuclear applications.
- Minimizing the use of highly enriched uranium (HEU) in civilian facilities and downblending excess stocks of HEU to provide a reliable supply of high-assay low-enriched uranium (HALEU) so the United States can supply fuel and targets for research reactors and medical isotope production facilities.
- Leveraging opportunities to expand access to the peaceful uses of nuclear technology consistent with Article 4 of the Nuclear Non-Proliferation Treaty, which can contribute to mitigating climate impacts as well as support advances in agriculture, clean water, and global health.
- Promoting closer collaboration between security and the nuclear application user communities to identify solutions that uphold nuclear security objectives and support and advance sustainable development goals.

NNSA's Engagement with the Advanced Reactor Community on Safeguards and Security by Design

The Fiscal Year 2021 Omnibus Appropriations Legislation (Consolidated Appropriations Act, 2021, Public Law 116-160) directed DOE/NNSA to evaluate the nonproliferation, security, and safeguards aspects of advanced reactors and promote the implementation of Safeguards by Design (SBD) features in advanced nuclear reactors. In response, DOE/NNSA launched the Advanced Reactor International Safeguards Engagement (ARISE) and International Nuclear Security for Advanced Reactors (INSTAR). The programs promote the timely incorporation of SBD and Security by Design (SeBD) respectively to help vendors meet international safeguards requirements and security regulations and best practices, improving the international deployment potential of U.S. designs.

What are SBD and SeBD?

SBD is a method of incorporating IAEA safeguards considerations (e.g., IAEA surveillance, containment, and monitoring equipment) as early as possible in the design process of a new or modified nuclear reactor designs and facility to prevent misuse of a facility or diversion of material by the State. SeBD refers to the early incorporation of nuclear security considerations (e.g., modifying the locations of doors or barriers, camera infrastructure for enhanced detection, delay, or response) to prevent material theft or facility sabotage by non-state or malicious actors.

Why is it important to engage with the advanced reactor community?

As governments around the world consider nuclear power as a carbon-free energy source, many U.S. vendors will seek to export their advanced reactor designs to meet the increased demand. Most countries are legally obligated to implement IAEA safeguards under the NPT, and U.S.-designed reactors exported to these countries will be subject to IAEA verification requirements. The Amended CPPNM, which entered into force in 2016, legally requires states to protect nuclear materials and facilities from theft or sabotage and has 127 signatories. By incorporating SBD and SeBD early in a project, U.S. reactor developers not only make their designs more exportable, they also protect the scope, schedule, and budget of their projects by reducing the risk of costly retrofits to meet safeguards and security requirements. Current Nuclear Regulatory Commission requirements reflect international safeguards and security, and SBD and SeBD measures can protect U.S. vendors from significant redesign costs if licensing requirements change in the future and in light of unique international security requirements.

How do the ARISE and INSTAR work with U.S. industry?

DOE/NNSA offers technical support from national laboratory experts to U.S. vendors throughout the design, regulatory review, licensing, and commissioning phases of a reactor.

- **ARISE** educates the U.S. nuclear industry on international safeguards legal requirements and regulations and conducts technical analyses to recommend ways to integrate safeguards considerations (e.g., approaches to account for nuclear material and maintain continuity of knowledge) into the facility design as early as possible.

- **INSTAR** provides the U.S. nuclear industry and newcomer countries with security tools and analysis for advanced and small modular reactors and supports SeBD technical partnerships with U.S. developers to incorporate protection related elements early, frequently, and continuously throughout the design of a new nuclear facility to achieve cost and risk informed results.

3.1.2 Strengthening U.S. Government Technical Nuclear Forensics Capabilities

A robust nuclear forensics capability enables the U.S. Government to identify and hold accountable any state, terrorist group, or other non-state actor that facilitates terrorist efforts to obtain or use radiological or nuclear weapons. Acknowledging its importance, the 2022 Nuclear Posture Review report, as well as previous NPRs issued by previous Administrations, have highlighted nuclear forensics as a key element of the U.S. Government strategy to deter state support for nuclear terrorism.

FIGURE 12: DOE/NNSA FORENSICS OPERATIONS

DOE/NNSA forensics team member processing samples.

DOE/NNSA plays a leading role in the U.S. Government's nuclear forensics mission, providing world-class scientific capabilities in support of the attribution of nuclear threats. This mission includes analyzing nuclear materials outside of regulatory control, assessing the design of interdicted nuclear threat devices, and assessing debris and other data from a detonated device. This information is combined with intelligence and law enforcement information to determine the nuclear material source and device origin.

Nuclear forensic capabilities are fundamental instruments of deterrence. While many terrorist groups are seemingly "undeterrable" because terrorists could receive technical or material assistance from a hostile foreign government, nuclear forensics for attributing nuclear material and devices is crucial to deterring external support from would-be nuclear terrorists. Nuclear forensic science underpins the very credibility of U.S. threats to retaliate against any state sponsors of nuclear terrorism.

For nuclear forensic capabilities to properly influence the behavior of foreign governments, continued investments are needed in the national laboratory infrastructure that enables forensic analyses and assessments, including by sustaining investments in research and development and scientific personnel. DOE/NNSA will therefore reinforce maintaining forensics-related expertise with the same persistence that it devotes to the scientists and engineers who service the U.S. nuclear stockpile. Likewise, DOE/NNSA and its mission partners will showcase U.S. forensic capabilities and cultivate international acceptance of the scientific integrity of nuclear forensics tools and techniques.

National policy on nuclear forensics has been established by presidential policy directives and implemented through federal mission partner programs. In August 2007, the first National Technical Nuclear Forensics (NTNF) policy directive was issued as a part of the National Strategy to Combat Weapons of Mass Destruction.

DOE/NNSA is taking on additional interagency responsibility for U.S. Government NTNF capabilities. This will allow the forensics mission to immediately benefit from improved timeliness and confidence during a crisis, in addition to providing long term stability and advocacy for the mission.

3.1.3 Leveraging the Benefits of Emerging Technologies While Minimizing the Risks

In remarks before the United Nations General Assembly in September 2021, President Biden committed to making "a profound investment in research and innovation…to develop new tools and technologies to help us tackle the challenges of this second quarter of the 21st century and beyond." DOE/NNSA is conducting over-the-horizon assessments to look expansively at emerging technologies and assess their possible impact to global nonproliferation and nuclear security norms and practices. In March 2022, DOE/NNSA completed the first study in its Strategic Outlook Initiative, looking at the emerging technology landscape over the next 15-20 years to evaluate the impact on DOE/NNSA's mission.

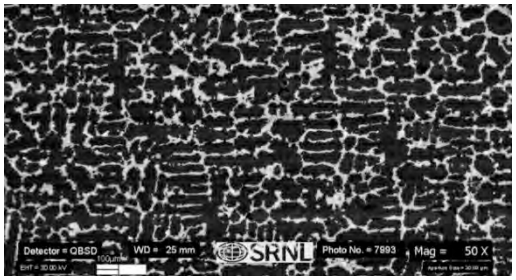
Emerging technologies—such as artificial intelligence (AI), advanced manufacturing, 5G, and blockchain—pose new challenges by potentially reducing traditional barriers to proliferation and increasing capabilities of potential adversaries to compromise the security of fissile material or facilities through theft or sabotage. For this reason, DOE/NNSA conducts systematic studies and assessments to understand the potential risks and benefits of emerging technologies. DOE/NNSA is investing in several emerging technology areas and program innovations to bolster its nuclear risk reduction mission. Additionally, DOE/NNSA is working with academia and partners such as the Stimson Center and the World Institute for Nuclear Security to gain new insights into the emerging technology space and its potential impacts on nuclear security.

DOE/NNSA continues to actively explore areas where emerging technologies can enhance and strengthen its nuclear threat reduction activities. Key initiatives include:

AI Tools for Earlier Proliferation Detection: DOE/NNSA is leading the U.S. effort to invest in Next-Generation AI to support early detection of nuclear threats, including covert nuclear material production and movement, weapons development activities, and nuclear detonations. DOE/NNSA is exploring AI-based methods to identify institutions with relevant expertise and their associated facilities, analyze open-source technical publications, detect illicit procurements by foreign companies, track the progress of weapons-related research, and fuse sensor data to improve proliferation assessments. High-consequence proliferation assessments require capabilities beyond commercial AI. Leveraging decades of experience understanding nuclear signatures, material characteristics, and other observable indicators of nuclear proliferation activity, DOE/NNSA and the national laboratories conduct multi-disciplinary research and development to develop data analytics approaches to better understand data that is already available and predict proliferation activities as early as possible.

Mobile System for HEU Downblending: Drawing on more than two decades of nuclear materials science, mobile systems, and the world-class science and engineering expertise of the national laboratories, DOE/NNSA is deploying a new capability to minimize the use of HEU globally. DOE/NNSA's Mobile Melt-Consolidate (MMC) system is a flexible tool, capable of processing a wide variety of HEU materials into a form that can no longer be used for a nuclear device. The MMC system allows this processing to take place at partner country's facilities and transforms weapons-usable nuclear material into a more proliferation-resistant, low-attractiveness waste form ready for permanent disposition outside of the United States. The MMC system also allows DOE/NNSA to avoid the international transport of HEU-bearing material and will reduce the overall amount of material returned to the United States.

FIGURE 13: MMC PRODUCT



Microstructure of a demonstration Mobile Melt Consolidate (MMC) product, showing a uranium-thorium (white) mixture microencapsulated in a metallic (black) matrix.

Other DOE/NNSA Emerging Technology Applications:

DOE/NNSA, in partnership with the labs, plants, and sites, is exploring the application of a range of additional emerging technologies to enhance the effectiveness of its efforts to prevent, counter, and respond to nuclear threats. These include the following exploratory efforts:

- **Unmanned Aerial Systems (UAS)**: DOE/NNSA works with the international nuclear security community to understand and mitigate the threat of unmanned aerial systems incursion at nuclear facilities and on materials both in situ and in transit. These efforts include collaborations on testing and evaluation of UAS and Counter-UAS systems. DOE/NNSA is also examining the potential utility of remote-operated systems for threat detection, delay and response as part of protection strategies for advanced nuclear reactors.

FIGURE 14: UNMANNED AERIAL SYSTEMS

Nevada National Security Site achieved operating capability to conduct Unmanned Aerial Vehicle experiments and safely and securely executed sustainable test range activities in support of federal, national laboratory, and industry missions.

- **AI for Nuclear Security**: DOE/NNSA is researching whether artificial intelligence and artificial neural networks could be used to leverage data signals already being captured at civilian nuclear facilities during normal business operations to improve insider threat detection and mitigation capabilities. DOE/NNSA awareness-building material on the applications of AI for physical protection operators, regulators, and for personnel involved in operation and procurement of security systems. Topics include how AI can be used in security systems, what security questions can be effectively answered via AI-enabled data fusion, AI-based simulation and analysis tools for threats to a nuclear facility, and the application of AI-based approaches to system testing.

Strengthening Export Controls to Address Proliferation-Sensitive Emerging Technologies:

While emerging technologies offer significant opportunities for human advancement, the diffuse nature and wide availability of these technologies also present U.S. national security challenges. Regulatory frameworks designed to prevent the diversion of WMD -related goods and technology, including Part 810 authorizations and dual-use license reviews, are critical first-line defenses so that proposed U.S. transfers of nuclear or other WMD-related commodities do not pose proliferation risk. DOE/NNSA provides expert advice and support to the multilateral export control regimes and to U.S. interagency partners so that U.S. export controls keep pace with potentially proliferation-sensitive emerging technology areas, including 5G and advanced semiconductors.

As one of the statutorily designated export control agencies, DOE/NNSA has a shared responsibility with the interagency to implement Section 1758 of the Export Control Reform Act of 2018 (50 U.S.C. § 4817) to assess emerging and foundational technologies of national security concern for the potential future application of export controls. DOE/NNSA accomplishes this by actively participating in NSC-run Sprint Groups – small working groups of technical experts that quickly determine areas of technology to be export controlled – and providing extensive technical input to this process through coordination with the national laboratories, DOE's Office of Science, and other relevant DOE stakeholders.

3.1.4 Achieving Permanent Threat Reduction Through New and Alternative Technologies

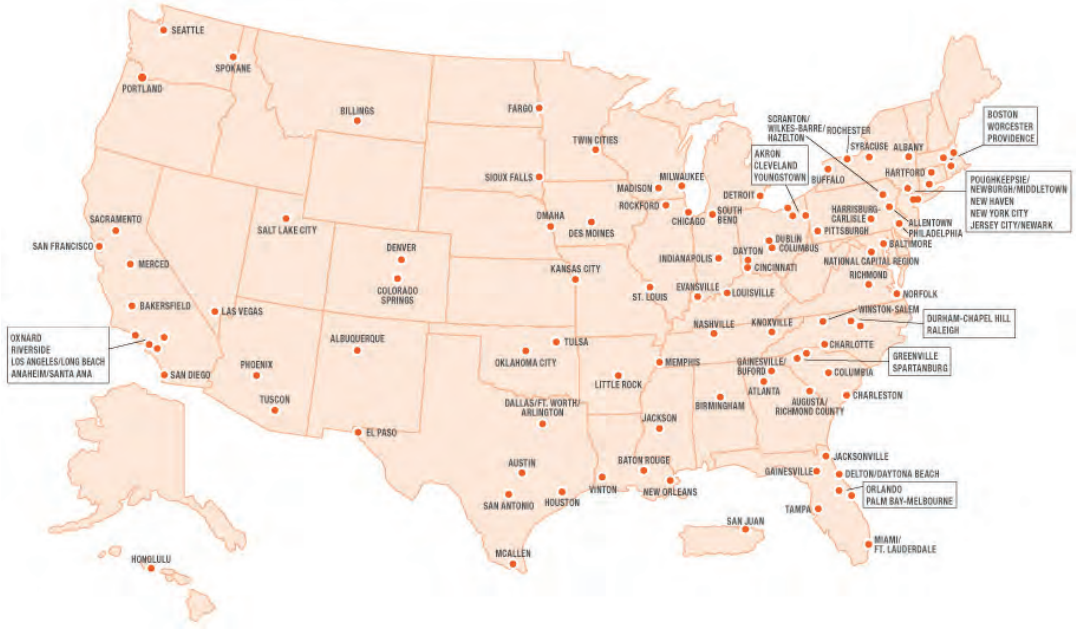
DOE/NNSA continues to strengthen its long-standing strategy to mitigate proliferation risk wherever possible by minimizing, and where possible eliminating, nuclear and radioactive materials that could be used by non-state actors in a radiological or nuclear threat device. Through technology innovations and collaborations with a range of domestic and international partners, DOE/NNSA works to field new and alternative technologies in the place of weapons-usable nuclear material and high-radioactivity sources that could be attractive targets for proliferators.

Supporting Peaceful Uses of Nuclear Technology Without the Use of Weapons-Usable Nuclear Material (WUNM)

DOE/NNSA supports the safe, secure, and peaceful use of nuclear technology without the use of Weapons-Usable Nuclear Material (WUNM) by modifying or converting facilities to eliminate the need for WUNM in civilian applications and by developing new high-density HALEU fuels.

- DOE/NNSA converts research reactors and medical isotope production facilities from HEU fuels and targets to HALEU fuel and targets. This eliminates both the use of HEU and the commercial supply and transit of HEU.
- DOE/NNSA is also qualifying new high-density HALEU fuels for use in high flux and high-performance research reactors, as these reactors cannot use existing HALEU fuels without significant loss of performance and capability. These first-of-a-kind HALEU fuels will also give research reactor designers options for building the next generation of research reactors to use LEU, not HEU, fuel.

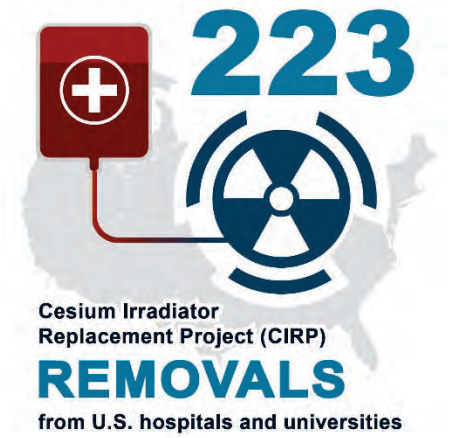
FIGURE 15: RADSECURE 100 METROPOLITAN CITIES



RadSecure 100, a new DOE/NNSA initiative launched in September 2021, focuses on enhancing radiological security in facilities in 100 U.S. metropolitan areas across the Nation that contain the highest priority materials, including cesium-137, cobalt-60, americium-241, and iridium-193. RadSecure 100 will reduce the risk of radiological terrorism by replacing the material or securing it.

DOE/NNSA reduces the risk of radiological terrorism at home and abroad by encouraging domestic and international partners to transition away from radioactive sources where feasible to more secure alternatives. Key initiatives include:

- Offering financial incentives and device removal support to domestic sites interested in replacing cesium-137 irradiators with non-radioisotopic X-ray devices under DOE/NNSA's Cesium Irradiator Replacement Project.
- Offering financial incentives and support removing devices to international partners interested in replacing cesium-137 or cobalt-60 devices.
- Leading technical information exchanges and discussions, in partnership with the IAEA, non-governmental organizations, and foreign partners to increase awareness of alternative technologies and to understand and eliminate or reduce barriers to implementing alternative technologies.



- Conducting studies that increase the amount of available data to inform users on the application of non-radioisotopic radiation technologies and supports research and development for non-radioisotopic technologies where viable radioactive source-free technologies do not currently exist.

- Working with other U.S. Government programs to evaluate policies on alternative technologies and coordinate strategies for encouraging the sustainable use of non-radioisotopic radiation technologies.

DOE/NNSA and the IAEA Partner to Increase Low- and Middle-Income IAEA Member State Access to Cancer Care Through Provision of Non-Source Based Technologies

DOE/NNSA partners with the IAEA to support Member States in transitioning away, when possible, from the use of devices and machines that use radioactive sources. For example, DOE/NNSA works with the IAEA's Department of Technical Cooperation and the Programme of Action for Cancer Therapy (PACT) to increase Member State access to cancer care through the provision of non-source-based devices, such as linear accelerators, as well as supporting training in the necessary regulatory infrastructure.

In June 2021, the U.S. Ambassador to the International Organizations in Vienna announced a $5 million (USD) contribution from DOE/NNSA to PACT to procure non-source-based technologies for cancer treatment in low to middle income countries. This achieved two purposes of permanently reducing the risk of radiological terrorism and of providing superior technology for improving cancer care quality and access.

3.1.5 Strengthening U.S. Government Counterproliferation Capabilities

DOE/NNSA makes essential contributions to both the U.S. Government's nonproliferation and counterproliferation missions. Nonproliferation efforts largely consist of *cooperative* diplomatic, legal, and regulatory means to dissuade and deter foreign states from attempting to obtain nuclear weapons; restrict access to weapons-relevant materials, technology, and expertise; and verify that nuclear energy is used strictly for peaceful purposes. By contrast, counterproliferation emphasizes *non-permissive* approaches, often involving intelligence, law enforcement, and military activities, to prevent, forestall, roll back, or eliminate efforts to develop or proliferate nuclear weapons.

DOE/NNSA supports these efforts by delivering expert analysis and technical capabilities to U.S. Government partners such as DOD, State which lead efforts to impede proliferant state attempts to acquire nuclear weapons. Working closely with partners in DOD, law enforcement, and the Intelligence Community, DOE/NNSA contributes to the development and implementation of strategic initiatives pertaining to potential nuclear aspirants to reduce nuclear threats to the United States and preserving international stability more generally. DOE/NNSA's technical capabilities and expertise provides the U.S. Government with options to achieve counterproliferation objectives.

Counterproliferation Across the Weapons Spectrum

Applying its science-based understanding of nuclear weapon design and production, DOE/NNSA is uniquely capable of supporting a variety of counterproliferation activities across the weapons

development spectrum. That is, whether a state is contemplating or just embarking on an illicit nuclear program or has made genuine progress toward a nuclear weapon capability.

Interdiction

In conjunction with U.S. interagency partners, DOE/NNSA maintains a substantial portfolio to enable U.S. Government export control and interdiction activities, working in close coordination with foreign government and multilateral regimes and U.S. law enforcement to curb the spread of proliferation-relevant technology and equipment worldwide.

DOE/NNSA participates in all four of the interagency interdiction groups—the Nuclear Interdiction Analysis Group, the Missile Trade Analysis Group, Shield (Chem/Bio), and the Technology Transfer Working Group for military and conventional commodities. DOE/NNSA provides comprehensive technical analyses of interdiction cases and makes policy recommendations to the interagency for potential action. These groups are the primary mechanism to counter foreign acquisition efforts.

FIGURE 16: EXPORT CONTROL TRAINING

Participants from the International Joint Field Operation, conducted by the International Nonproliferation Export Control Program and hosted by Croatia's Customs Administration, examine a mock shipment and associated paperwork to identify the commodity in question and identify any proliferation concerns associated with the shipment.

Export Control

Additionally, DOE/NNSA participates in the multilateral export control regimes, including the Missile Technology Control Regime, the Australia Group, and the Wassenaar Arrangement. NNSA's participation as part of the U.S. Government delegation aims to verify that export control lists remain current and relevant to address emerging technologies and proliferation trends.

DOE/NNSA also contributes to interagency and international efforts to address complex issues such as China's civil-military fusion. China poses a threat to U.S. economic and national security interests through ongoing attempts to illicitly acquire U.S. technology, and through the acquisition of legally exported information for the benefit of both its civilian and military sectors. DOE/NNSA contributes to efforts to counter these proliferation risks by conducting technical analyses of dual-use commodities and technologies and assessing and identifying commodities that pose a risk to aiding a military program. Moreover, DOE/NNSA provides extensive technical expertise to U.S. Government efforts to close gaps in U.S. regulations so that states or proliferators cannot exploit these gaps to acquire items or technologies that would contribute to their own military or WMD programs.

Looking Through the Lens of Integrated Deterrence

Applying the technical expertise of our national laboratories, DOE/NNSA advances the discussion of integrated deterrence at both the policy and technical level by (1) examining the technical tradeoffs between nuclear options and new technologies such as space, cyber, and advanced conventional weapons; and (2) identifying how the United States might reduce the role of nuclear weapons in its defense strategy while meeting military requirements and strengthening deterrence.

Integration generally refers to leveraging the synergies among the various elements of the deterrence toolkit to create stronger or more decisive effects than otherwise could be achieved. In context,

integrated deterrence is interpreted to include offense and defense; nuclear and conventional; U.S. and allied strategies and capabilities; and covert and overt capabilities – with cyberspace and outer space as cross-cutting factors.

At the national level, integrated deterrence strengthens security by offering a broad range of inter-connected capabilities spanning domains, physical spaces, alliance/partner relationships, and levels of competition and conflict. Integrated deterrence is particularly important in confronting a core challenge for the United States and its allies: to deter and defeat a nuclear-armed near-peer in a regional conflict over limited objectives without generating catastrophic nuclear escalation, as illustrated in the U.S. response to Russia's recent invasion of Ukraine.

The value of integration for reducing nuclear risk is potentially substantial. Integration can help to provide more non-nuclear options and thereby convey an improving U.S. ability to manage escalation risk below the nuclear threshold. It can also help to weaken the perception of a large first-mover advantage in cyberspace and outer space and to reduce the risk of escalation arising from misjudgments about U.S. strategic resolve.

The U.S. nuclear deterrent and U.S. nonproliferation/counterproliferation activities are mutually reinforcing. By extending deterrence to U.S. allies and partners, the United States removes incentives for these states to develop indigenous nuclear capabilities. Their refraining from proliferation discourages second-order responses from regional rivals.

3.1.6 Developing Technology and Approaches for Future Arms Control Agreements

The Administration's *National Security Strategy* makes clear its intent to increase strategic stability and strengthen risk reduction measures through arms control.

DOE/NNSA has a long history of providing technical and policy expertise in support of negotiation and implementation of nuclear arms control agreements. After the extension of the New START Treaty, the Administration engaged with Russian counterparts through the Strategic Stability Dialogue, a forum in which the United States and Russia sought to, among other things, lay the groundwork for future arms control agreements. China's accelerating nuclear modernization and expansion efforts continue to raise U.S. concerns about China's intent, but the Administration continues to explore potential opportunities to engage Beijing.

DOE/NNSA also provides the U.S. Government with unique, specialized, and field-tested capability for monitoring and verifying nuclear weapons material production and nuclear explosive testing activities in foreign countries in support of current or future negotiated agreements. DOE/NNSA continues to invest in research and development efforts to develop monitoring and verification technologies that can meet future nuclear arms control, nonproliferation, and security challenges. DOE/NNSA is actively considering the shape and format of future arms control agreements with an understanding that the security environment and technology itself are rapidly evolving.

- DOE/NNSA has developed a "Warhead Verification Capability Development Plan," which describes NNSA's plan for developing, assessing, and demonstrating verification capabilities in support of potential future arms control regimes. The plan outlines approaches, required capabilities, and readiness assessment against all weapon lifecycle stages.

- DOE/NNSA's Arms Control Advancement Initiative (ACAI) is a comprehensive investment into arms control monitoring and verification (M&V) capabilities. ACAI will support both existing M&V efforts as well as initiate and sustain several new M&V activities. Areas of investment include the establishment of a multi-lab, multi-disciplinary research and development effort focused on developing new arms control monitoring technologies as well as a research and development testbed, user facilities, and implementation of NNSA's Next Generation Arms Control human capital development and sustainment program.

FIGURE 17: DOE/NNSA'S ARMS CONTROL ADVANCEMENT INITIATIVE

3.2 Key Enablers – Innovate, Collaborate, Deliver

To address the ten objectives of its strategic framework and the areas of increasing priority, DOE/NNSA works in partnership with its laboratories, plants, and sites to leverage key enablers and core competencies. The enablers below leverage the organization's combined expertise to continually innovate, collaborate, and deliver proactive policy and technical solutions:

- Investing in a long-term strategy to prepare for future nonproliferation challenges
- Developing a world-class science, technology, and, engineering workforce
- Revitalizing infrastructure
- Strengthening DOE/NNSA resilience and applying lessons-learned from COVID-19

FIGURE 18: A WORLD-CLASS WORKFORCE

In 2021, DOE/NNSA Office of Management and Budget awarded 13 Minority Serving Institution Partnership Program grants as part of a larger effort to better serve tens of thousands of students and Minority Serving Institutions in STEM disciplines.

3.2.1 Investing in a Long-term Strategy to Prepare for Future Nonproliferation Challenges

Advancements in manufacturing, computing, and other emerging technologies—coupled with an evolving proliferation landscape—complicate DOE/NNSA's nuclear threat reduction mission by creating diverse pathways to developing a nuclear weapon and introducing different signatures and indicators of proliferation activity.

Stewarding Nuclear Competencies

DOE/NNSA invests in the Nonproliferation Stewardship Program, a long-term strategy to prepare the Nation to meet future nonproliferation goals and anticipate threats through relevant science and technology, testbeds and research environments, and modern expertise needed for high-priority nonproliferation applications, including nonproliferation competencies in uranium and weaponization sciences and engineering. DOE/NNSA recently completed the first step in the planning process of the Nonproliferation Stewardship Program to produce an initial Nonproliferation Competency Baseline (NCB) focused on competencies associated with special nuclear material production, namely competencies essential to plutonium production and processing and uranium processing and enrichment. Subject matter experts from the DOE/NNSA national laboratories, sites, and plants participated in NCB working groups to help identify and define the necessary skillsets within these areas. In the coming years, DOE/NNSA will focus on developing the highest priority competencies to the state of sufficiency to contribute to multiple U.S. Government nonproliferation and counterproliferation missions. Key focus areas will include:

- Continuing the development of test beds to address shortfalls in capabilities needed to support U.S. Government nonproliferation missions, and
- Supporting long-term projects to strengthen nonproliferation competencies in uranium and weaponization sciences and engineering.

3.2.2 Developing a World-Class Science, Technology and Engineering Workforce

Executing DOE/NNSA's nuclear and radiological threat reduction mission depends on a highly skilled, technically focused, and disciplined workforce. The Nuclear Security Enterprise must continue to invest in and develop a steady pipeline of the next generation of technical and policy professionals to enable cutting-edge scientific innovation and maintain a qualitative edge over adversaries. Key challenges include:

- An aging and retiring workforce.
- Recruitment and retention of staff in a competitive economy.
- Maintenance of a sustainable pipeline of talented and dedicated work force.
- Need for ongoing training to support emerging skills requirements.

DOE/NNSA continues to prioritize the need for state-of-the-art scientific and policy expertise to meet its enduring and emerging mission. DOE/NNSA is working to recruit, train, develop, and retain a skilled workforce through university outreach and workforce development programs including:

- **University Consortia for Nuclear Nonproliferation:** DOE/NNSA supports several university-based research consortia to migrate top talent toward technical applications in national nuclear security. In the past year, 87 degrees have been granted, including 27 Ph.Ds., bringing the total over the lifetime of the program to 682 degrees. Over the past decade, 162 of these graduates have gone on to new career placements in the DOE/NNSA's National Laboratories with another 47 taking jobs within other government agencies in the nuclear security arena. The program is establishing a fourth university consortium to conduct research and development needed to support NNSA's technical nuclear forensics missions.

- **DOE/NNSA Graduate Fellowship Program:** This program is one of the main succession pipeline programs to cultivate the next generation of DOE/NNSA and national security leaders, placing 50-65 fellows per year in DOE/NNSA programs, field offices, and other U.S. agencies. More than 85 percent of the program's 600-plus alumni accepted employment within NNSA or the broader national security community since the program's inception.
- **Nuclear Nonproliferation International Safeguards Graduate Fellowship Program:** This program, administered by the South Carolina Universities Research and Educational Foundation, promotes the development of safeguards professionals. To date, two students have completed their PhDs with research in a safeguards-related field, with many taking positions in the nuclear security enterprise and the IAEA.
- **Minority Serving Institution Partnership Program:** This program provides a sustainable science, technology, engineering, and math pipeline that prepares a diverse workforce through partnerships between DOE/NNSA laboratories, plants, and sites and 41 institutions comprising 18 Historically Black Colleges and Universities, five Tribal Colleges and Universities, and 18 Hispanic serving institutions.
- **Mid-Level Leadership Development Program:** This year-long program enhances the knowledge and skills of future DOE/NNSA leaders, including 360-degree assessments, training on a range of governance and management topics, a capstone project, and a 60-day rotational assignment.

Diversity, Equity, Inclusion, and Accessibility (DEIA)

DOE/NNSA prioritizes DEIA as a national security imperative to represent critical perspectives and talents in the national security workforce. DOE/NNSA's DEIA initiatives aim to make ongoing and lasting improvements to the organization's operating environment at every level.

Working groups at DOE/NNSA developed DEIA strategies that incorporate insights from office climate surveys as well as best practices to foster a diverse and inclusive workplace. DOE/NNSA will execute the strategy to promote a culture of inclusion and facilitate diversity, equality, and accessibility considerations in recruitment and advancement in DOE/NNSA organizations.

NNSA Minority Serving Institutions Internship Program (NNSA-MSIIP)

MSIIP offers talented undergraduate and graduate students at minority serving institutions an intensive 12-week or year-long internship to jump-start their careers. Throughout their internships, the students perform research, work on projects related to technical or policy priorities, and participate in business and government relations operations.

While participating in the MSIIP program, students receive training and mentorship from top professionals, including the government's leading scientists and engineers. Students develop professional skills and enhance their leadership capabilities, increasing their potential for future opportunities within the federal government.

MSIIP offers students paid opportunities to work at NNSA Headquarters, and NNSA labs, plants and sites, while completing their education and supporting NNSA's mission priorities to strengthen key science, technology, and engineering capabilities and enhance its leadership pipeline. Forty-six students completed the pilot program for 2020-2021, with a much larger class expected for the inaugural Class of 2022-2023 cohort.

3.2.3 Revitalizing Infrastructure

DOE/NNSA relies on a diverse array of infrastructure in the nuclear security enterprise—including laboratories, component manufacturing equipment, experimental facilities, test beds, high-performance computers, training facilities, and nuclear material handling and disposal facilities—to execute its nuclear threat reduction mission. Most of these assets are at DOE laboratories, plants, and sites.

However, these assets are aging even as the nuclear security enterprise seeks to keep pace with rapidly developing emerging technologies and sustain its world-class staff. To address current and emerging threats, DOE/NNSA strategically invests in its nuclear security enterprise-wide infrastructure, leverages assets across DOE/NNSA programs, and supports its interagency partners in their nonproliferation missions. Examples of DOE/NNSA activities include:

FIGURE 19: RADIOCHEMICAL PROCESSING LABORATORY OPERATIONS

At the Radiochemical Processing Laboratory, researchers create and implement innovative processes for environmental cleanup and the beneficial use of radioactive materials. (Photo by Andrea Starr, Pacific Northwest National Laboratory)

Constructing Training Facilities

- **The Oak Ridge Enhanced Technology and Training Center (ORETTC)**: DOE/NNSA is developing ORETTC, a new facility that will enhance DOE/NNSA's capacity to train experts in nuclear operations, nuclear safeguards, cyber, and emergency response. The facility will be used to conduct field training exercises and demonstrate nonproliferation-related technology. Once

completed, ORETTC will house the Simulated Nuclear and Radiological Activities Facility for training those responsible for safeguarding nuclear and radioactive material in the latest nuclear security, detection, and nonproliferation technologies.

- **Supporting the Establishment of a New Testing and Training facility for the IAEA:** DOE/NNSA is investing in the establishment of multilateral nonproliferation enrichment testing and training capabilities to assist the IAEA in developing and testing new safeguards technologies and approaches and train new inspectors. The new training facility will strengthen the IAEA's capabilities to detect and deter undeclared uranium enrichment activities.

Enhancing Laboratory Capabilities

- **Strengthening the IAEA's Network of Analytical Laboratories (NWAL):** DOE/NNSA is supporting investments in infrastructure and research for two U. S. national laboratories to become qualified as NWAL particle production laboratories for the IAEA. NWAL environmental sampling laboratories use actinide-containing reference particle materials to verify safeguards measurement accuracy. Producing such materials requires special infrastructure, equipment, and nuclear material. Toward that goal, DOE/NNSA is procuring essential instruments and developing reproduceable methods to produce uranium, plutonium, and thorium containing particles that meet the IAEA's specifications on product size, morphology, elemental, and isotopic compositions.
- **Training and Developing Technical Experts at the Radiochemical Processing Laboratory:** The Pacific Northwest National Laboratory's Radiochemical Processing Laboratory supports training and development of the next generation of actinide scientists and engineers addressing difficult nonproliferation challenges, which include novel production of plutonium, development of treaty monitoring tools and techniques, and testing and development of novel fuels for civilian and test reactors. This laboratory is serving as the only U.S.-based Comprehensive Test Ban Treaty International Monitoring System certified laboratory to analyze particulate and noble gas samples.
- **Deploying Modular, Mobile Systems:** DOE/NNSA—with a broad range of nimble, deployable capabilities that can be deployed in whole, or in part—addresses specific challenges or classes of challenges and can be easily upgraded as technology evolves. To this end, DOE/NNSA has developed a robust suite of capabilities that are deployable anywhere in the world on relatively short notice to characterize, stabilize, package, and remove highly enriched uranium and plutonium. DOE/NNSA is also developing additional mobile platforms that can downblend a wide range of HEU materials at partner facilities, establishing new disposition pathways for weapons-usable nuclear material.

Leveraging Defense Program Activities

- **Leveraging DOE/NNSA's Stockpile Surveillance**: DOE/NNSA leverages its stockpile surveillance to identify signatures, develop sensors and methods, and validate those sensors in realistic environments. Some of those activities include subcritical tests conducted at the Nevada National Security Site. DOE/NNSA's Office of Defense Programs is planning additional High Explosive Hydrodynamic Tests and Subcritical Experiment tests in FY 2023-FY 2024, and all relevant DOE/NNSA organizations will take advantage of those activities for nonproliferation programs as well.

Making Capital Equipment Investments

- **Enhancing Communication Technologies**: DOE/NNSA bolsters its mission resilience by enhancing communications technology to improve situational awareness, coordination with leadership, collaboration with partners, and dissemination of analyses in response to all-hazards threats.
- **Procuring Mission Critical Equipment**: DOE/NNSA continues procuring mission-critical equipment to recapitalize equipment that has exceeded its useful life. Priorities include handheld and vehicle-borne radiation detection equipment, high resolution spectroscopic identification systems, correlated neutron detectors, high-energy radiography equipment, and contamination survey meters.

3.2.4 Strengthening DOE/NNSA Resilience and Applying Lessons-Learned from COVID-19

Reaffirmed 24/7/365 Emergency Operations Capabilities

COVID-19 presented unprecedented circumstances for a wide range of sensitive operations. However, DOE/NNSA anticipates challenges with extensive emergency planning. DOE/NNSA modified pandemic and continuity plans at the Headquarters and field levels to quickly adapt operations, maximizing telework opportunities while modifying onsite operations. Meanwhile DOE/NNSA sites created innovative and resilient solutions to simultaneously maintain critical operations and keep the staff safe.

FIGURE 20: EMERGENCY PREPAREDNESS AND RESPONSE

NNSA's Ann Heinrich served as President of the 2021 International Conference on the Development of Preparedness for National and International Emergency Response in Vienna.

- The Consolidated Emergency Operations Center, which is responsible for maintaining 24/7/365 situational awareness for DOE/NNSA leadership, continued its support by utilizing alternate locations to preserve the health and safety of staff. DOE/NNSA collected and aggregated data throughout the enterprise to provide a common operating picture for strategic decision-making.
- DOE/NNSA institutionalized the Emergency Management Readiness Assurance Reporting Tool to provide the Agency with more uniform field performance reporting. The objective of this analysis is to identify trends and changes in Emergency Management programs and address emergency readiness gaps.
- DOE/NNSA maintained organizational resilience through continuity planning and communications, managing continuity of operations for all of DOE enabling coordination vertically from the field up to Headquarters as well as laterally across offices.
- DOE/NNSA continues to implement the Federal Mission Resilience Strategy as directed by Executive Order 13961, "Governance and Integration of Federal Mission Resilience." The Strategy's model of 'Assess, Distribute, and Sustain' reduces the reliance on reactive relocation of personnel to alternate locations, and emphasizes a more proactive full-time posture of distribution, and, as necessary, devolution to minimize disruptions to essential functions and support activities.

Strengthening DOE/NNSA Partnerships through Flexible Modes of Engagement

Over the course of the pandemic, DOE/NNSA has developed flexible and innovative measures to not only sustain but increase its outreach efforts to domestic and international partners. As a result, DOE/NNSA has improved coordination and gained efficiencies in pursuit of its nuclear threat reduction objectives.

DOE/NNSA will continue to build and strengthen relationships through in-person engagements when possible. However, DOE/NNSA will also build on the success of its remote engagements, amplifying outreach by combining in-person interaction with an array of remote engagement methods. DOE/NNSA will also continue to support a culture of innovation and agility—two key factors to success during the pandemic. DOE/NNSA:

- Adapted remote engagements, which allowed more frequent follow-up interactions to improve retention and sustainability of training to reach a wide audience (including the ability to accommodate more local as well as geographically dispersed participation.)
- Fostered a whole-of-government approach to strategic trade controls by bringing key U.S. interagency and international partners together remotely to exchange best practices.
- Invested in both synchronous and asynchronous tools (web portals, how-to videos, e-learning tools) to support training, exercises, and outreach and enlisted instructional systems designers to assist with identifying, reconfiguring, and delivering training and exercises. The development and deployment of new tools to enable remote participation resulted in a record number of participants in DOE/NNSA-sponsored events.
- Developed a process for conducting remote implementation, acceptance testing, and assurance activities to strengthen global material security with partner countries. Shared lessons learned and best practices across programs to further improve this process.
- Adapted and revised existing curricula to develop new all-virtual curricula for training, workshops, and technical exchanges on nuclear counterterrorism and response that incorporate adult learning concepts and learning design tools.
- Explored and researched virtual and augmented reality tools to supplement in-person, virtual, or hybrid training, workshops, and other activities.
- Procured additional personal computing technology to supplement and modernize in-person workshops and other engagements.

FIGURE 21: VIRTUAL ENGAGEMENTS

Augmented reality tool in use during virtual tabletop exercise.

CHAPTER 4

Conclusion

4.0 Conclusion

The *Prevent, Counter,* and *Respond* functional areas described in this plan form the overarching strategic framework for the activities that DOE/NNSA pursues to address global nuclear and radiological threats in support of U.S. Government policies and priorities. Looking ahead, DOE/NNSA will continue to reduce these threats through programs that:

- Reduce, remove, and eliminate weapons-usable nuclear and radioactive materials
- Secure nuclear and radioactive materials and facilities
- Control the spread of materials, technology, and expertise
- Develop leading edge proliferation detection capabilities
- Verify that international treaty and other obligations are being met
- Build scientific and technical understanding of nuclear and radiological threat devices
- Support efforts to impede proliferant states' ability to obtain nuclear capabilities
- Maintain readiness, strengthen and harmonize nuclear and radiological incident response
- Develop and maintain world-class nuclear forensics capabilities
- Lead enterprise-wide emergency management by utilizing an all-hazards approach

By harnessing its technical and policy expertise to reduce nuclear and radiological threats, DOE/NNSA will advance key U.S. Government priorities, including arms control on emerging military technologies and addressing the challenges posed by Russia, China, North Korea, and Iran. DOE/NNSA's work will also advance clean energy technologies and advanced reactor designs while minimizing potential proliferation risks. In addition to addressing the climate crisis and working towards net-zero emissions by 2050, these efforts will support the U.S. nuclear industry and strengthen the Nation's position as a leader in nuclear technology.

Maintaining a diverse workforce and world class infrastructure across the nuclear security enterprise is key for DOE/NNSA to continue accomplishing its mission. Strong partnerships with U.S. industry and other government agencies, as well as international collaboration through bilateral, regional, and multilateral organizations, will drive DOE/NNSA's future success.

By adopting a proactive, analytic posture that identifies, characterizes, and prepares for emerging trends and risks, DOE/NNSA will be as prepared as possible to respond to unanticipated events when they occur.

CHAPTER 5

Appendices

5.0 Appendices

Appendix A: Table of Figures

Appendix B: Requirements Mapping

This *Prevent, Counter, and Respond* report addresses the requirement for a *Defense Nuclear Nonproliferation Management Plan* in Title 50, Section 2575, of the United States Code (U.S.C).

50 U.S.C. § 2575	NNSA Response
(a) Plan Required. – The Administrator shall develop and annually update a five-year management plan for activities associated with the defense nuclear nonproliferation programs of the Administration to prevent and counter the proliferation of materials, technology, equipment, and expertise related to nuclear and radiological weapons in order to minimize and address the risk of nuclear terrorism and the proliferation of such weapons.	Report satisfies requirement.
(b) Submission to Congress. – (1) Not later than March 15 of each even-numbered year, the Administrator shall submit to the congressional defense committees a summary of the plan developed under subsection (a).	Report satisfies requirement.
(2) Not later than March 15 of each odd-numbered year, the Administrator shall submit to the congressional defense committees a detailed report on the plan developed under subsection (a).	Report satisfies requirement.
(3) Each summary submitted under paragraph (1) and each report submitted under paragraph (2) shall be submitted in unclassified form, but may include a classified annex if necessary.	Report satisfies requirement.
(c) Elements. ---The plan required by subsection (a) shall include, with respect to each defense nuclear nonproliferation program of the Administration, the following:	
(1) A description of the policy context in which the program operates, including---	
(A) a list of relevant laws, policy directives issued by the President, and international agreements; and	Appendix C
(B) nuclear nonproliferation activities carried out by other Federal agencies.	Sections 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.3.3
(2) A description of the objectives and priorities of the program during the year preceding the submission of the summary required by paragraph (1) of subsection (b) or the report required by paragraph (2) of that subsection, as the case may be.	Sections 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6,
(3) A description of the activities carried out under the program during that year.	Sections 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2,2,1, 2.2.2, 2.3.1, 2.3.2, 2.3.3

50 U.S.C. § 2575	NNSA Response
(4) A description of the accomplishments and challenges of the program during that year, based on an assessment of metrics and objectives previously established to determine the effectiveness of the program.	Sections 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2,2,1, 2.2.2, 2.3.1, 2.3.2, 2.3.3
(5) A description of any gaps that remain that were not or could not be addressed by the program during that year.	N/A
(6) An identification and explanation of uncommitted or uncosted balances for the program, as of the date of the submission of the summary required by paragraph (1) of subsection (b) or the report required by paragraph (2) of that subsection, as the case may be, that are greater than the acceptable carryover thresholds, as determined by the Secretary of Energy.	Appendix F
(7) An identification of funds for the program received through contributions from or cost-sharing agreements with foreign governments consistent [sic] section 2569(f) of this title during the year preceding the submission of the summary required by paragraph (1) of subsection (b) or the report required by paragraph (2) of that subsection, as the case may be, and an explanation of such contributions and agreements.	Appendix D
(8) A description and assessment of activities carried out under the program during that year that were coordinated with other elements of the Department of Energy, with the Department of Defense, and with other Federal agencies, to maximize efficiency and avoid redundancies.	Sections 2.1.3, 2.1.4, 2.1.5, 2.2.2, 2.3.2
(9) Plans for activities of the program during the five-year period beginning on the date on which the summary required by paragraph (1) of subsection (b) or the report required by paragraph (2) of that subsection, as the case may be, is submitted, including activities with respect to the following:	Requirement met.
(A) Preventing nuclear and radiological proliferation and terrorism, including through—	
(i) material management and minimization, particularly with respect to removing or minimizing the use of highly enriched uranium, plutonium, and radiological materials worldwide (and identifying the countries in which such materials are located), efforts to dispose of surplus material, converting reactors from highly enriched uranium to low-enriched uranium (and identifying the countries in which such reactors are located);	Sections 2.1.1
(ii) global nuclear material security, including securing highly enriched uranium, plutonium, and radiological materials worldwide (and identifying the countries in which such materials are located), and providing radiation detection capabilities at foreign ports and borders;	Sections 2.1.2, 2.1.3
(iii) nonproliferation and arms control, including nuclear verification and safeguards;	Sections 2.1.3, 2.1.4

50 U.S.C. § 2575	NNSA Response
(iv) defense nuclear research and development, including a description of activities related to developing and improving technology to detect the proliferation and detonation of nuclear weapons, verifying compliance of foreign countries with commitments under treaties and agreements relating to nuclear weapons, and detecting the diversion of nuclear materials (including safeguards technology); and,	Sections 2.1.4, 2.1.5
(v) nonproliferation construction programs, including activities associated [sic]Department of Energy Order 413.1 (relating to program management controls).	Section 3.2.3
(B) Countering nuclear and radiological proliferation and terrorism.	Sections 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2
(C) Responding to nuclear and radiological proliferation and terrorism, including through— (i) crisis operations; (ii) consequences management; and, (iii) emergency management, including international capacity building.	Sections 2.3.1, 2.3.2. 2.3.3
(10) A threat assessment, carried out by the Intelligence Community (as defined in section 3003(4) of this title), with respect to the risk of nuclear and radiological proliferation and terrorism and a description of how each activity carried out under the program will counter the threat during the five-year period beginning on the date on which the summary required by paragraph (1) of subsection (b) or the report required by paragraph (2) of that subsection, as the case may be, is submitted and, as appropriate, in the longer term.	Section 1.2
(11) A plan for funding the program during that five-year period.	Appendix E
(12) An identification of metrics and objectives for determining the effectiveness of each activity carried out under the program during that five-year period.	Sections 1.3, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2,2,1, 2.2.2, 2.3.1, 2.3.2, 2.3.3
(13) A description of the activities to be carried out under the program during that five-year period and a description of how the program will be prioritized relative to other defense nuclear nonproliferation programs of the Administration during that five-year period to address the highest priority risks and requirements, as informed by the threat assessment carried out under paragraph (10).	Sections 1.2, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2,2,1, 2.2.2, 2.3.1, 2.3.2, 2.3.3
(14) A description and assessment of activities to be carried out under the program during that five-year period that will be coordinated with other elements of the Department of Energy, with the Department of Defense, and with other Federal agencies, to maximize efficiency and avoid redundancies.	Sections 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2,2,1, 2.2.2, 2.3.1, 2.3.2, 2.3.3
(15) A summary of the technologies and capabilities documented under section 2576(a) of this title.	Section 2.1.5

50 U.S.C. § 2575	NNSA Response
(16) A summary of the assessments conducted under section 2576(b)(1) of this title.	Section 2.1.5
(17) Such other matters as the Administrator considers appropriate.	Requirement met.

Appendix C: Relevant Laws, Policy Directives, and International Instruments

The nuclear and radiological threat reduction activities of the Department of Energy's National Nuclear Security Administration (DOE/NNSA) operate within the context of many laws, Presidential Policy Directives (PPD), and international agreements and other international instruments. The most significant of these are listed below.

Laws

- *American Medical Isotopes Production Act of 2012*, Pub. L. 112-239, Div. C., Title XXXI, Subt. F.
- *Atomic Energy Act of 1954, as amended*, 42 U.S.C. §§ 2011 *et seq*.
- *Atomic Energy Defense Act, as amended*, 50 U.S.C. §§ 2501 *et seq*.
- *The Export Control Reform Act of 2018,* Pub. L.115-232, Div. A, Title XVII, Subt. B., 50 U.S.C. §§ 4801 *et seq*.
- *Henry J. Hyde United States-India Peaceful Atomic Energy Cooperation Act of 2006*, Pub. L. 109-401, Title I.
- National Defense Authorization Acts (Various).
- *National Nuclear Security Administration Act, as amended*, Pub. L. 106-65, Div. C., Title XXXII.
- *Nuclear Non-Proliferation Act of 1978*, as amended, Pub. L. 95-242.

Presidential Policy

- PPD-8: National Preparedness.
- NSPM-35: National Technical Nuclear Forensics.
- NSPM-36: Guidelines for United States Government Interagency Response to Terrorist Threats or Incidents in the United States and Overseas (classified directive).
- PPD-33: Detection of Nuclear Proliferation (classified directive).
- PPD-35: Weapons Command and Control, Safety, and Security.
- PPD-40: National Continuity Policy.
- PPD-42: Preventing and Countering Weapons of Mass Destruction Proliferation, Terrorism, and Use.

International Agreements and Other International Instruments

- Agreement Between the Government of the United States of America and the Government of the French Republic for Cooperation in the Operation of Atomic Weapons Systems for Mutual Defense Purposes.
- Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning Cooperation Regarding Plutonium Production Reactors, and the Amendment thereto.
- Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, with Annexes and Joint

Statement, and Amendments thereto (also known as the U.S.-Russia Plutonium Management and Disposition Agreement or PMDA, purportedly unilaterally suspended by the Russian Federation).

- Agreement Between the Government of the United States of America and the Government of the Russian Federation on Cooperation in Nuclear- and Energy-Related Scientific Research and Development.
- Agreement Between the Government of the United States of America and the Government of the United Kingdom of Great Britain and Northern Ireland for Cooperation on the Uses of Atomic Energy for Mutual Defense Purposes.
- Agreement between the Government of the United States of America, the Government of Australia, and the Government of the United Kingdom of Great Britain and Northern Ireland for the Exchange of Naval Nuclear Propulsion Information.
- Agreement between the United States of America and the International Atomic Energy Agency for the Application of Safeguards in the United States (and the Protocol Additional Thereto).
- Agreements for Peaceful Nuclear Cooperation pursuant to Section 123 of the *Atomic Energy Act* of 1954, as amended (Numerous).
- Convention on the Physical Protection of Nuclear Material and its 2005 Amendment.
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.
- Convention on Early Notification of a Nuclear Accident.
- Comprehensive Nuclear-Test-Ban Treaty. (Note: The United States has signed this treaty but has not ratified it. The treaty has not entered into force.)
- International Convention on the Suppression of Acts of Nuclear Terrorism.
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
- Nuclear Security Summit Communiques from 2010, 2012, 2014, and 2016.
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (also known as the Limited or Partial Test Ban Treaty, LTBT or PTBT).
- Treaty Between the United States of America and the Russian Federation on Measures for Further Reduction and Limitation of Strategic Offensive Arms (also known as the New Strategic Arms Reduction Treaty, or New START).
- Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests (also known as the Threshold Test Ban Treaty, TTBT).
- Treaty on the Non-Proliferation of Nuclear Weapons.
- United Nations Security Council Resolution 1540.

Appendix D: Foreign Contributions and Cost-Sharing Agreements

DOE is authorized to accept international contributions for any programs within the Office of Defense Nuclear Nonproliferation (DNN). During fiscal year (FY) 2021, DNN received a total of $5,513,620.28 (U.S. dollar equivalent) from three international contributors.

Foreign Government Contributions Received

FY	Program for Cooperation	Partner	Contributions (whole dollars)
2021	Global Material Security (GMS)	Norway	$99,978.62
2021	GMS	United Kingdom	$5,171,496.66
2021	GMS	Finland	$242,145.00
Total FY 2021			**$5,513,620.28**

Amount and Use of Foreign Contributions

International Contributor	Amount/Date Received	Use
Global Material Security		
Norway	$49,989.02 12/28/2020	The Norwegian Radiation and Nuclear Safety Authority provided these funds to GMS to support the construction of a northern branch of the Nuclear and Radiation Safety Agency (NRSA) of the Republic of Tajikistan. The new branch will enable NRSA to more effectively conduct its duties in the region, including licensing and inspection, provide nuclear and radiological security training for law enforcement agencies, and supervise the safe remediation of uranium legacy sites.
United Kingdom	$5,171,496.66 5/6/2021	Funds were used to enhance radiological security in India through a workshop on the benefits of alternative technologies, and in Tunisia by executing the removal and repatriation of four radioactive sources in the country. Funds also prevented nuclear smuggling in Lebanon to help with Port of Beirut recovery, and Turkey to provide portable radiation detection and interdiction equipment. Funds were used to provide physical security upgrades at nuclear facilities in Belarus. Funds will be used in the Democratic Republic of Congo and Jordan to increase security system effectiveness and reduce the risk associated with the unauthorized removal and/or sabotage of nuclear and radioactive materials.

Amount and Use of Foreign Contributions, Continued

International Contributor	Amount/Date Received	Use
Global Material Security		
Finland	$242,145.00 6/28/2021	Funds were used towards continuing the Green Border Security Initiative projects started in 2018 to strengthen the ability of the Ukraine State Border Guard Service in the Luhansk region to detect and deter nuclear smuggling on the Russian border.
Norway	$49,989.60 9/14/2021	The Norwegian Radiation and Nuclear Safety Authority provided these funds to ORS to support the construction of a northern branch of NRSA of the Republic of Tajikistan. The new branch will enable NRSA to more effectively conduct its duties in the region, including licensing and inspection, provide nuclear and radiological security training for law enforcement agencies, and supervise the safe remediation of uranium legacy sites.

Amounts Retained

During FY 2021, DNN used $5,513,620.28 (U.S. dollar equivalent) for designated projects. None of the foreign funding contributions that were received in FY 2021 have been retained.

Appendix E: FY 2023 Future Years Nuclear Security Program Plan

The information included in Appendix E comes directly from the Department of Energy FY 2023 Congressional Budget Request, Volume 1: National Nuclear Security Administration (DOE/NNSA).

(Dollars in Thousands)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Defense Nuclear Nonproliferation Appropriation [a]					
Defense Nuclear Nonproliferation					
Material Management and Minimization					
Conversion	110,000	110,000	153,260	+43,260	+39.3%
Nuclear Material Removal	40,000	40,000	41,600	+1,600	+4.0%
Material Disposition	190,711	190,711	256,025	+65,314	+34.2%
Laboratory and Partnership Support	60,000	60,000	0	-60,000	-100.0%
Total, Material Management and Minimization	**400,711**	**400,711**	**450,885**	**+50,174**	**+12.5%**
Global Material Security					
International Nuclear Security	78,939	78,939	81,155	+2,216	+2.8%
Radiological Security	275,000	275,000	244,827	-30,173	-11.0%
Nuclear Smuggling Detection	175,000	175,000	178,095	+3,095	+1.8%
Total, Global Material Security	**528,939**	**528,939**	**504,077**	**-24,862**	**-4.7%**
Nonproliferation and Arms Control	**148,000**	**148,000**	**207,656**	**+59,656**	**+40.3%**
Defense Nuclear Nonproliferation R&D					
Proliferation Detection	255,000	255,000	287,283	+32,283	+12.7%
Nuclear Detonation Detection	267,000	267,000	279,205	+12,205	+4.6%
Nonproliferation Fuels Development	20,000	20,000	0	-20,000	-100.0%
Nuclear Forensics R&D	40,000	40,000	44,414	+4,414	+11.0%
Nonproliferation Stewardship Program	59,900	59,900	109,343	+49,443	+82.5%
Total, Defense Nuclear Nonproliferation R&D	**641,900**	**641,900**	**720,245**	**+78,345**	**+12.2%**
NNSA Bioassurance Program	**0**	**0**	**20,000**	**+20,000**	**+0.0%**
Nonproliferation Construction					
18-D-150, Surplus Plutonium Disposition Project	148,589	148,589	71,764	-76,825	-51.7%
Total, Nonproliferation Construction	**148,589**	**148,589**	**71,764**	**-76,825**	**-51.7%**
Total, Defense Nuclear Nonproliferation Programs	**1,868,139**	**1,868,139**	**1,974,627**	**+106,488**	**+5.7%**

[a] FY 2021 Enacted had $40M for NTNF R&D in a separate control. For comparison purposes this amount is included in the DNN R&D line.

Funding by Congressional Control
Outyear Funding

(Dollars in Thousands)

	FY 2024 Request	FY 2025 Request	FY 2026 Request	FY 2027 Request
Defense Nuclear Nonproliferation				
Material Management and Minimization	**425,644**	**453,045**	**427,755**	**422,967**
Global Material Security	**515,897**	**534,986**	**539,159**	**538,936**
Nonproliferation and Arms Control	**207,188**	**214,854**	**216,529**	**216,439**
Defense Nuclear Nonproliferation R&D	**712,724**	**739,095**	**744,859**	**744,551**
NNSA Bioassurance Program	**20,000**	**20,000**	**20,000**	**20,000**
Nonproliferation Construction				
24-D-XXX, Pit Disassembly and Processing (PDP) Project	45,000	67,244	120,000	120,000
18-D-150, Surplus Plutonium Disposition (SPD) Project	92,257	35,000	0	0
Total, Nonproliferation Construction	**137,257**	**102,244**	**120,000**	**120,000**
Total, Defense Nuclear Nonproliferation Programs	**2,018,710**	**2,064,224**	**2,068,302**	**2,062,893**
Nuclear Counterterrorism Incident Response Program				
Emergency Operations	15,123	15,683	15,805	15,798
Counterterrorism and Counterproliferation	421,209	438,204	441,308	440,818
Total, Nuclear Counterterrorism Incident Response Program	**436,332**	**453,887**	**457,113**	**456,616**
Legacy Contractor Pensions and Settlement Payments	**40,447**	**41,296**	**42,163**	**43,048**
Subtotal, Defense Nuclear Nonproliferation Appropriation	**2,495,489**	**2,559,407**	**2,567,578**	**2,562,557**
Use of Prior Year Balances	**0**	**0**	**0**	**0**
Total, Defense Nuclear Nonproliferation Appropriation	**2,495,489**	**2,559,407**	**2,567,578**	**2,562,557**

Appendix F: Analysis and Explanation of FY 2021 Uncosted Balances

Background

When Congress appropriates funding for DOE programs, most funding remains available until expended in recognition of the multi-year execution requirements for many DOE programs. For NNSA's nuclear threat reduction programs, this can lead to funds that have not been costed by the end of one fiscal year being carried over into the subsequent fiscal year. These carry-over balances occur due to the long-term aspects of the Department's nonproliferation efforts, and the balances are managed and tracked as part of the Department's financial management system.

Following Government Accountability Office guidance and recommended practices, DOE establishes threshold carryover balances for uncosted balances across multiple categories of spending (e.g., funding for major contractors, construction projects, and programs). The thresholds provide metrics for review and an analysis framework. On a consistent basis, DOE/NNSA also assesses all uncosted carryover, particularly to identify any funds excess to program and project requirements. These amounts can be used to address emergent issues during the year of execution consistent with reprogramming guidelines, and also for formulating future program budget requests.

As per the requirements in the *National Defense Authorization Act for Fiscal Year 2016*, Sec. 3132 (50 U.S.C. § 2575(c)(6)), DNN reports to Congress annually on any uncommitted or other uncosted balances that exceed these thresholds. Uncommitted, or "unencumbered" balances include funds that have been obligated but not yet costed nor encumbered. Funds are "encumbered" through the award of direct contracts to non-management and operating (M&O) contractors, the award or issuance of subcontracts or purchase orders by M&O contractors to third parties, or certain other encumbering actions by M&O contractors. DNN measures financial performance in terms of the percentage of funds that have been costed and encumbered, rather than just the percentage of funds that have been costed, because a great deal of the program's work involves multi-year projects, or is performed overseas, and sound management and programmatic necessities generally require work to be fully completed and verified before DNN disburses funds in non-U.S. venues. Measuring financial performance only in terms of funds costed would not provide an accurate picture of the program's progress.

Overview of DNN Balances

At the end of FY 2021, the aggregate program costs plus encumbrances for DNN were 73.7 percent of the total available to cost, leaving 26.3 percent available in:

- The International Material Protection and Cooperation Program (IMPC) (a past program now reorganized into the GMS Program, which has remaining uncosted unencumbered prior year funds on account)
- The Global Material Security Program (GMS)
- Defense Nuclear Nonproliferation Research and Development (DNN R&D)
- National Technical Nuclear Forensics R&D
- The Material Management and Minimization Program (M3)
- The Nonproliferation and Arms Control Program (NPAC)

Details on the balances for each budget element, explanations for the balances, and a table showing FY 2021 budget execution data in detail are provided below. The COVID-19 pandemic's impacts on DNN

Programs' ability to engage efficiently in program implementation with domestic and international partners contributed significantly to the FY 2021 balances.

International Material Protection and Cooperation: (Total Uncosted $27.3 million, [$13.7 million encumbered, $13.6 million unencumbered])

At the end of FY 2021, International Material Protection and Cooperation costs plus encumbrances totaled $27.5 million, or 67.0 percent of total FY 2021 available funds. The uncosted balance total of $27.3 million (of which $13.7 million, representing 33.3 percent of available FY 2021 funds, was encumbered) exceeded the recommended threshold by $8.1 million. The $13.6 million in FY 2021 unencumbered balances support accelerated nuclear security engagement with international partners to protect, mitigate vulnerabilities and sustain security at nuclear sites and to support multilateral activities with the IAEA to improve nuclear security globally and the funds were also used to support radiation detection sustainability efforts, including equipment testing and maintenance, workshops, and exercises in multiple countries.

Global Material Security: (Total Uncosted $573.0 million, [$349.1 million encumbered, $223.9 million unencumbered])

At the end of FY 2021, GMS costs plus encumbrances totaled $788.9 million, or 77.9 percent of total FY 2021 available funds. The uncosted balance total of $573.0 million (of which $349.1 million, representing 34.5 percent of available FY 2021 funds, was encumbered) exceeded the recommended threshold by $76.6 million. The $223.9 million in FY 2021 unencumbered balances support three critical programs within GMS; (1) International Nuclear Security; (2) Radiological Security; and (3) Nuclear Smuggling Detection and Deterrence.

International Nuclear Security Program

The unencumbered balances for the International Nuclear Security Program ($103.1 million) support accelerated nuclear security engagement with international partners to protect, mitigate vulnerabilities and sustain security at nuclear sites, and to support multilateral activities with the IAEA to improve nuclear security globally.

Radiological Security Program

The unencumbered balances for the Radiological Security Program ($73.4 million) support continued work with domestic and international partners to secure high-risk radioactive materials. The balance includes $15.4 million of funding for the Oak Ridge Enhanced Technology and Training Center and $25.6 million to cover a portion of the remediation costs at the University of Washington following a cesium contamination incident.

Nuclear Smuggling Detection and Deterrence Program

The unencumbered balances for the Nuclear Smuggling Detection and Deterrence Program ($40.5 million) did not exceed the recommended threshold. Balances support high-priority activities in FY 2022, including acceptance testing, site assurance visits, workshops and exercises, and maintenance contracts.

International Contributions

The unencumbered balances for International Contributions (UK, Canada and Norway) ($6.9 million) support the removal of approximately 40 Canadian-origin high-activity radioactive sources from Mexico, conducting tabletop exercise (TTX) in support of efforts to increase the Moldovan National Police's capacity to provide timely response to security incidents and funds

for Jordan and Ukraine Physical Protection Upgrades, Transportation Security in Africa and Insider Threat Mitigation.

Defense Nuclear Nonproliferation Research and Development: (Total Uncosted $353.5 million, [$107.0 million encumbered, $246.5 million unencumbered])

At the end of FY 2021, DNN R&D costs plus encumbrances totaled $633.5 million, or 72.0 percent of total FY 2021 available funds. The uncosted balance total of $353.5 million (of which $107.0 million, representing 12.2 percent of available FY 2021 funds, was encumbered) exceeded the recommended threshold by $90.6 million. The $246.5 million in FY 2021 unencumbered balances are allocated to planned and approved work scope primarily at the national laboratories. They are spent at appropriate rates for the types of work conducted, as specified in approved Life Cycle Plans for each project defining their work scope and timeline against funds. These funds support long-lead (8–24 months) procurements, major field experiments and demonstrations, space-based nuclear detonation detection satellite payload interagency integration activities, major lab equipment purchases, and payment of laboratory salaries.

National Technical Nuclear Forensics R&D: (Total Uncosted $14.9 million, [$7.9 million encumbered, $7.0 million unencumbered])

At the end of FY 2021, National Technical Forensics R&D costs plus encumbrances totaled $31.3 million, or 81.7 percent of total FY 2021 available funds. The uncosted balance total of $14.9 million (of which $7.9 million, representing 20.7 percent of available FY 2021 funds, was encumbered) exceeded the recommended threshold by $.3 million. The $7.0 million in FY 2021 unencumbered balances are allocated to equipment procurements and research and development activities at national laboratories, sites and plants.

Material Management and Minimization: (Total Uncosted $353.2 million, [$186.9 million encumbered, $166.3 million unencumbered])

At the end of FY 2021, M3 costs plus encumbrances totaled $532.3 million, or 76.2 percent of total FY 2021 available funds. The uncosted balance total of $353.2 million (of which $186.9 million, representing 26.7 percent of available FY 2021 funds, was encumbered) exceeded the recommended threshold by $27.0 million. The $166.3 million in FY 2021 unencumbered balances support four critical programs within M3: (1) Conversion; (2) Nuclear Material Removal; (3) Material Disposition; and (4) Laboratory and Partnership Support.

Conversion Program

The unencumbered balances for the Reactor Conversion Program ($50.4 million) support completing post-irradiation examination activities at Idaho National Laboratory on various irradiation campaigns (MP-1, EMPIrE, and KJRR), planning and design activities for future irradiation experiments, multiple conversion activities including IVG.1M conversion work in Kazakhstan and KUCA conversion work in Japan, irradiation costs for the FUTURE-HFIR experiment, fuel fabrication demonstration and optimization activities, and reactor conversion analyses and other cross-cutting activities to support the conversion of USHPRRs; new projects, such as PRO-X and initial preparatory activities at Y-12 to begin a High-Assay LEU recovery project.

Nuclear Material Removal Program

The unencumbered balances for the Nuclear Material Removal Program ($24.5 million) support final construction of the Mobile Melt-Consolidate system; ongoing and future nuclear material removal campaigns from Asia, Europe, and North America; Mobile Uranium Facility and Mobile

Plutonium Facility readiness, including an international training exercise and equipment modernization; and contractor labor and travel to support future nuclear material removals.

Material Disposition Program

The unencumbered balances for the Material Disposition Program ($83.6 million) support U.S. Plutonium Disposition at multiple sites to continue program management and integration activities, including Strategic Laboratory Assessment (SLA)/Robotics and NEPA activities; pit disassembly and processing activities; disposition of MOX legacy materials; dilute and waste characterization technical activities; and ramping up operations in support of the dilute and dispose strategy. (Out of the $83.6 million, $44.3 million is associated with capital asset acquisition projects that are required to be funded in a single year but were costed over multiple years.) U.S. Uranium Disposition—$0.4 million at Y-12/NPO to continue HEU downblending activities; International Disposition—$1.4 million at multiple labs to continue International Plutonium Disposition activities, including technical exchanges with the United Kingdom, and standing up a robotics and automation working group that reports results in 2023.

Laboratory and Partnership Support Program

The unencumbered balances for the Laboratory and Partnership Support Program ($7.8 million) did not exceed the DOE threshold. Balances provide laboratory technical support for the development of neutron capture, accelerator, LEU, and other Mo-99 target technologies.

Nonproliferation and Arms Control: (Total Uncosted $59.3 million, [$26.2 million encumbered, $33.1 million unencumbered])

At the end of FY 2021, NPAC costs plus encumbrances totaled $177.0 million, or 84.2 percent of total FY 2021 available funds. The uncosted balance total of $59.3 million (of which $26.2 million, representing 12.5 percent of available FY 2021 funds, was encumbered) exceeded the recommended threshold by $3.8 million. The $33.1 million in FY 2021 unencumbered balances support four critical programs within NPAC: International Nuclear Safeguards; Nuclear Export Controls; Nuclear Verification; and Nonproliferation Policy.

Nuclear Safeguards

The unencumbered balances for International Nuclear Safeguards ($10.6 million) were used to conduct safeguards engagements where possible, provide for enhanced development of distance learning/engagements, redirected to advance the development of a nonproliferation enrichment safeguards testing and training platform and/or redirected to other nonproliferation opportunities with foreign partners through targeted peaceful uses engagement.

Nuclear Export Controls

The unencumbered balances for Nuclear Export Controls ($11.0 million) were used to accelerate the development of training courses in export licensing and industry outreach and to accelerate lab participation in export licensing review and adjudication.

Nuclear Verification

The unencumbered balances for Nuclear Verification ($7.1 million) were used to enhance team readiness for the uranium, plutonium, and nuclear test site verification teams to support key contracts to enable warhead, fissile material, and nuclear explosion monitoring, and disablement and dismantlement verification capabilities that were placed in early FY 2022.

Nonproliferation Policy

The unencumbered balances for Nonproliferation Policy ($4.4 million) will be used to implement statutory requirements and Part 810 licensing reviews.

Cost + Encumbered Status, End of Fiscal Year 2021 (dollars in thousands)	A	B	C	D B + C	E D / A	F A - D	G F / A
	Data						
Expens Program	Total Funds Available to Cost	YTD Cost	Total Uncosted Encumbered Obligations	Current Costs + Encumbrances	Costed or Encumbered as a % of Costing Authority	Total Uncosted Unencumbered Obligations	Unencumbered as % of Costing Authority
Operating							
DN10 Global Material Security	1,012,744,117	439,697,011	349,165,786	788,862,797	77.9%	223,881,320	22.1%
DN20 Defense Nuclear Nonproliferation R&D	880,036,189	526,486,376	106,992,457	633,478,832	72.0%	246,557,357	28.0%
DN30 Material Management and Minimization	698,533,024	345,273,366	186,972,258	532,245,624	76.2%	166,287,400	23.8%
DN40 Nonproliferation and Arms Control	210,066,081	150,745,644	26,262,755	177,008,398	84.3%	33,057,683	15.7%
DN50 National Technical Nuclear Forensics R&D	38,319,119	23,379,930	7,927,758	31,307,687	81.7%	7,011,432	18.3%
DN80 Legacy Contractor Pensions-NN	16,182,719	7,093,048	9,089,671	16,182,719	100.0%	0	0.0%
Elimination of Weapons Grade Plutonium Production	526,968	0	526,968	526,968	100.0%	0	0.0%
Global Threat Reduction Initiative	4,224,010	3,808,053	275,409	4,083,462	96.7%	140,548	3.3%
NN40 Nonproliferation and International Security NIS	119,660	32,337	52,418	84,755	70.8%	34,905	29.2%
NN50 International Material Protection and Cooperation IMPC	41,141,133	13,849,472	13,697,204	27,546,676	67.0%	13,594,457	33.0%
NN60 Fissile Materials Disposition	7,707,936	4,196,368	3,307,191	7,503,559	97.3%	204,377	2.7%
NN91 Highly Enriched Uranium HEU Reactor Conversion	84,552	51,070	0	51,070	60.4%	33,482	39.6%
NN92 International Nuclear and Radiological Material Removal and Protection	31,665,559	2,472,650	29,168,508	31,641,157	99.9%	24,402	0.1%
NN93 Domestic Radiological Material Removal and Protection	318,096	76,651	0	76,651	24.1%	241,445	75.9%
Russian Surplus Fissile Materials Disposition	139,046	0	139,046	139,046	100.0%	0	0.0%
Operating Total	2,941,808,209	1,517,161,973	733,577,428	2,250,739,401	76.5%	691,068,808	23.5%
Construction							
DN01 DNN Construction	87,374,988	30,460,773	1,647,302	32,108,075	36.7%	55,266,913	63.3%
	185,695,584	84,481,409	3,663,907	88,145,316	47.5%	97,550,268	52.5%
DN30 Material Management and Minimization	475,761	65,396	410,365	475,761	100.0%	0	0.0%
NN62 U.S. Surplus Fissile Materials Disposition	-2,242	-2,242	-0	-2,242	100.0%	0	0.0%
Construction Total	273,544,090	115,005,336	5,721,573	120,726,909	44.1%	152,817,181	55.9%
Grand Total	3,215,352,299	1,632,167,309	739,299,001	2,371,466,310	73.8%	843,885,989	26.2%

Appendix G: Threat Assessment Reports

As discussed in section 1.2 of this report, DOE/NNSA aligns its program activities to the current and emerging nuclear and radiological threat environment. Several sources characterize the threat environment including the following reports:

"Annual Threat Assessment of the U.S. Intelligence Community" (2022), https://www.dni.gov/files/ODNI/documents/assessments/ATA-2022-Unclassified-Report.pdf

"Climate Change and International Responses Increasing Challenges to U.S. National Security Through 2040", National Intelligence Estimate (2021), https://www.dni.gov/index.php/newsroom/reports-publications/reports-publications-2021/item/2253-national-intelligence-estimate-on-climate-change

"Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance", DIA (2019), https://www.dia.mil/Military-Power-Publications/

"The Future of Weapons of Mass Destruction: An Update", NDU (2021), https://ni-u.edu/wp/wp-content/uploads/2021/04/Future_of_WMD_Final.pdf

"Country Reports on Terrorism", DOS (2020), https://www.state.gov/country-reports-on-terrorism/

IAEA and Iran – IAEA Reports (2021), https://www.iaea.org/newscenter/focus/iran/iaea-and-iran-iaea-reports

"China Military Power: Modernizing A Force to Fight and Win", DIA (2019), https://www.dia.mil/Military-Power-Publications/

"Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments", DOS (2022), https://www.state.gov/adherence-to-and-compliance-with-arms-control-nonproliferation-and-disarmament-agreements-and-commitments/

Letter from the Panel of Experts established pursuant to resolution 1874 (2009) addressed to the President of the (UN) Security Council (3 September 2021), https://undocs.org/S/2021/777

"Military and Security Developments Involving the People's Republic of China", DOD (2021), https://media.defense.gov/2021/Nov/03/2002885874/-1/-1/0/2021-CMPR-FINAL.PDF

"Russia Military Power: Building a Military to Support Great Power Aspirations", DIA (2017), https://www.dia.mil/Military-Power-Publications/

"Application of Safeguards in the Democratic People's Republic of Korea", IAEA (2021), https://www.iaea.org/sites/default/files/gc/gc65-22.pdf

"National Strategy for Critical and Emerging Technologies", U.S. Government (2020), https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/10/National-Strategy-for-CET.pdf

"Global Trends 2040: A More Contested World", DNI (2021), https://www.dni.gov/files/ODNI/documents/assessments/GlobalTrends_2040.pdf

"North Korea Military Power: A Growing Regional and Global Threat", DIA (2021), https://www.dia.mil/Military-Power-Publications/

"IAEA Safeguards Statement for 2020", IAEA, https://www.iaea.org/sites/default/files/21/06/statement-sir-2020.pdf

International Physical Protection Advisory Service, IAEA, https://www.iaea.org/services/review-missions/international-physical-protection-advisory-service-ippas

"NTI Nuclear Security Index", Nuclear Threat Initiative (2022), https://www.ntiindex.org/news/country-actions-january-2022-update

"Nuclear Proliferation and Arms Control Monitoring, Detection, and Verification: A National Security Priority - Interim Report (2021), National Academies of Science, Engineering, and Medicine, https://www.nap.edu/catalog/26088/nuclear-proliferation-and-arms-control-monitoring-detection-and-verification-a

DOE/NA-0130

A Report to Congress

Prevent, Counter, and Respond—NNSA's Plan to Reduce Global Nuclear Threats
FY 2023-FY 2027

August 2023

United States Department of Energy
National Nuclear Security Administration
1000 Independence Avenue, SW
Washington, DC 20585