Prevent, Counter, and Respond—A Strategic Plan to Reduce Global Nuclear Threats

FY 2017–FY 2021

Report to Congress
March 2016

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

This page left blank intentionally.

Message from the Administrator

The Department of Energy's National Nuclear Security Administration (DOE/NNSA) is pleased to submit an update to *Prevent, Counter, and Respond—A Strategic Plan to Reduce Global Nuclear Threats (FY 2016–FY 2020)*. This report, along with DOE/NNSA's *Stockpile Stewardship and Management Plan*, informs our planning and program activities to ensure U.S. national security and advance global nuclear security.

As President Obama reaffirmed in the 2015 *National Security Strategy*, "No threat poses as grave a danger to our security and well-being as the potential use of nuclear weapons and materials by irresponsible states or terrorists." Reducing this threat is one of DOE/NNSA's enduring missions, as detailed in NNSA's *Enterprise Strategic Vision.*[1] Along with maintaining a safe, secure, and effective nuclear deterrent and providing naval nuclear propulsion, DOE/NNSA's efforts to prevent, counter, and respond to the threats of nuclear proliferation and terrorism make a vital contribution to U.S. national security.

Since the initial report was published in March 2015, there have been significant changes in the nuclear and radiological threat environment. Most notably, the Joint Comprehensive Plan of Action (JCPOA, also known as the "Iran deal") has blocked Iran's pathways to a nuclear weapon and is ensuring that Iran's nuclear program is exclusively peaceful. However, overall relations between the United States and the Russian Federation have worsened, and terrorist attacks in the past year in Europe and the United States have highlighted the evolving and unpredictable nature of the threat environment. This report describes these and other important developments, as well as their implications for our work.

Over the past two years, we have focused on ensuring that the programs responsible for preventing, countering, and responding to this threat are thoroughly integrated. As with our other DOE/NNSA missions pillars, our nuclear threat reduction work is enabled by the important crosscutting activities of advancing science, technology, and engineering; supporting our people and modernizing our infrastructure; and developing a management culture that promotes a safe and secure nuclear enterprise.

In February 2015, we proposed the alignment of all DOE/NNSA funding for preventing, countering, and responding to global nuclear dangers into one appropriation. To further integrate these critical activities, we transferred a number of functions from the Office of Emergency Operations to the Office of Counterterrorism and Counterproliferation in late 2015. This reorganization consolidates several related activities in order to improve collaboration and efficiency. The change also supports the Department's objective of improving its emergency management system; the Office of Emergency Operations will take on an expanded leadership role in implementing an all-hazards enterprise-wide capability.

This report addresses the requirement in 50 U.S.C. § 4309—which was added by Section 3132 of the *FY 2016 National Defense Authorization Act*—for DOE/NNSA to produce a *Defense Nuclear Nonproliferation Management Plan*. This report is provided to the following Members of Congress:

- **The Honorable John McCain**
  Chairman, Senate Committee on Armed Services

- **The Honorable Jack Reed**
  Ranking Member, Senate Committee on Armed Services

[1] The NNSA *Enterprise Strategic Vision* is available online at: http://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/Strategic_Vision_2015_8-21_screen%20quality.pdf.

- **The Honorable Mac Thornberry**
  Chairman, House Committee on Armed Services
- **The Honorable Adam Smith**
  Ranking Member, House Committee on Armed Services
- **The Honorable Bob Corker**
  Chairman, Senate Committee on Foreign Relations
- **The Honorable Ben Cardin**
  Ranking Member, Senate Committee on Foreign Relations
- **The Honorable Edward R. Royce**
  Chairman, House Committee on Foreign Affairs
- **The Honorable Eliot L. Engel**
  Ranking Member, House Committee on Foreign Affairs
- **The Honorable Thad Cochran**
  Chairman, Senate Committee on Appropriations
- **The Honorable Barbara A. Mikulski**
  Vice Chairwoman, Senate Committee on Appropriations
- **The Honorable Lamar Alexander**
  Chairman, Subcommittee on Energy and Water Development
  Senate Committee on Appropriations
- **The Honorable Dianne Feinstein**
  Ranking Member, Subcommittee on Energy and Water Development
  Senate Committee on Appropriations
- **The Honorable Harold Rogers**
  Chairman, House Committee on Appropriations
- **The Honorable Nita M. Lowey**
  Ranking Member, House Committee on Appropriations
- **The Honorable Michael K. Simpson**
  Chairman, Subcommittee on Energy and Water Development
  House Committee on Appropriations
- **The Honorable Marcy Kaptur**
  Ranking Member, Subcommittee on Energy and Water Development
  House Committee on Appropriations

If you have questions about this plan, please contact me or Mr. Clarence Bishop, Associate Administrator for External Affairs, at (202) 586-8343.

Sincerely,

Frank G. Klotz

Message from the Secretary

The Department of Energy's National Nuclear Security Administration (DOE/NNSA) has played a critical role in global efforts to reduce and eliminate nuclear dangers. From the work we did following the fall of the Soviet Union to secure weapons, materials, facilities, and expertise to the accelerated efforts to secure vulnerable nuclear material around the world following the President's 2009 Prague speech, we have done much to make the world a safer place. Because of these accomplishments and those of our international partners, we have eliminated highly enriched uranium (HEU) from 28 countries plus Taiwan to date. Of these 28 HEU removals, 13 have been completed since 2009. This progress will be further advanced by the upcoming removal of over 500 kilograms of excess HEU and plutonium from Japan.

Recently, the Department contributed to another landmark accomplishment by providing critical support to the negotiation of the Joint Comprehensive Plan of Action (JCPOA, also known as the "Iran deal"). The JCPOA has dramatically reduced the threat of nuclear proliferation by blocking Iran's pathways to a nuclear weapon, rolling back its nuclear infrastructure and stockpile, and granting unprecedented access to international inspectors. Scientists and engineers at the DOE/NNSA laboratories and sites were part of a DOE-wide effort to provide extensive technical analysis to U.S. negotiators to ensure that the technical underpinnings of the deal were solid. DOE's ability to provide this support was made possible by decades of investment in highly specialized expertise and facilities across the country.

The Department remains a central contributor to the United States' efforts to strengthen global nuclear security, including by supporting the Nuclear Security Summit process since its inception in 2010. The Summit process has driven concrete actions to reduce global nuclear threats and strengthened the broader international nuclear security architecture. A key DOE accomplishment in this area was the *Apex Gold* scenario-based policy discussion, an official Summit-related activity at which I hosted more than 40 countries and international organizations for an interactive discussion based around a fictional, transnational nuclear terrorism threat involving HEU out of regulatory control. Unfortunately, contemporary world events suggest that reality could resemble fiction without our ongoing commitment. Another key accomplishment was the March 2016 commissioning of China's nuclear security Center of Excellence, which will address China and the region's nuclear security training requirements, provide a forum for best practice exchanges, and serve as a venue for demonstrating advanced technologies related to nuclear security.

Our programs to reduce nuclear and radiological threats face a number of significant challenges moving forward, including increasing global stockpiles of plutonium, inadequately secured nuclear and radiological materials, and the threat of nuclear smuggling. These challenges must be addressed against the backdrop of geopolitical challenges, especially the emergence of significant terrorist threats around the world.

To ensure the Department is positioned to achieve its goals in this dynamic environment, we restructured our nuclear and radiological threat reduction programs over the last two years. Of note, in 2015, we realigned functions to strengthen the focus on enterprise-wide emergency management. The Deputy Secretary of Energy also established the Emergency Incident Management Council (EIMC) to increase cooperation and coordination across the Department and help all of DOE prepare for, mitigate, respond to, and recover from all-hazards emergencies, including major disruptions to our Nation's energy systems.

In sum, these organizational changes provide a more effective foundation to respond to future challenges and will enable us to continue to serve as a leader in the global effort to reduce and eliminate nuclear and radiological dangers. This report describes these changes in detail, and informs our planning and program activities as a companion piece to DOE/NNSA's *Stockpile Stewardship and Management Plan*.

Sincerely,

Ernest J. Moniz

Executive Summary

Prevent, Counter, and Respond—A Strategic Plan to Reduce Global Nuclear Threats (FY 2017–FY 2021) is an annual report that describes the complexities of the global nuclear security environment and the strategic approach the Department of Energy's National Nuclear Security Administration (DOE/NNSA) takes to prevent, counter, and respond to the threat of nuclear proliferation, and nuclear and radiological terrorism.[2]

One of DOE/NNSA's three mission pillars is nuclear threat reduction. This mission is linked to key priorities established in the 2015 *National Security Strategy,* the *Department of Energy Strategic Plan for 2014-2018,* and NNSA's 2015 *Enterprise Strategic Vision*.[3] The nuclear threat reduction mission is built around three functional areas:

- **Prevent** non-state actors and proliferant states from developing nuclear weapons or acquiring weapons-useable nuclear material, equipment, technology, and expertise and prevent non-state actors from acquiring nuclear and radiological materials for an improved nuclear device or radiological dispersal device (Chapter 2);
- **Counter** the efforts of both proliferant states and non-state actors to steal, acquire, develop, disseminate, transport, or deliver the materials, expertise, or components necessary for an improved nuclear device or radiological dispersal device, or the weapons themselves (Chapter 3); and,
- **Respond** to nuclear or radiological terrorist acts or accidents by searching for and rendering safe threat devices and materials; carrying out nuclear forensics activities; conducting consequence management actions following an event to protect lives, property, and the environment; and preparing for and supporting departmental emergencies through close coordination with the Department's Emergency Management Enterprise system (Chapter 4).

The FY 2017 edition of *Prevent, Counter, and Respond* is an update to last year's report, focusing on major changes in the threat environment and in DOE/NNSA's nuclear and radiological threat reduction programs. Additionally, the report provides new information on the infrastructure and human capital base that supports these programs.

There have been several developments since last year's report. Among the most important is the Iran Joint Comprehensive Plan of Action (JCPOA), which blocks Iran's pathways to a nuclear weapon and ensures that Iran's nuclear program is exclusively peaceful. The JCPOA represents a significant change to the nuclear proliferation threat environment. Other key developments in the threat environment include the emergence of new terrorist threats in Western Europe and the United States, increasingly frequent and sophisticated cyber-attacks, and the emergence of new and potentially proliferation-relevant technologies.

---

[2] This report addresses the requirement in 50 U.S.C. § 4309—which was added by Section 3132 of the *FY 2016 National Defense Authorization Act*—for DOE/NNSA to produce a *Defense Nuclear Nonproliferation Management Plan*. The specific requirements for the *Defense Nuclear Nonproliferation Management Plan*, and the location of the corresponding information within this document, are described in Appendix A.

[3] The *NNSA Strategic Vision* is available online at: http://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/Strategic_Vision_2015_8-21_screen%20quality.pdf.

The DOE/NNSA programs designed to reduce nuclear and radiological threats will, by necessity, respond to these and other changes. Implementation of the JCPOA, especially in areas such as support for International Atomic Energy Agency (IAEA) safeguards and the redesign and rebuild of the Arak reactor, will be an important body of work. Programs in the "Prevent" functional area also have been affected by factors such as internal strategic reviews of ongoing programs. The Administration's FY 2017 proposal to pursue the dilution and disposal approach to plutonium disposition, which enables plutonium to be disposed of much sooner with far lower technical risks and less funding than the mixed oxide (MOX) fuel approach, is also a significant change.

The DOE/NNSA programs designed to counter and respond to nuclear and radiological threats have also seen new developments over the last year, including establishment of the Department's Emergency Incident Management Council (EIMC) and the reorganization of the DOE/NNSA Office of Emergency Operations and the Office of Counterterrorism and Counterproliferation. These changes will increase coordination in preparing for, responding to, and recovering from all-hazards emergencies and major disruptions to our nation's energy system. The changes also consolidate all threat assessment and incident response assets involving nuclear and radiological material and facilities.

The global nuclear security environment has changed in important ways over the last year, and DOE/NNSA's nuclear and radiological threat reduction programs have evolved as well. The future is challenging and dynamic, but DOE/NNSA is fully committed to ensuring that our mission will be strategically and effectively executed today and into the future.

Prevent, Counter, and Respond—A Strategic Plan for Reducing Global Nuclear Threats (FY 2017–FY 2021)

Table of Contents

List of Figures ..... **ix**

List of Acronyms ..... **xi**

Legislative Language ..... **xiii**

Chapter 1 Introduction: Meeting the Challenges of Nuclear Proliferation & Terrorism **1-1**
- 1.1 Enduring Program Strategy, Objectives, and Prioritization 1-1
- 1.2 Characterizing the Threat Environment 1-3
- 1.3 Major Developments and Responses 1-5
  - 1.3.1 Iran and the Joint Comprehensive Plan of Action 1-6
  - 1.3.2 International and Domestic Terrorism 1-8
  - 1.3.3 Cybersecurity Threats 1-8
  - 1.3.4 Emerging Technologies 1-9

Chapter 2 Preventing Nuclear/Radiological Proliferation and Terrorism **2-1**
- 2.1 Program Description 2-1
- 2.2 Changes to Programs and Capabilities 2-1
  - 2.2.1 The Joint Comprehensive Plan of Action 2-1
  - 2.2.2 Plutonium Disposition Path Forward 2-2
  - 2.2.3 Work in the Russian Federation 2-5
  - 2.2.4 Results from Program Strategic Reviews 2-8
- 2.3 Update on the Infrastructure and Human Capital Base 2-11
  - 2.3.1 Description of the Infrastructure and Human Capital Base 2-11
  - 2.3.2 Key Infrastructure and Human Capital Challenges 2-15
- 2.4 Updated Future Program Plans 2-17
  - 2.4.1 Material Management and Minimization 2-17
  - 2.4.2 Global Material Security 2-19
  - 2.4.3 Nonproliferation and Arms Control 2-21
  - 2.4.4 Defense Nuclear Nonproliferation R&D 2-23
  - 2.4.5 Nonproliferation Construction 2-25

Chapter 3 Countering Nuclear/Radiological Proliferation and Terrorism 3-1
3.1 Program Description 3-1
3.2 Changes to Programs and Capabilities.....3-1
3.2.1 Realignment of Activities under CTCP.....3-1
3.2.2 CTCP as the Department's Lead for Nuclear Forensics 3-2
3.3 Update on the Infrastructure and Human Capital Base.....3-5
3.3.1 Description of the Infrastructure and Human Capital Base 3-5
3.3.2 Key Infrastructure and Human Capital Challenges 3-7
3.4 Updated Future Program Plan 3-8

Chapter 4 Responding to Nuclear/Radiological Threats and Terrorism 4-1
4.1 Program Description 4-1
4.2 Changes to Programs and Capabilities.....4-2
4.2.1 Realignment of Activities under the Office of Emergency Operations 4-2
4.2.2 Adoption of Enterprise-Wide Approach to Emergency Management.....4-3
4.2.3 Creation of the CTCP Office of Nuclear Incident Response.....4-5
4.3 Update on the Infrastructure and Human Capital Base.....4-5
4.3.1 Description of the Infrastructure and Human Capital Base 4-5
4.3.2 Key Infrastructure and Human Capital Challenges 4-9
4.4 Updated Future Program Plan 4-9

Chapter 5 Conclusion.....5-1

Appendix A Legislative Requirements Mapping Matrix..... A-1

Appendix B FY 2015 Accomplishments and Challenges B-1

Appendix C Foreign Contributions and Cost-Sharing Agreements C-1

Appendix D *FY 2017 Future Years Nuclear Security Program* Plan D-1

Appendix E Relevant Laws, Policy Directives, and International Agreements E-1

Appendix F Analysis and Explanation of FY 2015 Uncommitted Balances.....F-1

Appendix G Coordinated within DOE and the U.S. Interagency G-1

List of Figures

Figure 1. DOE/NNSA Strategic Approach to Reducing Nuclear and Radiological Threats 1-3
Figure 2. Projected Growth in Global Nuclear Energy Generation Capacity: 2012 and 2014 Forecasts..... 1-5
Figure 3. Iran Nuclear Discussions in Lausanne, Switzerland in March 2015 1-6
Figure 4. High-Performance Building Produced Using Additive Manufacturing at Oak Ridge National Lab 1-10
Figure 5. Robotic Lathe Used to Disassemble Pits as Part of the Plutonium Disposition Process 2-3
Figure 6. Shipment of Low Enriched Uranium (LEU) under the HEU Purchase Agreement with Russia 2-5
Figure 7. Removal of a Radiological Device from Temple University in Philadelphia 2-8
Figure 8. Advanced Test Reactor at Idaho National Laboratory 2-11
Figure 9. Interdiction Testing and Integration Laboratory at Pacific Northwest National Laboratory 2-12
Figure 10. Predictive Model of Acoustic Energy Propagation from Explosive Detonation..... 2-13
Figure 11. Laboratory, Plant, and Site Workforce Supporting DNN 2-14
Figure 12. DNN Federal Staff by Job Series Category 2-14
Figure 13. Nuclear Safeguards Inspection 2-15
Figure 14. Progress Towards Completing Material Management and Minimization Goals 2-18
Figure 15. Progress Towards Completing Global Material Security Goals..... 2-20
Figure 16. Progress Towards Completing Nonproliferation and Arms Control Goals 2-22
Figure 17. Progress Towards Completing Research and Development Goals 2-24
Figure 18. Participants in an International Nuclear Forensics Workshop..... 3-3
Figure 19. *Silent Thunder* Exercise at the Massachusetts Institute of Technology..... 3-4
Figure 20. Z Facility at Sandia National Laboratories..... 3-5
Figure 21. Laboratory, Plant, and Site Workforce Supporting CTCP..... 3-6
Figure 22. CTCP Federal Staff by Job Series Category..... 3-7
Figure 23. Requested and Enacted Funding for Counterterrorism and Counterproliferation Activities..... 3-7
Figure 24. Progress Towards Completing Counterterrorism and Counterproliferation Goals 3-8
Figure 25. Recent Incidents Impacting the Department's Approach to Emergency Management 4-4
Figure 26. Aerial Measuring System Helicopter..... 4-6
Figure 27. National Atmospheric Release Advisory Center 4-6
Figure 28. DOE/NNSA Emergency Response Assets 4-7
Figure 29. Laboratory, Plant, and Site Workforce Supporting Emergency Response and Management 4-8
Figure 30. Federal Staff Supporting Emergency Response and Management by Job Series Category 4-8

This page left blank intentionally.

List of Acronyms

CFR	Code of Federal Regulations
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTCP	Office of Counterterrorism and Counterproliferation
CTR	Cooperative Threat Reduction
DHS	Department of Homeland Security
DNFSB	Defense Nuclear Facilities Safety Board
DNN	Office of Defense Nuclear Nonproliferation
DNN R&D	Office of Defense Nuclear Nonproliferation Research and Development
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOS	Department of State
DP	Office of Defense Programs
EIMC	Emergency Incident Management Council
EM	Environmental Management
ETRAC	Emerging Technologies Research Advisory Committee
ETWG	Emerging Technologies Working Group
EU	European Union
FBI	Federal Bureau of Investigation
FMD	Fissile Materials Disposition
FUSION	Focused, United, Scientific, Innovative, Open, and National
FYNSP	Future Years Nuclear Security Program
GMS	Office of Global Material Security
GTRI	Global Threat Reduction Initiative
HAMMER	Hazardous Materials Management and Emergency Response
HEU	Highly Enriched Uranium
HHS	Department of Health and Human Services
IAEA	International Atomic Energy Agency
IMPC	International Material Protection and Cooperation
IND	Improvised Nuclear Device
INF	Intermediate-Range Nuclear Forces
IPC	Interagency Policy Committee
IPMEG	International Plutonium Management Experts Group
ISIL	Islamic State of Iraq and the Levant
JCPOA	Joint Comprehensive Plan of Action
kg	kilograms
LEU	Low Enriched Uranium
LOB	National Laboratory Operations Board
M^3	Office of Material Management and Minimization

M&O	Management and Operating
MDI	Mission Dependency Index
MNEPR	Multilateral Nuclear Environmental Programme in the Russian Federation
Mo-99	Molybdenum-99
MOA	Memorandum of Agreement
MOD	Ministry of Defense
MOX	Mixed Oxide
MPC&A	Material Protection, Control, and Accounting
MT	Metric Tons
NE	Office of Nuclear Energy
New START	New Strategic Arms Reduction Treaty
NGFP	NNSA Graduate Fellowship Program
NIPC	Office of Nuclear Incident Policy and Cooperation
NIS	Nonproliferation and International Security
NLDC	National Laboratory Directors Council
NNSA	National Nuclear Security Administration
NPAC	Office of Nonproliferation and Arms Control
NPT	Nuclear Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
NSC	National Security Council
NSDD	Office of Nuclear Smuggling Detection and Deterrence
NSPD	National Security Presidential Directive
P5+1	China, France, Germany, Russia, the United Kingdom, and the United States
PMDA	U.S.-Russia Plutonium Management and Disposition Agreement
PMEG	U.S.-Japan Plutonium Management Experts Group
PMUG	U.S.-U.K. Plutonium Management Users Group
PPD	Presidential Policy Directive
PWG	Plutonium Disposition Working Group
RAP	Radiological Assistance Program
RPM	Radiation Portal Monitor
SSP	Stockpile Stewardship Program
UCG	Unified Command Group
U.K.	United Kingdom
U.S.	United States
WMC	Warhead Measurement Campaign
WMD	Weapons of Mass Destruction
WUNM	Weapons-Usable Nuclear Material

Legislative Language

Title 50 of United States Code Section 4309 (50 U.S.C. § 4309), requires that:

> …in each fiscal year, the [NNSA] Administrator shall submit to the congressional defense committees 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 A.

Chapter 1: Introduction
Meeting the Challenges of Nuclear Proliferation & Terrorism

1.1 Enduring Program Strategy, Objectives, and Prioritization

The Department of Energy's National Nuclear Security Administration's (DOE/NNSA) directly supports the security and safety of our nation through its three enduring mission pillars: maintaining a safe, secure, and effective nuclear weapons stockpile; reducing the threat of nuclear proliferation and terrorism; and providing naval nuclear propulsion. This update to the 2015 report *Prevent, Counter, and Respond—A Strategic Plan to Reduce Global Nuclear Threats* focuses on the strategy for executing the second of these mission pillars.

The nuclear and radiological threat environment is characterized by both persistent challenges and rapidly evolving threats and trends. To pursue U.S. nuclear security goals within this environment, DOE/NNSA organizes its threat reduction activities into three functional areas that cover the entire threat spectrum. This approach was set out in NNSA's 2015 *Enterprise Strategic Vision,* and is linked to the U.S. policy priorities established in documents such as the 2015 *National Security Strategy*, the 2011 *National Strategy for Counterterrorism*, and the 2010 *Nuclear Posture Review*.

Programs in all three functional areas—prevent, counter, and respond—are guided by rigorous risk assessments and prioritization, as well as close coordination with interagency partners. To execute these programs, as well as its other mission pillars, DOE/NNSA conducts the important crosscutting activities of advancing science, technology and engineering; supporting its people and modernizing its infrastructure; and developing a management culture that promotes a safe and secure nuclear enterprise. Under the prevent-counter-respond continuum, DOE/NNSA works to:

1. **Prevent** non-state actors and proliferant states from developing nuclear weapons or acquiring weapons-useable nuclear material, equipment, technology, and expertise and prevent non-state actors from acquiring nuclear and radiological materials for an improvised nuclear device (IND) or radiological dispersal device (RDD);
2. **Counter** the efforts of both proliferant states and non-state actors to steal, acquire, develop, disseminate, transport, or deliver the materials, expertise, or components necessary for a nuclear weapon, IND, or RDD; and,
3. **Respond** to nuclear or radiological terrorist acts or accidents by searching for and rendering safe threat devices and materials; carrying out nuclear forensic activities; conducting consequence management actions following an event to protect lives, property, and the environment; and preparing for and supporting departmental emergencies through close coordination with the Department's Emergency Management Enterprise system.

Through this prevent-counter-respond strategic approach, DOE/NNSA pursues the following objectives:

- Minimize and, when possible, eliminate excess weapons-usable nuclear material, ensure sound management principles for remaining nuclear materials, and support peaceful uses of nuclear energy by making nuclear materials available for these purposes;
- Achieve adequate security, protection, control, and accounting for all nuclear and radiological materials worldwide (in accordance with internationally accepted recommendations), and prevent the illicit trafficking of nuclear weapons and nuclear and radiological materials;
- Prevent the proliferation of weapons of mass destruction (WMD)— as well as relevant dual-use materials, equipment, technology, and expertise—by state and non-state actors through nuclear safeguards and export controls and by strengthening nonproliferation and arms control regimes;
- Develop effective technologies to detect nuclear weapons proliferation and nuclear detonations and support the monitoring and verification of foreign commitments to treaties and other international agreements and regimes;
- Strengthen nuclear counterterrorism and counterproliferation capabilities by developing scientific and technical capabilities to understand nuclear threat devices, designs, and concepts (including INDs) and to address risks arising from lost or stolen foreign nuclear weapons and their components;
- Reduce the terrorist value of nuclear or radiological weapons by maintaining the capability to respond to, manage, avert, and contain the consequences of nuclear and radiological incidents in the United States or elsewhere in the world;
- Respond to nuclear and radiological terrorist acts and accidents by searching for and rendering safe threat devices and materials; carrying out nuclear forensics activities; conducting consequence management actions following an event to protect lives, property, and the environment; and providing emergency services through close coordination with the Department's Emergency Management Enterprise system; and,
- Improve the Department's all-hazards emergency preparedness and response capability for complex, cascading, and enduring incidents.

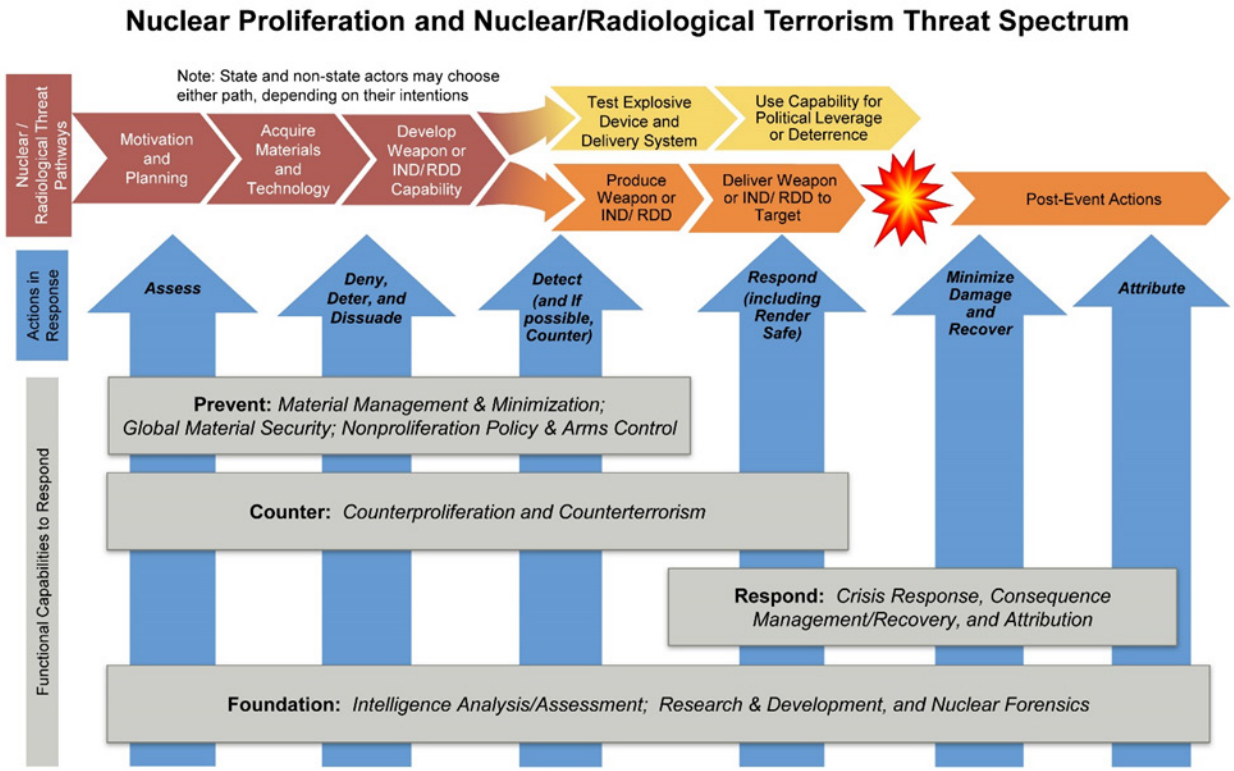

Figure 1. DOE/NNSA Strategic Approach to Reducing Nuclear and Radiological Threats

At the individual program level, U.S. policy goals established through the interagency process, program management judgment, Intelligence Community assessments, and a variety of other external factors directly influence DOE/NNSA's risk-informed prioritization process. DOE/NNSA programs generally use classical risk assessment calculations (i.e., assessed threats, level of vulnerability, probability, and degree of consequences), which are tailored to their missions and capabilities and influenced by external considerations (e.g., evolution of threat trends, time-urgency of a specific threat, windows of opportunity to act, level of long-term political support and cooperation from partners, adequacy of technical capabilities, and availability of resources).

1.2 Characterizing the Threat Environment

An effective understanding of the threat environment is necessary in order to plan and execute nuclear and radiological threat reduction activities. The Intelligence Community, including the DOE Office of Intelligence and Counterintelligence, works to ensure that DOE/NNSA programs are responsive to global developments. The DOE/NNSA Office of Defense Nuclear Nonproliferation (DNN) also conducts "over-the-horizon" strategic studies to identify trends, threats, and opportunities relevant to the organization's work.

Based on these assessment activities, last year's edition of *Prevent, Counter, and Respond* outlined several key trends in the threat environment, including challenges to state control over nuclear and radiological materials, strains on the nonproliferation and arms control regimes, challenges associated with civil nuclear power expansion, and risks from expanded trade and changing technologies. These trends are consistent with the key judgments on the nuclear threat environment that were included in the classified appendix to last year's report. Since the release of last year's report, certain events have further underscored the significance of these trends.

Challenges to State Control over Nuclear and Radiological Materials

Over the last year, events in Syria, Iraq, and Yemen demonstrated that there is eroding control within weak or failing states. In some cases, this trend has been associated with emerging violent non-state actors, including the Islamic State of Iraq and the Levant (ISIL). These groups—and the potential for others to develop in unstable regions of the world—represent a significant threat. This threat is heightened by the prospect that violent non-state actors could access nuclear and radiological materials and knowledge.

Strains on Nonproliferation and Arms Control Regimes

Events of the past year have reinforced the strains on the nonproliferation and arms control regimes. While the Nuclear Non-Proliferation Treaty (NPT) Review Conference in April and May 2015 demonstrated the broad international support for the NPT and the critical role it plays in global security, it did not produce a final consensus document. The Intermediate-Range Nuclear Forces Treaty also faced continued pressures from Russia's violations of its treaty obligations, which were documented in the Department of State's August 2015 *Report on Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments*. (The next update to this report is scheduled to be released in April 2016).

Successes

The JCPOA was finalized since the release of last year's report, and several key treaties have made progress toward entering into force. Notably, a significant number of countries (including the United States) deposited their instruments of ratification, acceptance, or approval of the 2005 Amendment to the Convention on the Physical Protection of Nuclear Materials. As of March 2016, 94 countries have ratified the Amendment and Euratom has acceded to it, with 8 more countries required for the Amendment to enter into force. The United States' ratification of the Amendment has helped to create significant momentum toward that objective.

Challenges Associated with Civil Nuclear Power Expansion

Recent forecasts predict less dramatic total growth in global nuclear energy generation than had been projected previously. However, many states are still planning ambitious nuclear energy programs, and the forecast for growth among "nuclear newcomers" (states that do not currently have civil nuclear power programs and generally have little experience with managing nuclear technologies) has actually increased relative to previous estimates. Ensuring that these "nuclear newcomers" are able to develop safety, security, safeguards, export controls, and emergency response systems to support their emerging nuclear energy programs will require a concerted effort by the international community. Safeguards may be a particularly challenging area, especially given the IAEA's increased responsibilities.

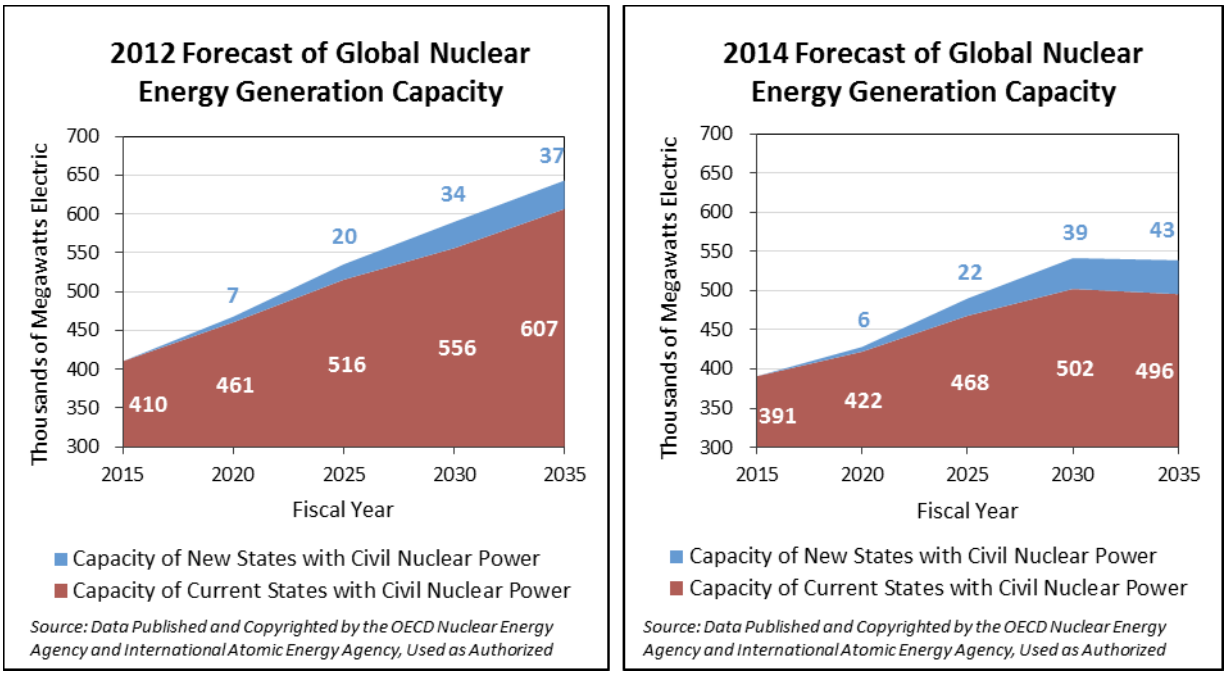

Figure 2. Projected Growth in Global Nuclear Energy Generation Capacity: 2012 and 2014 Forecasts (Graphic Shows the Midpoint between the Published "Low" and "High" Estimates)

Another significant development related to the expansion of civil nuclear power was the August 2015 signing of the host state agreement to establish an IAEA Low Enriched Uranium (LEU) Bank in Kazakhstan. This initiative will provide states with additional confidence in their ability to obtain nuclear fuel without developing sensitive fuel cycle technologies and facilities. As such, it will help support safe and secure nuclear power growth in ways that prevent proliferation and promote global security. Agreements for peaceful U.S. nuclear cooperation with China and South Korea, which entered into force in October and November 2015, respectively, also will play an important role promoting nuclear power safely and securely.

Risks from Expanded Trade and Changing Technologies

Events over the past year have illustrated the risks that attend expanded trade volumes and advancing technologies. For example, one rapidly developing technology with proliferation implications is additive manufacturing. Projected growth rates for this technology continue to increase. A major industry report released in April 2015 forecasted that worldwide additive manufacturing revenue will grow from $5 billion in 2015 to $21 billion by 2020. Moreover, this 2020 revenue forecast is more than double the 2020 forecast from the previous year's report. Additionally, recent events have further underscored the risk posed by offensive cyber-attacks.

1.3 Major Developments and Reponses

Since the last edition of the *Prevent, Counter, and Respond* report, there have been a number of significant developments that reinforce the trends identified above. DOE/NNSA has drawn on its capabilities, including its science and technology base, to respond to these developments.

1.3.1 Iran and the Joint Comprehensive Plan of Action (JCPOA)

After a lengthy multilateral negotiating process, on July 14, 2015, the P5+1 (China, France, Germany, Russia, the United Kingdom, and the United States), the European Union (EU), and Iran finalized the JCPOA. On January 16, 2016, Implementation Day, the IAEA reported that Iran had verifiably completed all of its required nuclear-related steps, and the EU and United States took action to provide Iran the promised sanctions relief laid out in the plan.

The JCPOA includes an array of restrictions and monitoring provisions to effectively prevent Iran from developing a nuclear weapon and provides ample response time should Iran choose to violate the terms of the plan. The JCPOA blocks each of Iran's pathways to a nuclear weapon and rolls back its nuclear infrastructure and stockpile to ensure the "breakout" time to develop the nuclear material necessary for a nuclear weapon will be no less than one year for at least the next 10 years. It also provides for a robust, comprehensive, and enduring inspections regime to ensure Iran's compliance with the JCPOA, as well as its obligations under the NPT. Importantly, Iran affirms in the JCPOA that under no circumstances will it ever seek, develop, or acquire any nuclear weapons, nor will it undertake certain types of research and development that could contribute to developing a nuclear weapon.

DOE's nuclear experts provided critical technical analysis and support throughout these negotiations. The laboratories and sites involved include Argonne National Laboratory in Argonne, IL; Lawrence Livermore National Laboratory in Livermore, CA; Los Alamos National Laboratory in Los Alamos, NM; Oak Ridge National Laboratory in Oak Ridge, TN; Pacific Northwest National Laboratory in Richland, WA; Sandia National Laboratories in Albuquerque, NM and Livermore, CA; Savannah River National Laboratory in Aiken, SC; the Y-12 National Security Complex in Oak Ridge, TN; and the Kansas City National Security Campus in Kansas City, MO.

Figure 3. Iran Nuclear Discussions in Lausanne, Switzerland in March 2015

Uranium Enrichment

The JCPOA specifies that for the next 15 years Iran will not enrich uranium above 3.67 percent uranium-235, which is well below the enrichment level necessary to develop a nuclear weapon. During this period, Iran's stockpile of uranium enriched up to 3.67 percent uranium-235 will not exceed 300 kilograms (kg);

these levels also fall well below the amount necessary for even a single nuclear weapon. Prior to the JCPOA, Iran possessed a stockpile equivalent to almost 12,000 kg of LEU in hexafluoride form. The JCPOA thus required Iran to reduce its stockpile of enriched uranium by 98 percent, and it commits Iran to maintain this stockpile limit for 15 years. Additionally, under the JCPOA Iran may not exceed 5,060 IR-1 centrifuges at its Natanz uranium enrichment facility for 10 years. Iran's underground Fordow facility will be converted into a nuclear physics and technology center that will not enrich uranium, perform uranium enrichment research and development, or keep any nuclear material for the next 15 years.

Reactor and Spent Fuel Activities

The JCPOA requires Iran to redesign and rebuild its heavy water research reactor in Arak. Without this provision, the Arak reactor could have produced enough weapons-grade plutonium for one to two nuclear weapons per year. With the new design, the reactor will produce considerably less plutonium per year and of a quality not suitable for nuclear weapons. The United States and its P5+1 and EU partners have approval authority on the final design prior to construction. The existing Arak reactor internal core structure has been removed and rendered inoperable by filling its openings with concrete. It will be replaced with a new internal core structure that meets U.S. and international nonproliferation requirements. For added assurance, Iran will also ship out of the country all of the spent fuel from this reactor for the lifetime of its operation. Furthermore, for the next 15 years, Iran will not stockpile heavy water in excess of the pre-determined amount needed to operate the modernized Arak reactor and other very limited research needs.

Iran has agreed not to engage in any spent fuel reprocessing (the technology for chemically separating plutonium contained in spent fuel from uranium and highly radioactive waste products) or related research and development for 15 years and has stated that it does not intend to pursue reprocessing thereafter. Iran has also declared its intent to ship out of the country all spent fuel for all present and future power and research nuclear reactors.

International Atomic Energy Agency Monitoring

Under the JCPOA, Iran has informed the IAEA that it will apply the Additional Protocol to its Comprehensive Safeguards Agreement with the IAEA, and it will implement the Modified Code 3.1, which requires that Iran provide design information about nuclear facilities well in advance of their construction. These requirements apply indefinitely.

Iran must allow the IAEA to monitor the implementation of the nuclear measures in the JCPOA, including transparency measures that go beyond routine safeguards and beyond even the more expansive Additional Protocol measures. These transparency measures include:

- Long-term IAEA presence in Iran;
- IAEA monitoring of uranium ore concentrate produced by Iran from all uranium ore concentrate plants for 25 years;
- Containment and surveillance of centrifuge rotors and bellows for 20 years;
- Use of IAEA-approved and -certified modern technologies, including online enrichment measurement and electronic seals;
- Daily IAEA access as requested to relevant buildings at Natanz; and,
- A crucial new mechanism for resolving disputes over IAEA access to sensitive facilities in Iran so that the IAEA gets the access it needs in a timely fashion.

The JCPOA represents an important change to the nuclear proliferation threat environment, one that has potential positive impacts not just in Iran but across the region and throughout the NPT regime. The Department of Energy is confident that the technical underpinnings of the JCPOA are sound, and it stands ready to assist in its implementation, as explained in Section 2.2.1.

1.3.2 International and Domestic Terrorism

In his 2009 speech in Prague, Czech Republic, President Obama stated that "the most immediate and extreme threat to global security" is the prospect of a terrorist group acquiring a nuclear weapon. The threat of terrorism has been underscored by developments since the publication of last year's *Prevent, Counter, and Respond* report.

Over the last year, major terrorist attacks have occurred in locations around the world, including Belgium, Egypt, France, Kenya, Lebanon, Nigeria, Syria, Yemen, and the United States. These attacks, especially those carried out by groups or radicalized individuals in Western Europe and the United States, illustrate the persistence of the terrorist threat to the security of the United States and its allies.

The continued challenge posed by ISIL over the last year is another development in this area. ISIL has recruited thousands of foreign fighters to Iraq and Syria from across the globe and leveraged technology to spread its violent extremist ideology and to incite terrorist acts. In a March 2015 testimony to the House Armed Services Committee, then-Assistant Secretary of Defense for Homeland Defense and Global Security Eric Rosenbach noted that "the Islamic State in Iraq and the Levant (ISIL)'s efforts and its interest in acquiring WMD" represent a major security concern.

While none of the terrorist events in 2015 involved the use of nuclear or radiological materials, they underscored the importance of DOE/NNSA's programs to prevent, counter, and respond to nuclear and radiological terrorism, as well as other nonproliferation and counterterrorism efforts across the U.S. government. Examples of key DOE/NNSA activities to reduce the threat of nuclear and radiological terrorism include:

- Securing, removing, and/or eliminating vulnerable nuclear and radiological materials;
- Deploying fixed and mobile radiation detection systems to deter, detect, and interdict illicit trafficking in nuclear and radiological materials;
- Developing tools and procedures to counter INDs by locating them and rendering them safe;
- Reducing the terrorist value of nuclear or radiological weapons by maintaining a capability to avert and contain the consequences of nuclear and radiological incidents; and,
- Supporting counterterrorism efforts across the U.S. government by contributing to nuclear counterterrorism capabilities maintained by the Federal Bureau of Investigation (FBI) and Department of Defense (DOD), providing technical support to the Department of Homeland Security (DHS), supporting the Intelligence Community's assessment of nuclear threats, and providing training and equipment to law enforcement and first responders.

1.3.3 Threats to Cybersecurity

The threat that cyber-attacks pose to national security has been illustrated by a number of high-profile incidents, including recent cyber intrusions into U.S. government data systems. To accomplish its nuclear threat reduction mission, DOE/NNSA works with foreign and domestic partners to develop and deploy a range of computer-based protection technologies and digital assets across a diverse set of domestic and foreign nuclear and radiological storage and production facilities, as well as sites that use these materials,

such as laboratories and hospitals. While these digital technologies have greatly increased the probability of detecting and interdicting unauthorized access to these sites, they also may present new vulnerabilities in the cyber domain. Accordingly, DOE/NNSA has increased its focus on nuclear cybersecurity threats.

Cyber threats represent a potential shift in the nature of threats to DOE/NNSA's nuclear security mission. Adversaries may seek to take advantage of cyber-attacks or combined cyber- and physical attacks to achieve a high-consequence event with minimal investment and minimal chances of attribution, making an effective response difficult.

Response to the Cyber Threat

DOE/NNSA's threat reduction programs are actively engaged in meeting the cyber threat challenge. In September 2014, DNN established a joint Headquarters-Laboratory Cybersecurity Task Force charged with defining the cyber threat as it pertains to DNN's nuclear nonproliferation mission, evaluating the impacts of that threat to the nuclear security posture of DNN's partner countries, and developing recommendations to respond to the cyber challenge. The Task Force worked closely with other federal agencies to complete this task, including collecting best practices information from agencies such as the Nuclear Regulatory Commission (NRC). The Task Force is also supporting the development of an interagency working group on nuclear nonproliferation cybersecurity in order to ensure effective coordination on this issue moving forward.

After careful analysis, the Cybersecurity Task Force recommended that DNN take a number of proactive steps. As a result of these recommendations:

- DNN established the DNN Headquarters-Laboratory Cybersecurity Support Team, which works to develop a systematic threat analysis model that includes cyber, increase threat awareness and cybersecurity competency among DNN staff, and support the development of an interagency working group on nuclear nonproliferation cybersecurity.
- DNN has begun developing programmatic cyber strategies for each office within DNN, which will facilitate planning and prioritizing investments. These strategies will evolve into a DNN Programmatic Roadmap for Cybersecurity that will include one-, three-, and five-year program goals tailored to specific countries and regions; a comprehensive threat reference model; a formalized risk education program; a standardized approach to benchmarking; a comprehensive communications plan; robust performance criteria; and programmatic cost estimates to implement these strategies.

1.3.4 Emerging Technologies

Emerging technologies with potential nuclear proliferation implications constitute an important component of the shifting threat environment. These technologies offer potential benefits to DOE/NNSA, industry, and the academic community, but may also pose proliferation and terrorism risks. DOE/NNSA is therefore studying how best to mitigate the risks associated with these technologies while harnessing their benefits, including for national security.

The Emerging Technologies Working Group

In July 2015, DOE/NNSA established the Emerging Technologies Working Group (ETWG) as a formal coordination mechanism across the DOE/NNSA complex to identify and analyze emerging technology developments. The ETWG is responsible for making recommendations to the NNSA Administrator through the NNSA Management Council concerning policies and guidance to exploit benefits of emerging technologies while mitigating any potentially negative impacts. DOE/NNSA's DNN and Defense Programs offices co-chair the group, which also includes representatives from the DOE/NNSA Office of

Counterterrorism and Counterproliferation (CTCP), the DOE Office of Intelligence and Counterintelligence, and other key offices within the Department. The group also receives support from subject matter experts at the national laboratories.

Near-Term and Longer-Term Priorities

Additive manufacturing is a dual-use technology with potential proliferation impacts that is rapidly expanding on a global scale. As such, it represented a logical starting point for the work of the ETWG. The group is working across DOE/NNSA to consider policies and guidance for the use of additive manufacturing technologies in the DOE/NNSA complex, with the goal of addressing the potential proliferation risks of the technology without unduly inhibiting mission-critical work. Specifically, the ETWG is working with the Department's Office of Classification to develop guidance for controlling information related to this technology. The group is also assisting in developing policy guidance to support U.S. government participation in multilateral export control regimes on this issue.

Figure 4. High-Performance Building Produced Using Additive Manufacturing at Oak Ridge National Lab

In addition, the ETWG is identifying other emerging technologies that may present risk. The ETWG will work with relevant DOE/NNSA program offices, laboratories, plants, and sites to understand both the risks and opportunities associated with various emerging technologies. The group will convene workshops on those technologies as required to facilitate information sharing.

Interagency Coordination

DOE/NNSA also addresses emerging technologies through cooperation with other federal agencies. For example, DOE/NNSA has contributed to Department of State (DOS)-led interagency discussions on multilateral export controls for additive manufacturing and other emerging technologies. DOE/NNSA also sends a representative to the Emerging Technologies Research Advisory Committee (ETRAC) at the Department of Commerce (DOC). ETRAC is a technical advisory committee that advises DOC on emerging technologies of interest and the potential impact of export regulations on research activities. Other important interagency coordination on this issue has been carried out by DNN Research and Development, which worked with DOD to co-sponsor a 2015 study by the JASON advisory group on the potential proliferation impact of emerging technologies. This study is informing research priorities within DOE/NNSA, DOD, and other departments and agencies.

Chapter 2: Prevent
Preventing Nuclear/Radiological Proliferation and Terrorism

2.1 Program Description

DNN has primary responsibility for the "prevent" functional area within the DOE/NNSA's nuclear and radiological threat reduction mission pillar. DNN supports this goal by providing policy and technical leadership to prevent or limit the spread of materials, technology, and expertise relating to nuclear and radiological threats; developing technologies to detect nuclear proliferation worldwide; eliminating or securing inventories of surplus weapons-usable materials and infrastructure; and reducing the risk that hostile nations or terrorists could acquire nuclear weapons or weapons-usable material. DNN executes its mission by drawing broadly on the Department's scientific and technical expertise and engaging international partners.

2.2 Changes to Programs and Capabilities

Since the publication of last year's *Prevent, Counter, and Respond* report, several major events have occurred that will change the way in which DOE/NNSA addresses the threat of nuclear proliferation and nuclear and radiological terrorism. First, the Joint Comprehensive Plan of Action (JCPOA), also known as the "Iran deal," has blocked Iran's pathways to a nuclear weapon and is ensuring that Iran's nuclear program is exclusively peaceful. The JCPOA will influence multiple DOE/NNSA nonproliferation activities, including support for redesigning and rebuilding the Arak reactor, IAEA safeguards, and export control reviews. Second, several separate assessments have found that the MOX fuel approach to plutonium disposition would be riskier and more expensive than an alternate approach based on material dilution and disposal. As a result of these findings, the Administration has proposed to terminate the MOX fuel approach to plutonium disposition and pursue the dilution and disposal approach in the FY 2017 Budget Request. This approach enables plutonium to be disposed of much sooner with far lower technical risks and less funding than the MOX fuel approach. Third, Russia has curtailed many aspects of bilateral nuclear security cooperation with the United States. Even though cooperation with Russia has decreased, nuclear security engagement with other partners—including China, India, and the IAEA—has increased. In addition to these major, event-driven changes to nonproliferation programs, there has also been program evolution as a result of internally-driven strategic reviews.

2.2.1 The Joint Comprehensive Plan of Action

DOE/NNSA programs will provide critical support to JCPOA implementation, including support to the IAEA's safeguards mission, the Arak reactor conversion, and review of proposed nuclear related transfers to Iran by other states. Such activities will be conducted consistent with U.S. laws and regulations and will be limited to functions that are necessary to ensure full and successful JCPOA implementation. Key activities will include the following:

- With regard to safeguards and monitoring, DOE/NNSA will provide extensive technical expertise, equipment, and training to support the IAEA's ability to monitor JCPOA implementation. DOE/NNSA also will continue its longstanding and comprehensive support for the IAEA's broader safeguards mission around the world.
- In the area of reactor conversion, DOE/NNSA will represent the United States as the co-chair (along with China) of the P5+1 and EU working group on the redesign and reconstruction of the Arak reactor.
- In the area of nuclear and dual-use transfers to Iran by other countries, the JCPOA and United Nations Security Council Resolution 2231 establish a procurement channel to oversee all such proposed transfers. The United Nations Security Council will make decisions about proposed transfers based on the recommendations of the Procurement Working Group of the JCPOA Joint Commission. This working group is composed of representatives of the P5+1, EU, and Iran, with the EU representative serving as Coordinator. DOE/NNSA will participate in a U.S. interagency working group that will support the U.S. role in the JCPOA procurement channel by evaluating proposed nuclear-related transfers to Iran's nuclear and non-nuclear civilian industries.

Additionally, DOE/NNSA will evaluate and consider other technical elements of the JCPOA and its implementation, and provide support where needed.

2.2.2 Plutonium Disposition Path Forward

Plutonium disposition is one of the largest activities within the DNN portfolio, with a scope that includes construction projects, plutonium oxide conversion campaigns at two different sites, and a number of smaller supporting activities. The Plutonium Management and Disposition Agreement (PMDA) between the United States and the Russian Federation requires the disposition of 34 metric tons (MT) of weapon-grade plutonium by both states. Although the current U.S. approach has been to dispose of this plutonium by fabricating it into MOX fuel and irradiating that fuel in light water reactors, as a result of a number of cost and program reviews it is now clear that this will cost more and take longer than initially anticipated. As a result, the Administration has proposed in its FY 2017 Budget Request to terminate the MOX approach to plutonium disposition and pursue the dilution and disposal approach. Under the new approach, the plutonium can be disposed of decades sooner than the MOX approach, at less than half the cost and with far lower technical risks. The new approach will enable to Department to be more responsible stewards of taxpayer dollars while upholding our commitment to dispose of surplus plutonium.

This decision has been made as a result of careful consideration and detailed analyses, including several studies by experts both inside and outside of the Department. As part of DOE's efforts to improve the efficiency of the plutonium disposition mission, Secretary Moniz established the Plutonium Disposition Working Group (PWG) in June 2013 to conduct a detailed analysis of options for the disposition of surplus plutonium. In April 2014, the PWG issued their report titled *Analysis of Surplus Weapon-Grade Plutonium Disposition Options*.

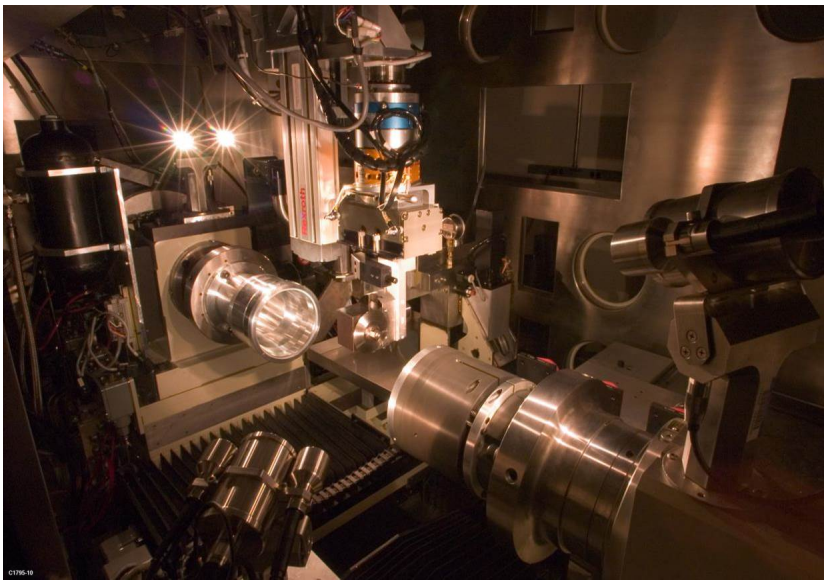

Figure 5. Robotic Lathe Used to Disassemble Pits as Part of the Plutonium Disposition Process

The 2014 PWG report identified one option, dilution, and disposal in a repository, that is technically viable, less expensive, and of relatively low risk as compared to the MOX fuel option. The dilution and disposal option involves diluting plutonium oxide with inhibiter materials, packaging it into approved containers, and shipping the diluted plutonium to a repository for permanent disposal. The Department already has disposed of over 4 metric tons of plutonium at the Waste Isolation Pilot Plant in Carlsbad, New Mexico using this dilution and disposal method, demonstrating the feasibility of this approach.

Following the release of the PWG report, the *Consolidated and Further Continuing Appropriations Act, 2015* directed that construction on the MOX Fuel Fabrication Facility continue and that additional cost studies and technology alternative studies be conducted. The *National Defense Authorization Act for FY 2015* also mandated an independent assessment and validation of the 2014 PWG analysis.

The Department tasked the Aerospace Corporation, a federally funded research and development center, to conduct these congressionally-mandated assessments. In April and October 2015, Aerospace Corporation completed two reports documenting its assessments of the PWG analysis. Additionally, in June 2015 the Secretary of Energy assembled a Red Team to assess options for the disposition of surplus weapon-grade plutonium. The Red Team was chaired by Dr. Thomas Mason, Director of Oak Ridge National Laboratory and was comprised of 18 experts, including both current and former employees of Savannah River National Laboratory; Los Alamos National Laboratory; Idaho National Laboratory in Idaho Falls, ID; Sandia National Laboratories; Oak Ridge National Laboratory; the United Kingdom National Nuclear Laboratory; and the Tennessee Valley Authority, as well as private nuclear industry and capital project management experts.

Both the Aerospace Corporation and Red Team assessments confirmed that the MOX fuel approach will be significantly more expensive than anticipated. The MOX fuel approach is expected to require approximately $800 million to $1 billion in funding annually for decades. Moreover, both assessments confirmed that even the best-case scenario for the MOX fuel approach would be riskier and more expensive than the worst-case scenario for the dilution and disposal approach. As a result, the Administration has proposed to terminate the MOX fuel approach to plutonium disposition beginning in FY 2017 and to pursue the dilution and disposal approach, which enables plutonium to be disposed of much sooner with far lower technical risks and less funding than the MOX fuel approach.

In FY 2016, as directed in the *FY 2016 Consolidated Appropriations Act*, the Department will begin advance planning on the dilution and disposal approach and submit to the Committees on Appropriations of both Houses of Congress a report that includes an evaluation of program risks and a lifecycle cost estimate and schedule for the alternative. Additionally, as directed by the *FY 2016 National Defense Authorization Act*,

the Department is proceeding with the development of a new Performance Baseline cost estimate for the MOX facility. This estimate is expected to be completed later in FY 2016.

In FY 2017, the Department will carry out the following activities to advance the dilution and disposal approach:

- Complete pre-conceptual design for the program and begin conceptual design;
- Continue development of a detailed lifecycle baseline for the program that includes storage of surplus pits at Pantex, outside of Amarillo, TX, pit disassembly and oxide conversion at Los Alamos National Laboratory, oxide conversion at the Savannah River Site, dilution and disposal of the plutonium, transportation, and any other supporting costs required for the program baseline (this lifecycle baseline will be independently validated and approved in FY 2018);
- Perform studies to optimize the final waste form, including optimizing container loading and material configuration at the repository; and,
- Conduct the environmental analyses and examine the potential legislative changes to enable the disposition of diluted plutonium at an appropriate facility.

Focus on Cooperative Activities: Collaboration between DNN and the DOE Office of Nuclear Energy on Bilateral and Multilateral Plutonium Management Initiatives

The collaboration between DNN's Office of Material Management and Minimization (M^3) and the DOE Office of Nuclear Energy (NE) on plutonium management is a key example of intra-departmental cooperation. The two organizations coordinate bilateral and multilateral technical expert groups that share lessons learned concerning plutonium management. This collaboration is based on the synergy between the two organizations' respective expertise: M^3 has significant experience in implementing plutonium minimization strategies, and NE has unique expertise in commercial nuclear power reactors, advanced reactor designs, disposal options, and the overall nuclear fuel cycle. Together, M^3 and NE co-chair the following three groups:

- *U.S.-Japan Plutonium Management Experts Group (PMEG): The PMEG is co-chaired by M^3, NE, and Japan's Ministry of Economy, Trade, and Industry, and reports to the U.S.-Japan Nuclear Security Working Group. To date, three PMEG meetings have occurred, focusing on the technical approaches and challenges the two countries face in the area of plutonium management.*
- *U.S.-U.K. Plutonium Management Users Group (PMUG): The PMUG was established under the Nuclear Threat Reduction channel of the U.S.-U.K. Mutual Defense Agreement to discuss areas of common interest related to plutonium management and to formalize technical exchanges on the U.S. experience with plutonium disposition. The first PMUG meeting took place in April 2015, and a follow-on meeting is planned for 2016.*
- *International Plutonium Management Experts Group (IPMEG): The IPMEG brings together representatives from the United States, the United Kingdom, France, and Japan to exchange information, find commonalities, and develop potential technical solutions and policy recommendations concerning plutonium management. In the future, IPMEG membership may be opened to other countries with stockpiles of separated plutonium.*

As evidenced by previous Nuclear Security Summit communiqués, despite differences in plutonium management strategies, a shared commitment exists to prevent non-state actors from acquiring plutonium. The PMEG, PMUG, and IPMEG provide a tangible manifestation of that commitment. These groups provide a neutral forum to discuss issues related to plutonium management in a way that transcends national politics.

2.2.3 Work in the Russian Federation

The Material Protection, Control, and Accounting (MPC&A) program within DNN's Office of Global Material Security (GMS) has worked cooperatively with organizations in the Russian Federation since 1994 to secure vulnerable nuclear materials. The MPC&A program supports physical protection and material control and accounting systems to protect against both outsider attack and insider theft of nuclear materials. Since its inception, the program has implemented upgrades at 73 nuclear warhead sites, 25 nuclear material sites, and 8 Navy fuel sites in Russia. DNN also worked with Russia on other nuclear and radiological threat reduction activities, including recovering 800 Russian origin radioisotope thermoelectric generators and securing 78 radiological material sites in Russia in cooperation with other international partners. Over the last several years, the scope of material security cooperation with Russia has gradually been reduced as major MPC&A upgrades were completed and the focus of work shifted to sustainment. The shift towards these activities is consistent with the goal of transitioning responsibility for sustaining installed upgrades to Russia and establishing a nuclear and radiological security relationship between Russia and the United States that is based on bilateral best practices sharing and capacity building.

Figure 6. Shipment of Low Enriched Uranium (LEU) under the HEU Purchase Agreement with Russia

U.S.-Russia nuclear and radiological security cooperation decreased dramatically over the past two years because of deteriorating bilateral relations. These events accelerated the transition away from an assistance model of nuclear and radiological security cooperation to one based more on technical exchanges and sharing best practices. Russia still retains the largest quantities of weapons-usable nuclear material in the world, spread across a very large complex. The ongoing security of nuclear material in Russian Federation remains a key concern.

Changes in Nuclear and Radiological Security Cooperation with Russia from 2013 to Present

Most bilateral nuclear and radiological security activities between the United States and Russia were originally carried out under DOD's Cooperative Threat Reduction (CTR) agreement, which expired in 2013. Russia and the United States agreed to continue cooperation under the 2003 Framework Agreement on a Multilateral Nuclear Environmental Programme in the Russian Federation (MNEPR), and in 2013 signed a MNEPR bilateral protocol as a basis for further collaboration. At that time, Russia's Ministry of Defense (MOD) notified representatives from DOE/NNSA that the MOD would not renew bilateral nuclear and radiological security cooperation at Russian MOD sites.

In 2014, against the backdrop of serious tensions over Russia's aggression in Ukraine and violation of the Intermediate-Range Nuclear Forces Treaty, U.S.-Russian nuclear and radiological security cooperation was further curtailed. Representatives from Rosatom—Russia's State Corporation for Atomic Energy—

informed U.S. representatives that many aspects of bilateral nuclear and radiological security cooperation between Russia and the United States would not continue. Much of the nuclear and radiological security cooperation with Rosatom that was planned under MNEPR was suspended, including work at several civilian Rosatom facilities and work at Rosatom's weapons complex facilities. Rosatom asserted that it would complete all discontinued work without U.S. assistance. Subsequently, U.S. nuclear and radiological security assistance to Russia was further constrained by funding restrictions imposed by the U.S. Congress.

Current Status of Work in Russia

Although the vast majority of bilateral nuclear and radiological security cooperation with Russia has ended, DOE/NNSA continues limited activities with nine Rosatom sites and organizations approved for continuing bilateral cooperation, as well as seven non-Rosatom civilian sites. DOE/NNSA also maintains cooperation with Russia's independent Federal Service for Environmental, Industrial, and Nuclear Supervision, known as "Rostechnadzor." Limited cooperation related to radiological source recovery and upgrades to source storage facilities also continues. These activities are subject to congressional restrictions on contracts with, or assistance to, the Russian Federation.

The remaining DOE/NNSA work in Russia, which is performed with funding carried over from prior years, focuses on nuclear and radiological security capacity-building activities such as training and technical exchanges, as well as limited equipment procurement and upgrade activities. These efforts help Russian partners sustain previously implemented systems and maintain expertise among nuclear site personnel. DOE/NNSA is exploring areas for nuclear security research and development cooperation with Russia that will focus on issues of common concern to both countries. There is also merit in maintaining working-level relationships among nuclear security professionals in the United States and Russia through both bilateral and multilateral engagements.

DOE/NNSA also works with Russia outside the CTR and MNEPR frameworks on Russian-origin fuel returns from third countries. Since the Russian Research Reactor Fuel Return program began in 2002, DOE/NNSA has worked with Russia to successfully repatriate more than 2,200 kilograms of Russian-origin HEU from around the world—enough for 88 nuclear weapons. This has resulted in the complete removal of all Russian-origin HEU from 11 countries, including a removal from Uzbekistan announced in September 2015 that made that country completely free of HEU. Russia has repeated on several occasions that it intends to continue cooperation with the United States on the return of Russian-origin fuel from third countries.

While GMS continues very limited engagement with Russia, partnerships with other countries have and will continue to see an increase in activity. Specifically, support for nuclear security training and sharing of best practices is increasing with China and India. An important example of work in this area is the program's technical support for China's Nuclear Security Center of Excellence, which opened in March 2016 and will address China's domestic nuclear security training requirements, provide a forum for bilateral and regional best practice exchanges, and serve as a venue for demonstrating advanced technologies related to security. GMS is also increasing its assistance to the IAEA by supporting subject matter experts, developing guidance and training, leading trainings and exercises, and assisting with policy and programmatic implementation.

The Role of Fixed Detection Systems in Nuclear Smuggling Detection and Deterrence

Within DNN, the mission of GMS's Office of Nuclear Smuggling Detection and Deterrence (NSDD) is to strengthen the capacity and commitment of foreign governments to deter, detect, and interdict illicit trafficking in nuclear and other radioactive materials across and within international borders and through the global maritime shipping system.

Fixed radiation detection systems (also referred to as radiation portal monitors or RPMs) play an important role in broader U.S. efforts to counter nuclear smuggling. These systems are one of the tools the program uses to provide an overall system of detection capability in foreign countries. RPMs are capable of detecting both small quantities of special nuclear material and the radiological materials that could be used in a radiological dispersal device or "dirty bomb." On several occasions, NSDD-provided systems have led to the detection of materials and the arrest of smugglers.

A primary element of U.S. counter nuclear smuggling efforts is to deter smugglers from transiting nuclear materials. The presence of fixed detection systems helps achieve this goal by impacting the risk calculus of would-be nuclear smugglers. If a smuggler is not deterred by the presence of an RPM, they would need to try to either defeat or bypass the fixed system. Attempts to defeat a system could include concealing or shielding material, forging paperwork, or bribing border officials. As the smuggler adds new variables or players into the operation, the complexity and overall risk increases. Efforts to bypass RPMs require more complex logistics, and treacherous terrain often limits a smuggler's "off-road" options. NSDD further complicates the smuggler's task by providing mobile detection systems for use at internal locations and concealing some RPMs along high trafficking routes.

NSDD is part of a coordinated, interagency, defense in depth approach that employs technical, law enforcement, and intelligence resources to counter the threat of nuclear smuggling. NSDD plays a critical role in this effort by providing partners with training and technical means to find and identify nuclear and radiological materials and decrease the chances these materials could fall into the hands of terrorists.

The utility of the fixed detection systems is illustrated by the following examples of specific interdiction cases:

- *April 2014: Two Armenian citizens attempting to sell radiological material were arrested in a Georgian sting operation. Georgian authorities arrested the two individuals after they crossed the green border near the Sadakhlo border crossing. The smugglers chose to carry the material across the green border specifically to avoid the fixed detectors that they knew were located at the official crossing point. In this instance, the presence of fixed RPMs at the border changed the smugglers' risk calculus. The smugglers chose a riskier route, which exposed them to detection by Georgian law enforcement officials. (NSDD equipped Sadakhlo in 2007; Georgian government officials confirmed the smugglers' knowledge and intent to bypass the fixed system.)*
- *July 2014: A Kyrgyz citizen was criminally charged for concealing and transporting a cylinder of cesium-137 in a rail shipment of scrap metal entering Kazakhstan, which was detected by RPMs provided by NSDD. Open-source reports stated that the material was concealed in such a way that indicated this was an attempted smuggling operation.*

2.2.4 Results from Program Strategic Reviews

Programs within DNN routinely evaluate their work to ensure that they remain focused on the highest priorities and employ the most effective mechanisms to achieve them. In addition, programs periodically undertake major strategic reviews or reassessments, particularly in light of changes in the threat environment, budget reallocations, or other events. In many cases, these reviews include input from other federal agencies, the interagency, and outside experts. The reviews are generally classified or otherwise sensitive, and are not produced for public distribution. Since the publication of last year's *Prevent, Counter, and Respond* report, strategic reviews have been carried out in the areas of radiological security, nuclear smuggling detection and deterrence, nuclear material removal, and reactor conversion. These strategic reviews have resulted in more effective and prompt risk reduction, new approaches to meeting the mission, and more well-defined program scope.

Radiological Security Strategic Review

The Radiological Security Program within GMS supports the protection, replacement, recovery, and disposal of radiological materials from sites worldwide. Each curie of material that is protected or removed reduces the risk of a terrorist acquiring it for use in a radiological dispersal device or "dirty bomb."

Figure 7. Removal of a Radiological Device from Temple University in Philadelphia

As a result of an on-going strategic review, the Radiological Security Program has transitioned its primary focus from protecting radiological sources at their point of use to emphasizing risk reduction through additional means, including removing and/or consolidating sources; promoting non-isotopic, alternative technologies to permanently reduce the number of sources in civil applications, where appropriate; and supporting efforts with industry to build more secure devices and facilities, known as "security by design." This approach is expected to result in fewer high-activity, vulnerable radiological sources in the future and, therefore, fewer facilities to protect. The strategic review also resulted in an improved estimate of the total number of buildings containing radiological material that DNN plans to secure over the life-cycle of the program. Buildings in countries that are not expected to permit DNN-funded security enhancements within their territory are no longer included in this estimate. The program will continue radiological security engagement with these countries through consultative technical exchanges.

As a result of the strategic review, and in line with current funding estimates, security enhancements are estimated to be completed at all known facilities containing radiological materials in eligible partner countries by 2033, 11 years sooner than under previous estimates. Because of the changes in program scope resulting from the strategic review, the total number of facilities containing radiological materials

requiring DNN-funded security upgrades has been reduced from 8,500 to 4,394. Redirecting a portion of the program's resources from securing materials in place to removing or consolidating sources and reducing the number of sources in use will allow for more effective risk reduction within current projected resource levels.

Nuclear Smuggling Detection and Deterrence Strategic Review

The NSDD program within GMS deploys radiation detection systems at key locations as part of the U.S. government's layered, defense-in-depth approach to countering nuclear material trafficking.

NSDD conducted its first strategic review in 2012 in response to a significant reduction in funding. The results of this strategic review were vetted with the interagency through the Global Nuclear Detection Architecture sub-Interagency Policy Committee (sub-IPC) process. In 2014, the program initiated a second strategic review in response to the rise of terrorist organizations and the deterioration of nuclear security cooperation with Russia. This strategic review broadly consisted of four key activities:

- Conducting a threat assessment;
- Identifying gaps in the existing Global Nuclear Detection Architecture;
- Exploring innovative capacity-building approaches and technical detection solutions; and,
- Sharing preliminary strategic review outcomes with U.S. government and international partners.

As part of this review, NSDD assembled scientific, policy, and project management experts from DOE/NNSA, the national laboratories, and external consultancies. Over the course of six months, participants engaged in multiple briefings, workshops, and small group exercises, and conducted both quantitative and qualitative analyses.

The high-level conclusions of the NSDD strategic review were that critical smuggling pathways remain vulnerable and that NSDD must employ a mix of traditional and novel approaches to close off these remaining pathways. In addition, the review found that NSDD should continue engaging with partners and international organizations to ensure long-term systems operation and sustainment. The results of the review were briefed to the DOD, DOS, DHS, and the National Security Council (NSC), all of which supported the findings of the review and the proposed future program approach. The results of the strategic review directly influenced the implementation work plans for FY 2017–2021 and will continue to inform program guidance in areas such as foreign outreach and sustainability.

Nuclear Material Removal Strategic Review

The Nuclear Material Removal program within the M^3 office achieves permanent threat reduction by supporting the removal, consolidation, and disposition of excess nuclear material from civilian sites worldwide. In 2015, M^3 completed a multi-year classified review of its Nuclear Material Removal program, which included indirect inputs from the Intelligence Community, DOS, and the NSC. As part of this review, the office developed a classified, prioritized list of all civilian nuclear material that it plans to remove or confirm the disposition of over the next five years.

To develop this list, M^3 carried out a number of actions in coordination with the laboratories, plants, sites, and other DOE/NNSA offices. First, the office established a comprehensive list of civilian HEU and plutonium around the world, using information from Headquarters program managers and subject matter experts at the Y-12 National Security Complex, the Savannah River Site, Argonne National Laboratory, and Idaho National Laboratory. Program staff also consulted with the DOE/NNSA Office of Counterterrorism and Counterproliferation as well as the DOE Office of Intelligence and Counterintelligence to gather additional details regarding the material.

This information was combined and consolidated, and the material was ranked based on attractiveness to adversaries, site and country threat level, and other priority factors. Based on this review, M^3 developed an updated, classified prioritization of remaining removals which will support future planning and budget requests.

Reactor Conversion Review

M^3's Reactor Conversion program works with countries and facilities worldwide to convert HEU research reactors from HEU to LEU fuel. The program conducted a strategic review in 2015 with a review team whose members included current and former technical experts and senior executives from the national laboratories, as well as experts from industry. The program's scope was a key aspect of the strategic review. Until 2015, the Reactor Conversion program scope was approximately 200 HEU reactors worldwide to be converted or verified as shutdown. Over half of the remaining reactors to be addressed were in Russia. However, as a result of the recent suspension of reactor conversion efforts with Russia, the Russian facilities included in the program's scope were reduced to only those HEU facilities that Russia had indicated may be future candidates for conversion. As part of the strategic review, the program removed 41 Russian facilities from consideration that Russia had made clear were not candidates for conversion. These facilities included, for example, HEU-fueled nuclear icebreakers and facilities that were believed to have at least partial defense missions. The new program scope, which is subject to change based on new information or geopolitical circumstances, includes 156 HEU research reactors or isotope production facilities to be converted or verified as shutdown. This represents the total number of reactors worldwide slated for conversion. In some cases, the DNN Reactor Conversion program will directly fund and execute the work. In other cases, states will convert their own reactors, with the DNN Reactor Conversion program providing technical support on a peer-to-peer basis.

Focus on Cooperative Activities: Synergy between DNN and DOE/NNSA's Office of Defense Programs on Warhead Dismantlement and Transparency

DOE/NNSA's Office of Defense Programs (DP) is responsible for maintaining a safe, secure, and effective U.S. nuclear weapons stockpile, including dismantling nuclear weapons that have been retired as a result of changing strategic requirements. There are several areas of synergy between these dismantlement activities and the work of DNN.

DP's dismantlement of U.S. nuclear warheads can help create a favorable environment for DNN's nuclear and radiological threat reduction work in foreign countries. This synergy was highlighted in the 2010 Nuclear Posture Review*, which noted that "by reducing the role and numbers of U.S. nuclear weapons—meeting our NPT [Nuclear Non-Proliferation Treaty] Article VI obligation to make progress toward nuclear disarmament—we can put ourselves in a much stronger position to persuade our NPT partners to join with us in adopting the measures needed to reinvigorate the non-proliferation regime and secure nuclear materials worldwide." In particular, DNN and DP collaborate on the Warhead Measurement Campaign (WMC), a joint effort to support arms control verification and emergency response. Under the WMC, DP provides DNN with access to nuclear weapons and components so that DNN can measure radiation signatures. The data collected through the WMC helps DNN define technical limits and opportunities for arms control verification measurements while protecting sensitive warhead information. The data also supports DOE/NNSA's emergency response mission by contributing to the development of new diagnostic technologies used in render safe operations. The campaign began in FY 2011 and has measured eight warhead pits from the enduring U.S. nuclear weapons stockpile at Pantex and seven canned subassemblies at the Y-12 National Security Complex. At the end of the WMC, all data will be archived and preserved to support arms control, emergency response, and other national security missions.*

2.3 Update on the Infrastructure and Human Capital Base

The infrastructure and human capital base is increasingly an area of focus within DOE and NNSA. NNSA's *Enterprise Strategic Vision* identified supporting the workforce and modernizing the infrastructure as a key crosscut that supports all three DOE/NNSA mission pillars. The Secretary created the National Laboratory Operations Board (LOB) in 2013, focusing on the revitalization of the Department's general purpose infrastructure as a key priority. In 2014, the LOB coordinated the Department's first integrated assessment of general purpose infrastructure across all 17 laboratories, as well as DOE/NNSA plants and sites, using common standards and an enterprise-wide approach. DOE/NNSA is building on the results of this assessment by collecting additional information on each real property asset across the nuclear security enterprise, including the core capabilities that each asset supports, the asset's importance to those capabilities, and the ease or difficulty of replacing the asset. This information is used to calculate a Mission Dependency Index (MDI) for each asset, which is crucial for risk-informed decision-making.

This system makes it possible for DNN, and other DOE/NNSA nuclear and radiological threat reduction programs, to look across the entire nuclear security enterprise and identify assets that support its mission. In many cases, assets that are critical to the nuclear and radiological threat reduction mission are leveraged by multiple users, and these programs use just a small fraction of the capacity. Understanding the importance of such assets to DOE/NNSA's nuclear threat reduction mission can help improve infrastructure management decisions and program planning. Based on a combination of MDI data and other inputs, Section 2.3.1 provides an overview of some of the most distinctive and specialized assets, and provides an overview of the specialized federal, lab, plant, and site workforce that supports the DNN mission.

DNN faces significant challenges in the areas of both infrastructure and human capital. Two key examples of such challenges—shortages in the safeguards workforce and issues with nuclear materials management infrastructure—are described in Section 2.3.2. Infrastructure and human capital issues for the other programs in the nuclear threat reduction mission are covered in Sections 3.3 and 4.3.

2.3.1 Description of the Infrastructure and Human Capital Base

Infrastructure Base

DNN programs to prevent nuclear proliferation and nuclear and radiological terrorism rely on a robust infrastructure, including laboratories, experimental facilities, test beds, high performance computing, and material disposal facilities. The facilities supporting DNN's work are often owned and primarily funded by other DOE or NNSA program offices, with DNN serving as one of many facility users. Many of these assets are at DOE/NNSA's laboratories, plants, and sites, but others are located in sites operated by other DOE offices, including the Offices of Science, Nuclear Energy, and Environmental Management. Examples of the most specialized and distinctive assets supporting each DNN program are summarized below:

Figure 8. Advanced Test Reactor at Idaho National Laboratory

- The M^3 program receives and stores spent nuclear fuel removed from foreign countries in fuel basins at the Savannah River Site and Idaho National Laboratory; develops LEU fuel for research reactors using the Advanced Test Reactor and the Fuels and Applied Science Building at Idaho National Laboratory

(see Figure 8) as well as Building 208 at Argonne National Laboratory; and uses H-Canyon at the Savannah River Site and the TA-55 Plutonium Facility at Los Alamos National Laboratory to convert various forms of plutonium to oxide for ultimate disposition.

- The Nonproliferation and Arms Control (NPAC) program conducts nonproliferation and safeguards training at a wide variety of laboratory facilities, including the Hazardous Materials Management and Emergency Response (HAMMER) training facility at the Hanford Site, safeguards laboratory at Oak Ridge National Laboratory, and the Advanced Test Reactor and safeguards lab at Idaho National Laboratory. NPAC also supports a network of national laboratories that provide analytical support for IAEA safeguards. This network includes specialized facilities at Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and Savannah River National Laboratories.
- The GMS program uses a test bed for radiation portal monitors and physical security components at Pacific Northwest National Laboratory (Figure 9), Los Alamos, and Oak Ridge National Laboratories. GMS uses the DOE National Training Center's Integrated Safety and Security Training and Evaluation Complex and the HAMMER facility to train foreign partners on guard force performance testing best practices and the use of radiation detection equipment. GMS also uses HAMMER and training areas at Sandia, Los Alamos, Oak Ridge, and Pacific Northwest National Laboratories, as well as the Y-12 National Security Complex, for international training. Finally, GMS has used the New Brunswick Laboratory in Argonne, IL to provide training on how to develop and attest standards as well as improve destructive analysis laboratory techniques in order to make more accurate measurements.

Figure 9. Interdiction Testing and Integration Laboratory at Pacific Northwest National Laboratory

- The DNN R&D program relies on supportive capabilities at a number of laboratories, plants, and sites that enable mission-relevant research and development activities.

Research to Advance U.S. Nuclear Explosion Monitoring Capability

A key DOE/NNSA goal is to contribute to improving U.S. government capabilities to detect, locate, discriminate, and characterize underground nuclear explosions in foreign countries. Current nuclear explosion monitoring techniques are limited by our understanding of how seismic waves are generated from the source of an underground disturbance and then propagated through geologic media to a sensor (e.g., a seismometer). DNN R&D is conducting research to understand these effects by conducting unique experiments at the Nevada National Security Site that also leverage data from decades of nuclear testing there. These source physics experiments generate terabytes of data for validating models, testing hypotheses, and improving tools that can be used to increase monitoring confidence at ever decreasing explosive yields. In 2015, DOE/NNSA successfully executed the fourth test shot in this series.

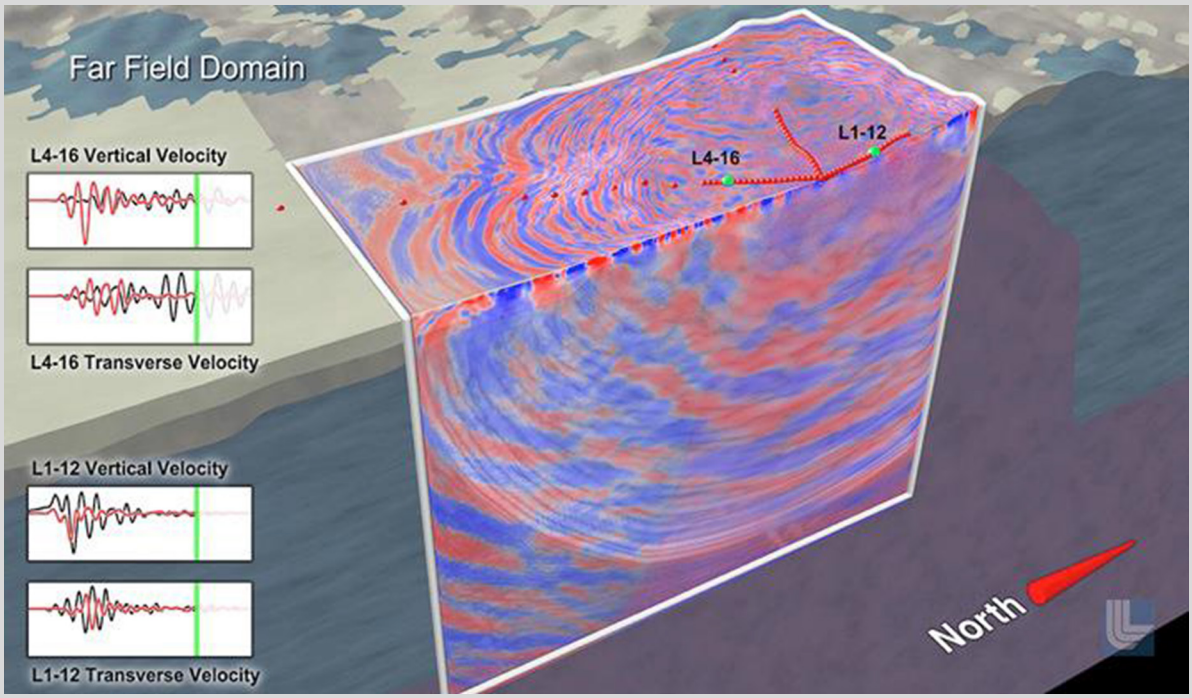

Figure 10. Predictive Model of Acoustic Energy Propagation from Explosive Detonation

Human Capital Base

To accomplish its mission, DNN leverages the workforce at DOE/NNSA's laboratories, plants, sites, as well as laboratories run by DOE's Office of Science, Office of Nuclear Energy, and Office of Environmental Management. The breakdown of the laboratory, plant, and site workforce supporting DNN is shown in Figure 11. This graphic includes employees directly supporting DNN as well as DNN's pro-rated share of the "indirect" workforce (i.e., those workers supporting the general operation of the laboratory, plant, or site).

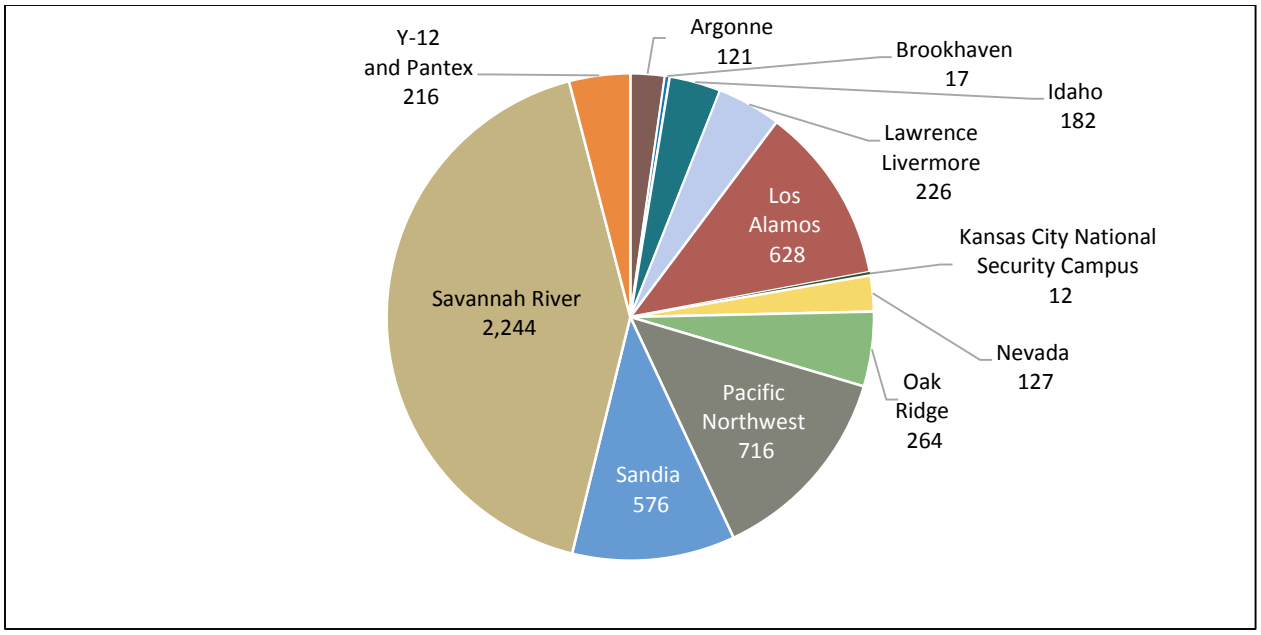

Figure 11. Laboratory, Plant, and Site Workforce Supporting DNN in FY 2015 (FTEs)

The M&O workforce at each laboratory, plant, and site performs work for multiple program offices. This model allows DNN to have direct, targeted access to experts across a wide variety of fields. For example, DNN can engage experts in the physical security of U.S. nuclear facilities to help improve the security of nuclear materials abroad or leverage nuclear fuel development experts to convert research reactors from HEU to LEU fuel.

DNN's federal workforce carries out a number of critical functions, including supporting the negotiation of nuclear and radiological security cooperation with foreign countries, carrying out informed technical oversight of M&O work activities, developing budgets, evaluating program effectiveness, managing contracts, and establishing program strategic direction. As of August 2015, the DNN workforce included 179 federal employees. The functions of the federal workforce are represented in Figure 12.

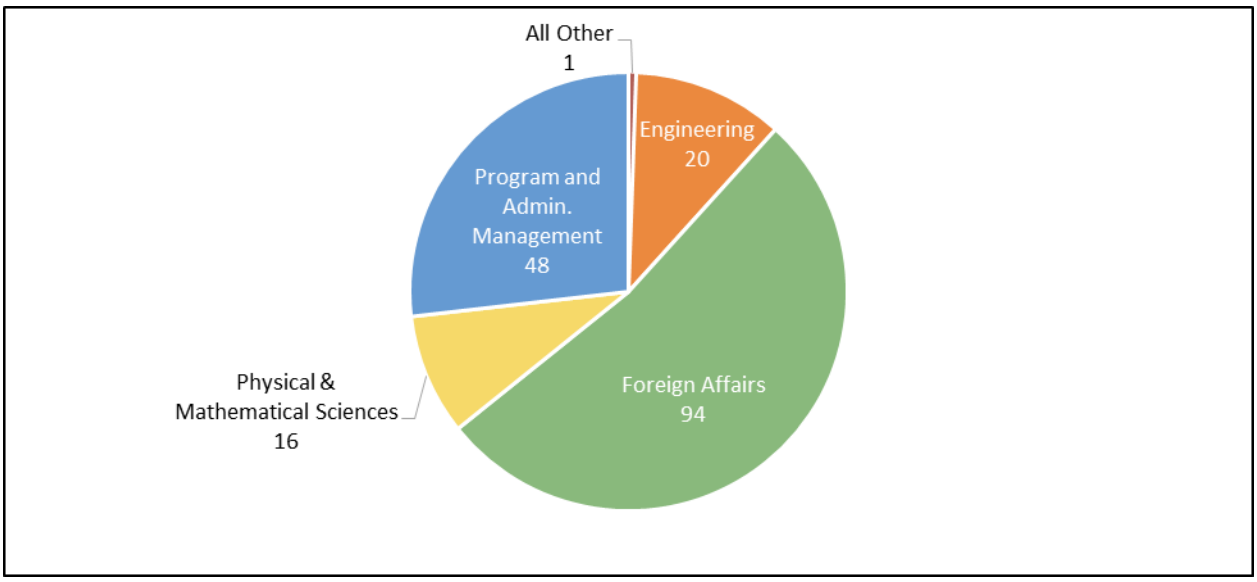

Figure 12. DNN Federal Staff by Job Series Category in FY 2015 (Headcount)

A significant portion of the DNN federal workforce (just under one third) is eligible for retirement within the next five years. Managing the impact of these retirements will require recruitment of both experienced and entry-level staff. As DNN backfills retirees with new staff, the organization is seeking, where possible, to fill entry-level positions with staff having advanced technical degrees relevant to those jobs. A key tool in this recruitment effort is the NNSA Graduate Fellowship Program (NGFP), a year-long fellowship program for graduate-level students interested in careers in nuclear security. The NGFP Class of 2014–2015 included 34 Fellows, of whom 40 percent had backgrounds in science or engineering disciplines. After completing the fellowship, over 60 percent of the class secured permanent employment within the DOE/NNSA complex. Another important workforce development tool is DNN's three university-based research consortia, which link leading universities with national laboratories to provide cutting edge research and development related to nuclear nonproliferation. The consortia also advance DNN's human capital goals by linking academic researchers with national laboratory investigators in nuclear nonproliferation.

2.3.2 Key Infrastructure and Human Capital Challenges

Shortage of Safeguards Experts

Safeguards are technical measures applied to nuclear material and activities, primarily by the IAEA, in order to independently verify that nuclear facilities are not misused and nuclear material is not diverted from peaceful uses. States accept these measures through safeguards agreements. The international safeguards system is under more strain today than at any point in history. Constrained budgets, demanding high-profile investigations, increases in the quantity of nuclear material under IAEA safeguards, and evolving safeguards requirements and approaches all are placing increased burdens on the IAEA's already limited resources. In addition, the workforce supporting international safeguards faces many of the same demographic challenges confronting the nuclear workforce as a whole, with high percentages of retirees expected in the near future. This includes the predicted retirement of an estimated 50 percent of the IAEA's safeguards staff in a five-year period and a comparable loss of safeguards experts at the national laboratories. Studies estimate that over 80 percent of the existing international safeguards specialists at the national laboratories will be retired or have transitioned to work in another field by 2024. DOE/NNSA recognizes the urgent need to address safeguards and nonproliferation human capital challenges.

Figure 13. Nuclear Safeguards Inspection

In response to a 2006-2007 study on challenges to the international safeguards system, DOE/NNSA established the safeguards Human Capital Development program to cultivate sustainable academic and technical programs that recruit, educate, train, and retain the next generation of international safeguards professionals. The program has built a pipeline of new talent into the national laboratories and into positions at the IAEA. Key elements of this effort include:

- **University Engagement**: The program's university engagement effort incorporates safeguards into graduate engineering curricula and develops university-laboratory partnerships to attract top-level students to the field. The program has worked with two dozen universities to identify faculty leaders, develop or strengthen safeguards and nonproliferation course material, promote interdisciplinary education, provide guest lectures by laboratory subject matter experts, and encourage students to seek opportunities in the field.
- **Internship Opportunities**: The program offers students the opportunity to pursue summer safeguards internships at nine DOE national laboratory locations. The interns are matched with senior mentors and given the opportunity to work directly on DOE/NNSA safeguards projects to gain hands-on knowledge of safeguards technologies. Since 2008, the Next Generation Safeguards Initiative has sponsored more than 500 internship positions across the national laboratory complex.
- **Short Courses**: Short courses give students and professionals the opportunity to study a specific safeguards topic, typically at a national laboratory or nearby university. The program sponsors six to eight short courses each year (reaching approximately 200 students annually) and uses interactive and hands-on approaches. Courses are currently targeted at mid-career professionals and Intelligence Community personnel. The majority of courses are open to an international audience.
- **Professional Development**: The professional development component of the program aims to engage and retain early- and mid-career professionals in the safeguards field. Efforts include providing access to training materials and courses and encouraging involvement with DOE/NNSA-sponsored safeguards projects at the national laboratories. The program also sponsors post-doctoral fellows at eight national laboratories. Eighty percent of post-doctoral fellows have converted to full-time laboratory staff.

The safeguards Human Capital Development program is a component of DOE/NNSA's Next Generation Safeguards Initiative. This initiative is a comprehensive effort to revitalize the international safeguards system. The initiative is composed of five pillars: Safeguards Policy, Concepts and Approaches, International Nuclear Safeguards Engagement, Technology Development, and Human Capital Development. For more information, see the Next Generations Safeguards Initiative brochure at http://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/Next%20Generations%20Safeguards%20Initiative_0.pdf.

Challenges with Nuclear and Radiological Materials Management Infrastructure

Much of DOE/NNSA's infrastructure is old, obsolete, and in poor condition. More than 50 percent of its facilities are over 40 years old, nearly 30 percent date to the Manhattan Project era, and 12 percent are currently excess and no longer needed. At the end of FY 2015, NNSA had ~$3.7 billion in deferred maintenance, and the condition of nearly two-thirds of facilities were rated as less than adequate for performing current missions. DNN is facing particularly acute challenges in the area of infrastructure for nuclear and radiological materials management.

For example, the Plutonium Facility (PF-4) at Los Alamos National Laboratory is a unique facility that supports many programs of national significance such as plutonium sustainment, surveillance and science, space and defense power systems, and DNN's material disposition program. PF-4 houses the Advanced Recovery and Integrated Extraction System, which disassembles surplus weapons pits and converts the resultant plutonium metal to an oxide form for ultimate disposition. (Pit disassembly and oxide conversion are necessary first steps in both the MOX fuel and dilution and disposal approaches to plutonium disposition, and therefore the Administration's proposed termination of the MOX fuel

approach to plutonium disposition in the FY 2017 Budget Request will not eliminate DNN's need for pit disassembly and conversion services.) In June 2013, programmatic operations were paused in PF-4 due to issues related to the conduct of operations and criticality safety. The result of the operational pause is that Los Alamos National Laboratory has not achieved the targeted annual rates of pit disassembly and conversion, which is an essential step in the plutonium disposition process. However, significant progress has been made over the past year in conducting readiness assessments for and resuming some PF-4 operations. Given recent progress, restart authorization for the Advanced Recovery and Integrated Extraction System is forecasted to meet its planned milestone at the end of May 2016, with full PF-4 operations expected to resume later that year.

Additionally, several key facilities at the Savannah River Site, including H-Canyon/HB-Line, L-Basin, and K-Area, support the receipt, storage, and disposition of plutonium and spent nuclear fuel. These facilities directly support meeting nuclear nonproliferation commitments by enabling the removal of HEU spent fuel and separated plutonium from foreign countries. Aging infrastructure and lack of sustained funding for maintenance and recapitalization continues to strain the ability of the Savannah River Site to support these critical missions.

DOE/NNSA efforts to use Savannah River's H-Area Facilities to convert various forms of plutonium to oxide as part of the material disposition process illustrate the difficulty of operating aging nuclear facilities. The start-up of operations experienced numerous delays, including three revisions of the DOE-STD-3009 Documented Safety Analysis and suspension of the DOE Readiness Assessment to address concerns with HB-Line Conduct of Operations. Authorization to begin operations was achieved in August 2014 upon subsequent implementation of the necessary corrective actions. Since operations began, there have been at least two operational pauses resulting from significant operational issues that involved criticality safety control violations.

In addition to the materials processing capabilities at Los Alamos and Savannah River, DNN depends on facilities at other sites to receive, store, and dispose of nuclear and radiological materials. DNN's access to important facilities has been impaired as a result of the suspension of operations at the Waste Isolation Pilot Plant in New Mexico and regulatory issues in several other states. Ultimately, DNN's ability to achieve permanent threat reduction depends on access to storage and disposal pathways for nuclear and radiological materials. DNN is working collaboratively with other DOE offices to address these issues. In the area of radiological source disposal, DNN also is examining potential mechanisms for source licensees to set aside funding to eventually transport and dispose of their radiological sources. This would shift some of the financial burden for radiological threat reduction from taxpayers to radiological source users and also would provide incentive for the transition from radiological sources to alternative, non-isotopic technologies.

2.4 Updated Future Program Plans

2.4.1 Material Management and Minimization (M^3)

The M^3 program reduces the risk of nuclear proliferation and terrorism by minimizing and, when possible, eliminating nuclear materials and ensuring sound management principles for materials that remain. The program's multi-year performance metric goals and other planned milestones are described below and graphically represented in Figure 14.

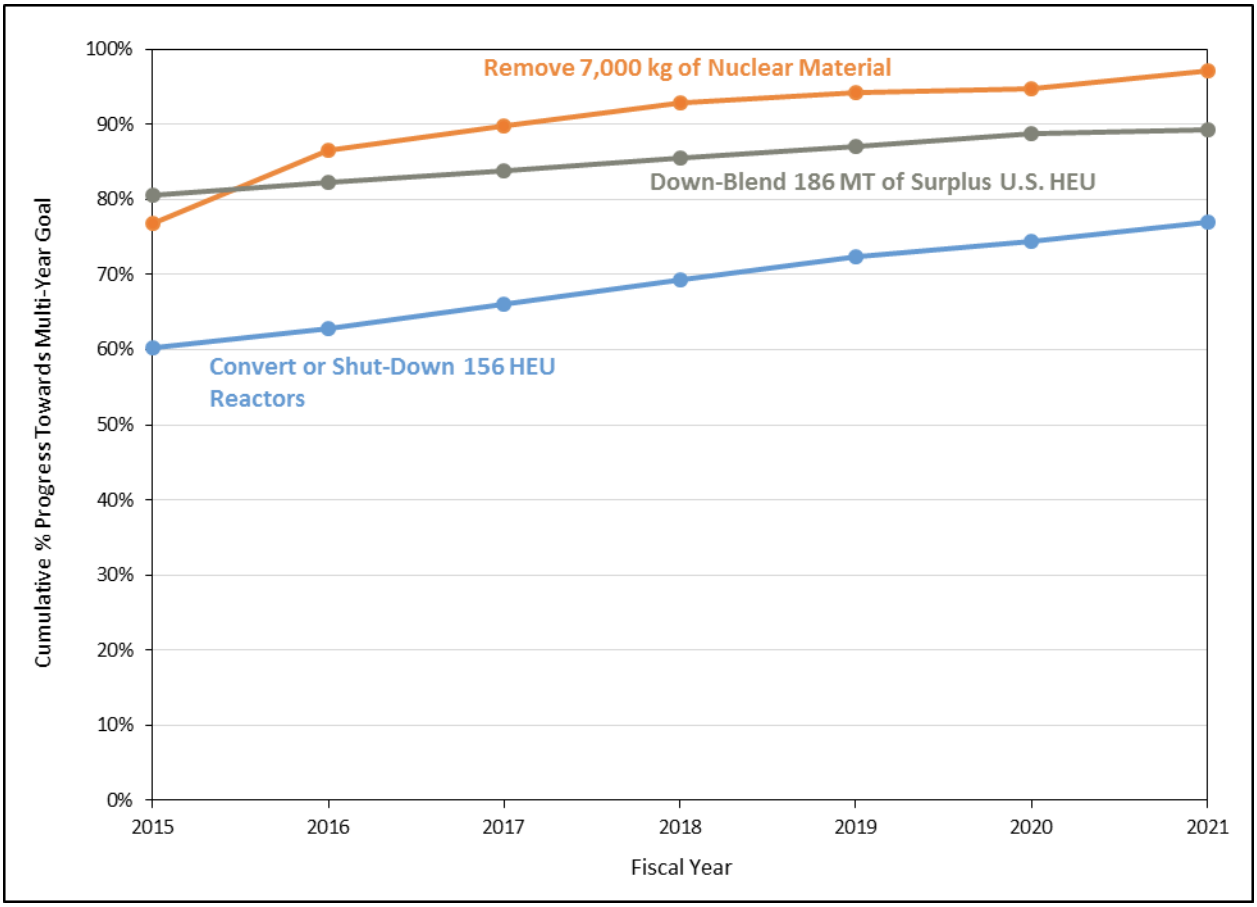

Figure 14. Progress Towards Completing Multi-Year Material Management and Minimization Goals

Explanation of Multi-Year Goals

Remove 7,000 kg of Nuclear Material: This effort began in 1996. The goal reflects an estimate of the total amount of vulnerable nuclear material (HEU and plutonium) globally that has been determined to be a likely candidate for removal. This determination is based on the level of risk that the material poses, the availability of a disposal pathway, whether the material is considered to be in excess of national needs, and the likelihood of securing agreement to remove the material. The projected completion date is 2022. Following completion of this multi-year goal, additional removals could take place if risk factors change, new disposal pathways become available, new material is declared excess, or political barriers to material removal are resolved.

Down-Blend 186 MT of Surplus U.S. HEU: This effort began in 1998. The goal reflects the total amount of U.S. HEU currently declared excess and planned for down-blending. The projected completion date is 2030.

Convert or Shut-Down 156 HEU Reactors: This effort began in 1978. The goal reflects all civilian HEU research reactors and commercial-scale isotope production facilities globally, excluding 41 Russian facilities that are no longer within the program's scope. The projected completion date is 2035.

Other Planned Milestones

- FY 2016 – Establish a Uranium Lease and Take-Back program.

- FY 2016 – Establish the first non-HEU-based molybdenum-99 production capability in the United States.
- FY 2017 – Conduct Emerging Threats mock deployment.
- FY 2018 – Complete conceptual design and seek Critical Decision 1 approval to begin preliminary design for the plutonium dilution and disposal line item construction project at the Savannah River Site.
- FY 2018 – Complete and independently validate the life-cycle cost baseline for the plutonium dilution and disposal program, as per the requirements of DOE Order 413.3B.
- FY 2018 – Establish additional non-HEU based molybdenum-99 production capabilities in the United States.
- FY 2019 – Complete the conversion of all international molybdenum-99 producers to LEU-based production.
- FY 2020 – Complete legacy material disposal in Building 9206 at the Y-12 National Security Complex to reduce risk.
- FY 2017–2021 – At the Savannah River Site and Los Alamos National Laboratory, convert various forms of plutonium into oxide for eventual disposition.

2.4.2 Global Material Security (GMS)

The GMS program reduces the risk of nuclear proliferation and nuclear and radiological terrorism by working with partner countries to increase the security of vulnerable stockpiles of nuclear weapons, weapon-usable nuclear materials, and radiological materials, as well as to improve partner countries' abilities to deter, detect, interdict, and investigate illicit nuclear material trafficking. The program's multi-year performance metric goals and other planned milestones are described below and graphically represented in Figure 15.

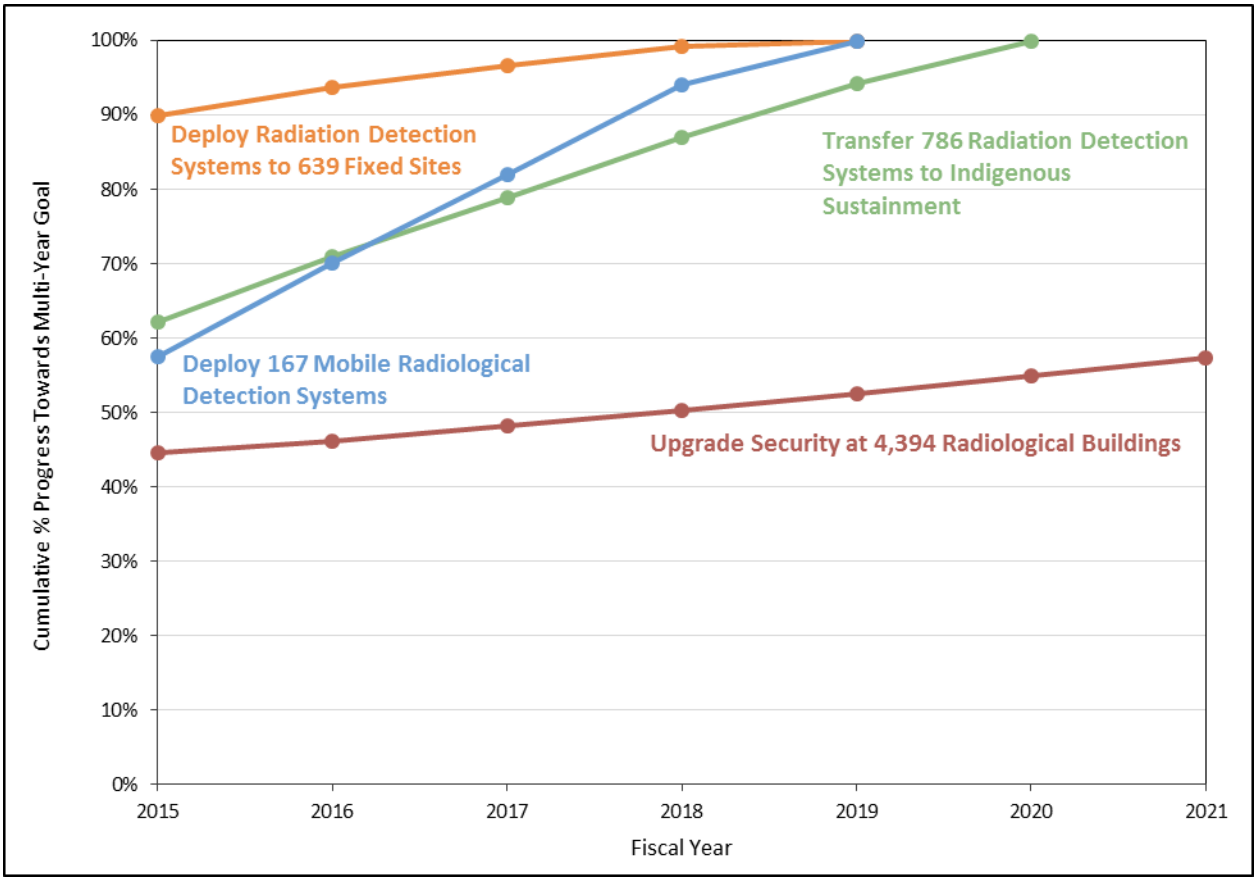

Figure 15. Progress Towards Completing Multi-Year Global Material Security Goals

Explanation of Multi-Year Global Material Security Goals

Deploy Radiation Detection Systems to 639 Fixed Sites: This effort began in 1998 by equipping Russian sites in partnership with Russia's Federal Customs Service. The goal reflects an intermediate milestone in the NSDD effort, and the projected completion date is FY 2019. This activity will continue after this intermediate milestone is completed. The total number of radiation detection systems to be deployed over the life cycle of the program will depend on the inherently dynamic threat environment. For example, NSDD deployment plans have recently been impacted by factors such as the emergence of new customs unions, the changing relationship with Russia, and the rise of ISIL in the Middle East.

Deploy 167 Mobile Radiation Detection Systems: This effort began in 2008. The goal reflects an intermediate milestone in the NSDD effort, and the projected completion date is FY 2019. This activity will continue after the intermediate milestone is completed. As with fixed site radiation detection systems, the total number of mobile detection systems to be deployed over the life cycle of the program will depend on the evolving threat environment.

Transfer 786 Radiation Detection Systems to Indigenous Sustainment: This effort formally began in 2008. The goal reflects an intermediate milestone in the NSDD effort, and the projected completion date is FY 2020. This activity will continue after this intermediate milestone is completed. The total number of radiation detection systems to be transferred to indigenous sustainment over the life cycle of the program will depend on the evolving threat environment.

Upgrade Security at 4,394 Radiological Buildings: This effort began in 2004. The goal reflects the total number of buildings worldwide in eligible partner countries assessed as having high priority radiological material and being in need of security upgrades. The projected completion date is 2033.

Other Planned Milestones

- FY 2016 – Complete equipment purchases for the national nuclear training center in Kazakhstan.
- FY 2020 – Complete development of fundamental MPC&A curriculum for a national nuclear training center in Kazakhstan.
- FY 2017–2021 – Remove additional excess and unwanted sealed radiological sources from locations in the United States, resulting in a cumulative total of more than 46,765 sources removed.
- FY 2017–2021 – Continue ongoing nuclear security capacity building cooperation in at least 14 core countries and annually initiate capacity building engagement in up to 8 additional countries.
- FY 2017–2021 – Develop and implement cybersecurity training courses; engage international partners on cybersecurity best practices for nuclear facilities; and improve on these best practices by developing new cybersecurity techniques, procedures, and technologies.
- FY 2017-2021 – Provide flexible radiation detection systems for targeted screening of small maritime vessels and at high priority airports in the Middle East, Eastern Europe, Africa, and Asia.
- FY 2017–2021 – Engage up to 13 partners annually to strengthen foreign partner nuclear forensic capabilities.
- FY 2017–2021 – Expand support for the voluntary replacement of high-activity radiological sources with non-isotopic based technologies.

2.4.3 Nonproliferation and Arms Control

The NPAC program reduces the risk of nuclear proliferation and terrorism by strengthening the nonproliferation and arms control regimes. The program applies its unique expertise to develop and implement programs and strategies to: strengthen international nuclear safeguards; control the spread of nuclear material, equipment, technology, and expertise; verify nuclear reductions and compliance with nonproliferation and arms control treaties and agreements; and develop programs and strategies to address nonproliferation and arms control challenges and opportunities. The program's multi-year performance metric goals and other planned milestones are described below and graphically represented in Figure 16.

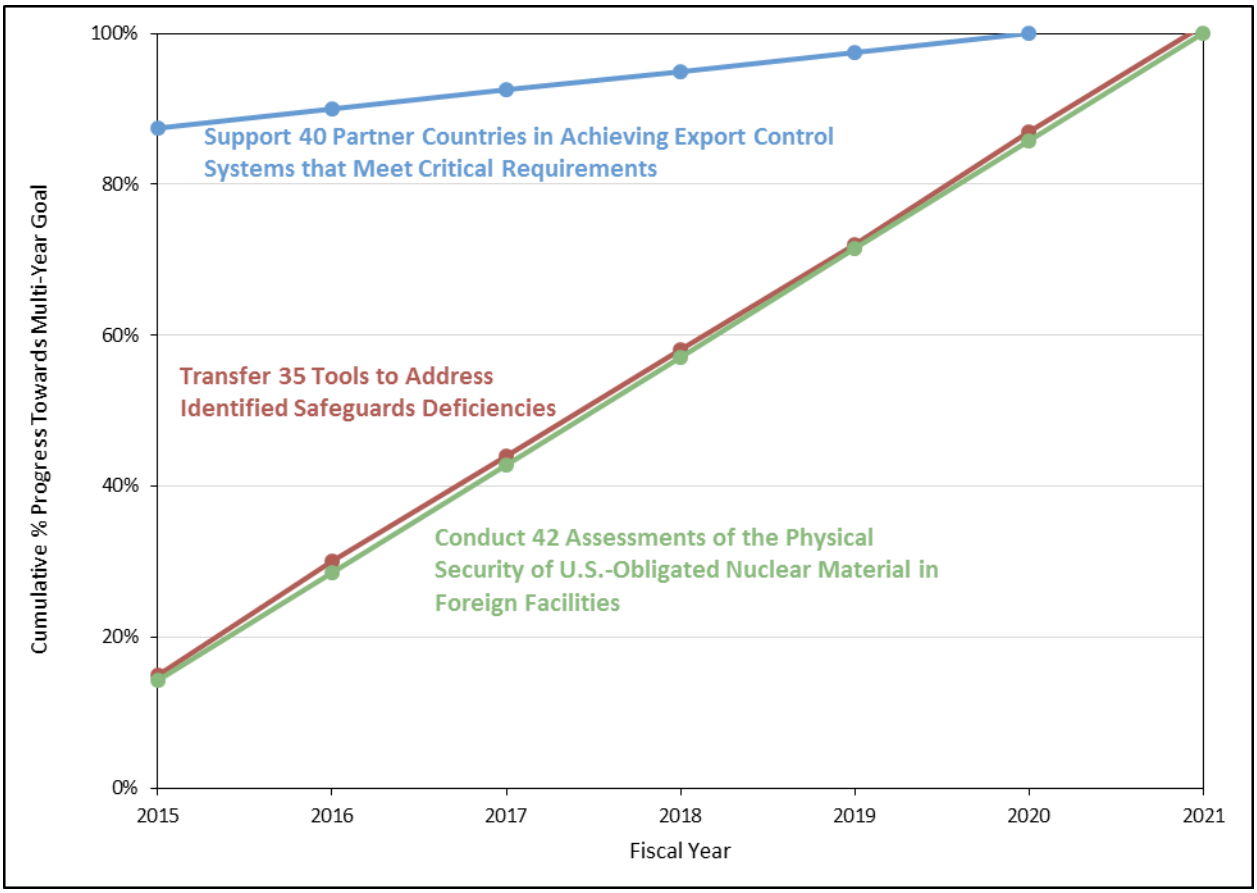

Figure 16. Progress Towards Completing Multi-Year Nonproliferation and Arms Control Goals

Explanation of Multi-Year Goals

Support 40 Partner Countries in Achieving Export Control Systems that Meet Critical Requirements: This metric reflects progress since FY 2008. The projected completion date is FY 2020. It is anticipated that the program will engage additional countries on export control activities after FY 2020 because of evolving threats, U.S. government policy priorities, and new countries establishing nuclear energy programs. The program also will continue to engage in regional sharing of best practices with many of the countries that have met the milestone.

Transfer 35 Tools to Address Identified Safeguards Deficiencies: This metric reflects the number of tools transferred, under DOE/NNSA's Next Generation Safeguards Initiative, since FY 2015. The transferred tools (e.g., new technologies for gas centrifuge enrichment plant monitoring) are deployed and used in international regimes and other countries to address identified safeguards deficiencies. The goal reflects a planned level of effort of five tools transferred per year from FY 2015 through FY 2021. Support for the international safeguards regime addresses an enduring need and is expected to continue after completion of the multi-year goal.

Conduct 42 Assessments of the Physical Security of U.S.-Obligated Nuclear Material in Foreign Facilities: This metric reflects the number of assessments conducted since FY 2015. The goal reflects a planned level of effort of six assessments conducted per year from FY 2015 through FY 2021. This activity addresses a need that will endure as long as there is U.S.-obligated nuclear material located at foreign facilities.

Other Planned Milestones

- FY 2016 – As part of DOE/NNSA's Next Generation Safeguards Initiative, demonstrate proof-of-concept for a global identification and monitoring system of uranium hexafluoride cylinders.
- FY 2016 – Perform a comprehensive update of the Nuclear Suppliers Group Trigger List and Dual Use Annex Handbooks.
- FY 2017 – Support implementation of the JCPOA to address Iran's nuclear program through safeguards and export control activities.
- FY 2017 – As part of DOE/NNSA's Next Generation Safeguards Initiative, field test advanced safeguards approaches for the IAEA for gas centrifuge enrichment plants.
- FY 2017 – Complete transition of export control license adjudication to a new U.S. government-wide system, in compliance with a Presidential Export Control Reform mandate.
- FY 2017–2021 – Provide operations planning and maintain short-notice readiness of previously developed technologies and capabilities to support U.S.-led verifiable dismantlement of nuclear programs in countries of proliferation concern.
- FY 2017–2021 – Develop advanced technologies and concepts for warhead and fissile material transparency and verification regimes, including for implementation of the New Strategic Arms Reduction Treaty, and analysis of the impact of future initiatives on DOE and NNSA sites.
- FY 2017–2021 – Annually perform technical reviews of approximately 6,000 U.S. export licenses.
- FY 2017–2021 – Provide approximately 3,000 technical analyses per year supporting detection and interdiction of nuclear and dual use commodity transfers to foreign programs of concern.
- FY 2017–2021 – As part of DOE/NNSA's Next Generation Safeguards Initiative, develop and refine advanced concepts and approaches to international safeguards that will result in more effective and efficient IAEA verification.
- FY 2017–2021 – Provide technical assistance to up to three Section 123 Agreements for Cooperation and their administrative arrangements per year.
- FY 2017–2021 – Process 40–50 Part 810 specific authorization applications and requests for amendments per year and review over 100 Part 810 general authorization reports for compliance with Part 810 regulations per year.

2.4.4 Defense Nuclear Nonproliferation R&D

The DNN R&D program reduces the risk of nuclear proliferation and terrorism by developing innovative unilateral and multilateral technical capabilities to detect, identify, locate, and characterize foreign nuclear weapons program activities, illicit diversion of special nuclear materials, and global nuclear detonations. The program also includes research and development that supports nuclear counterterrorism and incident response activities. The program's multi-year performance metric goals and other planned milestones are described below and graphically represented in Figure 17.

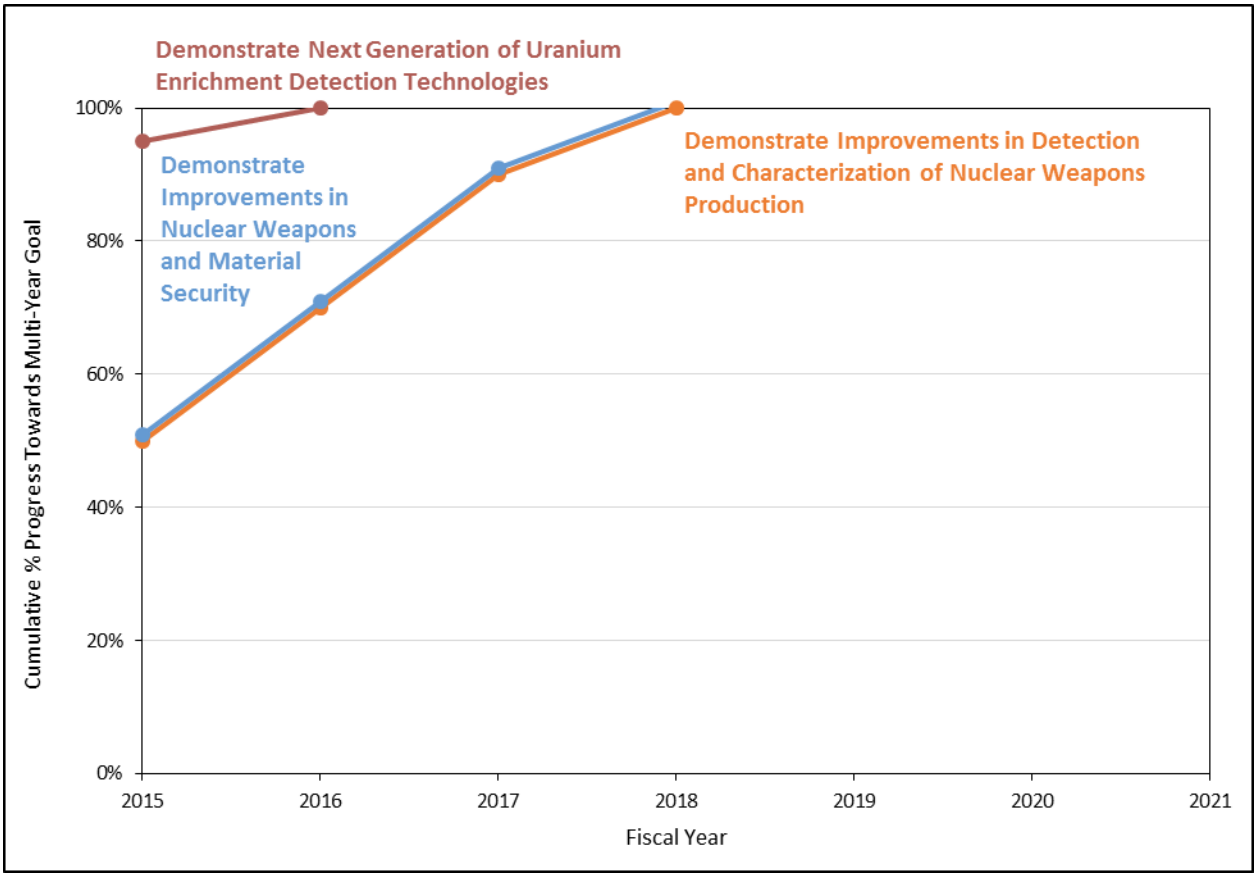

Figure 17. Progress Towards Completing Multi-Year Research and Development Goals

Explanation of Multi-Year Goals

Demonstrate Next Generation of Uranium Enrichment Detection Technologies: This effort began in FY 2007. The goal reflects a multi-year campaign to demonstrate a specific set of next-generation technologies, but research and development in this area addresses an enduring need and will continue after this campaign is completed. The projected completion date for the multi-year goal is FY 2016.

Demonstrate Improvements in Nuclear Weapons and Material Security: This effort began in FY 2014. The goal reflects a multi-year campaign to demonstrate a specific set of next-generation technologies, but research and development in this area addresses an enduring need and will continue after this campaign is completed. The projected completion date for the multi-year goal is FY 2018.

Demonstrate Improvements in Detection and Characterization of Nuclear Weapons Production: This effort began in FY 2014. The goal reflects a multi-year campaign to demonstrate a specific set of next-generation technologies, but research and development in this area addresses an enduring need and will continue after this campaign is completed. The projected completion date for the multi-year goal is FY 2018.

Other Planned Milestones

- FY 2016–2018 – Provide for advanced sensor and algorithm development around operational testing at joint nonproliferation test bed.
- FY 2016–2018 – Conduct test monitoring experimentation for seismic source physics in the second and third test beds, per long-term test plan.
- FY 2018 – Develop next generation nuclear detection technologies.

- FY 2016–2021 – Maintain the nation's space-based global nuclear detonation detection capability by delivering scheduled sensor payloads and supporting payload-side integration, pre-launch, and post-launch testing.

2.4.5 Nonproliferation Construction

The Nonproliferation Construction program consolidates the construction costs for DOE/NNSA nuclear nonproliferation programs, which primarily are the construction projects associated with U.S. plutonium disposition efforts.

Explanation of Multi-Year Goals

Multi-year goals and associated performance targets are currently being adjusted to reflect the planned dilution and disposal approach to plutonium disposition.

Other Planned Milestones

- FY 2017 – Develop a plan for the proposed termination of the MOX Fuel Fabrication Facility project with the contractor and begin implementation.
- FY 2018 – Seek Critical Decision 1 approval to begin the preliminary design for the Japan Fast Critical Assembly line item construction project at the Savannah River Site.
- FY 2018 – Seek Critical Decision 1 approval to begin the preliminary design for the proposed plutonium dilution and disposal line item construction project at the Savannah River Site.
- FY 2021 – Complete the proposed termination of the MOX Fuel Fabrication Facility project.

This page left blank intentionally.

Chapter 3: Counter
Countering Nuclear/Radiological Proliferation and Terrorism

3.1 Program Description

The Office of Counterterrorism and Counterproliferation (CTCP) has primary responsibility for the "counter" functional area under DOE/NNSA's nuclear threat reduction mission. CTCP reduces the threat of nuclear proliferation and nuclear and radiological terrorism through innovative science, technology, and policy solutions. In particular, CTCP's Nuclear Counterterrorism program's activities reduce the risk of terrorist acquisition or use of nuclear devices and materials. The office also develops the technical understanding required to characterize, detect, and defeat the range of nuclear threat devices that a non-state actor could potentially construct. Additionally, CTCP's nuclear counterproliferation efforts consist of strategies employed after proliferant states have obtained nuclear materials, technologies, or devices. CTCP leads these missions across DOE/NNSA, generating scientific knowledge that influences a wide range of domestic and international security policies.

CTCP uses its specialized knowledge of nuclear threat devices—which include improvised nuclear devices (INDs), proliferant devices, and stockpile weapons outside of state control—to inform U.S. and international policy relating to nuclear counterterrorism and counterproliferation. These policies cover a broad spectrum, including security standards for nuclear material storage and transport, search and detection, nuclear incident response, nuclear forensics, and other technical and policy work in the nuclear threat arena. One of the primary technical activities of the CTCP program is to evaluate the vulnerability of nuclear materials that could be exploited in an IND and provide the U.S. government with accurate assessments of how well various IND configurations would function. CTCP develops tools and procedures for rendering safe an IND and for understanding forensic signatures following the detonation of an IND. CTCP's technical and scientific understanding of nuclear threat devices and nuclear materials actively influences emergency response policies at the federal, state, and local level and contributes to the development of long-term options for disposing of special nuclear material.

3.2 Changes to Programs and Capabilities

3.2.1 Realignment of Activities under CTCP

DOE/NNSA has continued to realign its program offices to better correspond with the functional areas under the prevent-counter-respond continuum. In late 2015, several functions previously executed by the Office of Emergency Operations were transferred to CTCP. These functions include nuclear incident response, nuclear forensics, and international emergency management and cooperation. The realignment consolidated under one organization all threat assessment and incident response assets involving nuclear and radiological material, as well as all international counterterrorism and emergency response capacity-building activities. This restructuring allows for better coordination and execution of these missions. CTCP now consists of the following offices:

- **Office of Nuclear Incident Policy and Cooperation:** This office develops and implements policy, provides technical solutions, and builds capacity to strengthen domestic and international capabilities in the areas of counterterrorism, counterproliferation, and nuclear incident response. This mission is accomplished through technical assistance, exercises, and training on nuclear counterterrorism, emergency preparedness, and incident response activities. The Office of Nuclear Incident Policy and Cooperation provides liaison officers who offer guidance to DOD military commands and other government agencies and serves as the lead for departmental coordination on counterterrorism, counterproliferation, and international nuclear incident policies.
- **Office of Nuclear Threat Science:** This office executes technical activities required to advise and enable all aspects of U.S. government nuclear counterproliferation and nuclear counterterrorism missions. The office leverages DOE/NNSA expertise on nuclear weapons design, science, surety, and materials to analyze nuclear threat devices and constituent materials, including INDs, proliferant state weapons, and devices outside of a foreign state's control. The Office of Nuclear Threat Science also assists and advises the U.S. government on developing plans and countermeasures against a wide range of nuclear threats and devices, directly supports the NSC in developing and implementing nuclear counterterrorism and nuclear counterproliferation policies, and leads nuclear threat reduction technical exchange activities with selected international partners.
- **Office of Nuclear Forensics:** In addition to the activities described above, this office sustains nuclear forensic personnel, equipment, key facilities, and operations in support of NSC-sponsored policy initiatives.
- **Office of Nuclear Incident Response:** This office manages the Department's incident response assets that support nuclear counterterrorism, counterproliferation, crisis response, and consequence management. The Office directs, organizes, trains, and equips federal, laboratory, plant, and site personnel to respond to any domestic or international nuclear and radiological accident or incident in support of the requesting federal, state, local, tribal, or foreign government. The Office also maintains a level of operational readiness to meet departmental and national requirements.

3.2.2 CTCP as the Department's Lead for Nuclear Forensics

CTCP's Office of Nuclear Forensics is now the Department's lead organization for nuclear forensics. This discipline involves the technical evaluation of nuclear materials and related items recovered out of regulatory control, with the goal of determining the history and origin of the material or items. The United States maintains effective and robust forensics and attribution capabilities so that, should nuclear and radiological smuggling or an attack be attempted or take place, appropriate actions can be taken and the responsible parties identified.

Given the cross-cutting nature of nuclear forensics, a number of organizations within the Department make important contributions in this area:

- The CTCP Office of Nuclear Forensics maintains the operational capability for pre-detonation device disassembly and forensic examination, provides operational support for forensic response to post-detonation events, and coordinates the forensic analysis of special nuclear materials. To carry out these missions, CTCP maintains a readiness posture to deploy ground sample-collection teams, deploy device disposition and assessment teams, and conduct laboratory operations in support of bulk nuclear material and post-detonation forensics.

Figure 18. Participants in an International Nuclear Forensics Workshop

- DNN R&D conducts research to improve the U.S. technical nuclear forensic capability. This research is focused on technical areas in which limitations or uncertainties in current techniques exist, as well as areas where emerging technologies may revolutionize nuclear forensic methods. DNN R&D's work in this area supports and is augmented by the IND assessment activities of the CTCP Office of Nuclear Threat Science.
- DNN's GMS works to strengthen foreign partner nuclear forensic capabilities, which are integral to a robust program to deter and counter illicit nuclear smuggling and strengthen the security of nuclear and radiological material.
- DOE, in addition to the functions above, is responsible for the National Nuclear Forensic Library of the United States.

Focus on Cooperative Activities: Collaboration between the DOE/NNSA Office of Counterterrorism and Counterproliferation, DOE/NNSA Office of Defense Nuclear Nonproliferation, and Federal Bureau of Investigation on Counterterrorism Training

The Office of Nuclear Incident Policy and Cooperation (NIPC) within CTCP conducts tailor-made tabletop exercises to increase WMD counterterrorism awareness and capabilities, both domestically and internationally. Since 1999, the WMD counterterrorism tabletop exercise program has trained over 11,000 federal, state, local, and foreign officials. To maximize participation and practical value to participants, these exercises are unclassified and not formally evaluated or scored.

NIPC coordinates closely with DNN's GMS program when conducting domestic Silent Thunder *tabletop exercises for locations with civil nuclear material or radiological sources. These collaborative exercises combine the collective expertise of the two organizations to provide integrated nonproliferation and counterterrorism training. Prior to the exercises, GMS provides voluntary security enhancements to reduce the potential for theft or misuse of radiological materials that could be used in a dirty bomb. These voluntary upgrades are in addition to security enhancements required by the Nuclear Regulatory Commission and state governments since 2006, and can include training in how to respond to security incidents. After these GMS security enhancements are complete, NIPC collaborates with the Federal Bureau of Investigation (FBI) to hold a tabletop exercise at the facility regarding security alarm response and whole-of-government crisis and consequence management capabilities in the event of a terrorist incident. The exercise serves as a "capstone" to the GMS-funded security upgrades, providing the facility owner and federal, state, and local officials an opportunity to develop an in-depth understanding of specific responsibilities in the event of a terrorist WMD incident. DOE/NNSA and the FBI jointly conduct eight* Silent Thunder *exercises per year at domestic locations across the United States.*

Figure 19. *Silent Thunder* Exercise at the Massachusetts Institute of Technology

3.3 Update on the Infrastructure and Human Capital Base

3.3.1 Description of the Infrastructure and Human Capital Base

Description of the Infrastructure Base

As described in Section 2.3, DOE/NNSA's workforce and infrastructure crosscutting capability supports all of the DOE/NNSA mission pillars. Like the programs that support the "prevent" and "respond" functional areas, CTCP draws heavily on DOE/NNSA's science and technical base.

CTCP, through the Nuclear Counterterrorism program, is responsible for developing the scientific and technical knowledge that explores the "realm of the possible" with regard to IND configurations. CTCP carries out this technical work using predictive models validated through experimental campaigns. These campaigns rely primarily on two types of infrastructure: high performance computing platforms to design predictive models concerning nuclear threat device performance, and experimental facilities to refine and validate these models. Computer platforms and codes supporting these functions include those developed specifically for the CTCP mission as well as others developed for the Stockpile Stewardship Program (SSP). These assets serve as an essential resource for CTCP and provide a prime example of leveraging DOE/NNSA infrastructure for multiple national security missions.

Developing and validating these computational codes depends on specialized experimental facilities, primarily at Lawrence Livermore, Los Alamos, and Sandia National Laboratories. This infrastructure is principally dedicated to and supported by the SSP, with limited, supplemental funding from CTCP as appropriate. CTCP relies on these experimental facilities to carry out a number of functions, including formulating and characterizing material samples, performing precision measurements from small to large-scale explosives, hydrodynamic testing to establish material properties and chemistry, and measuring nuclear data.

As described in Section 2.3, DOE/NNSA is deploying new tools to track real property assets in the nuclear security enterprise and identify the key mission or missions that they support using a new Mission Dependency Index. Based on this data and other inputs, some of the most distinctive and specialized experimental facilities supporting the CTCP mission are described below:

Figure 20. Z Facility at Sandia National Laboratories

- PF-4, Los Alamos Neutron Science Center, Dual-Axis Radiographic Hydrodynamic Test facility, gas guns, Ancho Canyon, and the Proton Radiography facility at Los Alamos National Laboratory;
- The Superblock, Contained Firing Facility, High Explosives Application Facility, and gas guns at Lawrence Livermore National Laboratory;
- The Z Facility (Figure 20) and Thunder Range at Sandia National Laboratories; and,

- The National Criticality Experiments Research Center, Joint Actinide Shock Physics Experiment Research gas gun, the Big Explosives Experimental Facility, and the Baker Compound at the Nevada National Security Site.

Description of the Human Capital Base

The expertise of the workforce at DOE/NNSA's laboratories, plants, and sites are the foundation that supports the CTCP mission. Leveraging the unique national assets described above, these scientists and technical specialists perform the work needed to characterize, detect, and defeat nuclear threat devices. They also support international nuclear security and counterterrorism dialogues, WMD counterterrorism tabletop exercises, and nuclear information security policy and practices.

The CTCP mission and the SSP rely on many of the same technical competencies. As such, there is significant overlap between the workforces supporting the two missions. The technical personnel who support the CTCP mission generally developed their skills supporting SSP, and many work primarily on SSP and support CTCP on a part-time basis.

The workforce supporting CTCP at each laboratory, plant, and site is shown in Figure 21. This graphic includes employees directly supporting CTCP as well as CTCP's pro-rated share of the "indirect" workforce (i.e., those workers supporting the general operation of the laboratory, plant, or site).

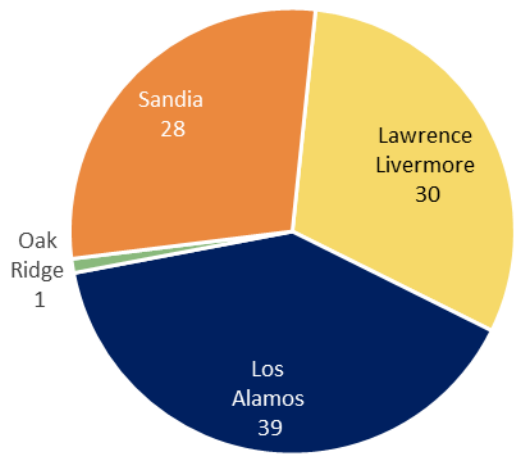

Figure 21. Laboratory, Plant, and Site Workforce Supporting CTCP in FY 2015 (FTEs)

A small federal workforce at DOE/NNSA Headquarters manages and directs the CTCP program. The functions of this workforce are represented in Figure 22.

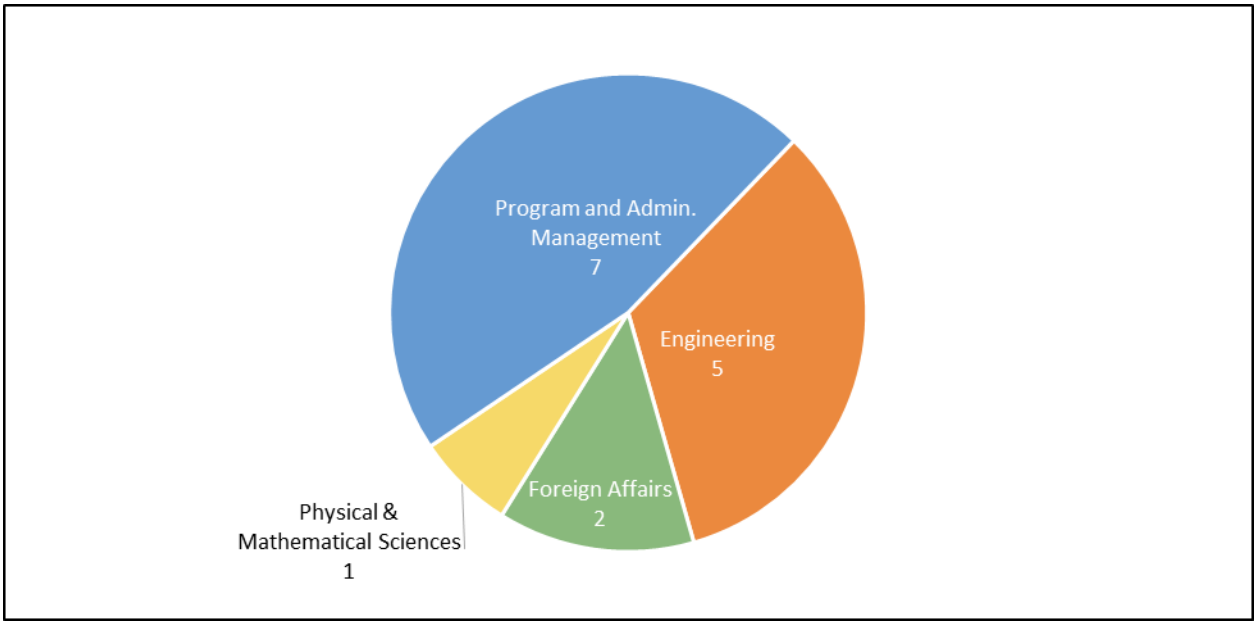

Figure 22. CTCP Federal Staff by Job Series Category in FY 2015 (Headcount)

3.3.2 Key Infrastructure and Human Capital Challenges

Impact of Funding Volatility on the CTCP Workforce

Funding constraints and budget volatility are important challenges across DOE/NNSA's nuclear threat reduction programs. However, over the past several years funding challenges have been particularly acute for the CTCP programs. As shown in Figure 23, enacted funding has been significantly lower than the President's request, putting the program on a downward funding trajectory. (This graphic shows funding for these activities on a comparable basis, notwithstanding changes to the budget structure that occurred from FY 2013 through FY 2015.)

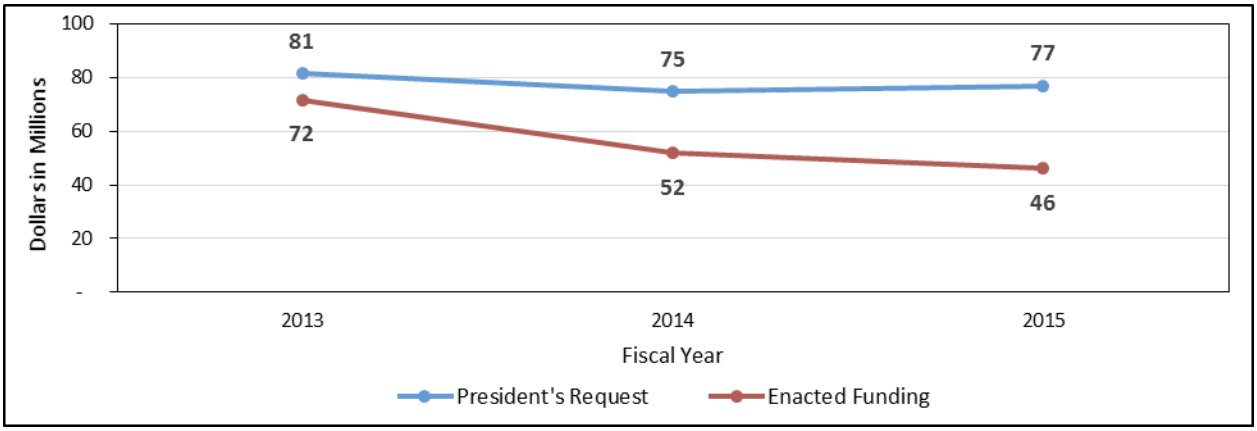

Figure 23. Requested and Enacted Funding for Counterterrorism and Counterproliferation Activities

As a result of these budget reductions, CTCP technical efforts have been significantly curtailed. For example, the start of a series of experiments to validate a national predictive modeling capability for nuclear threat device emergency disablement scenarios has been deferred by two years. These funding issues have also adversely impacted the program's human capital base. Not only have opportunities for scientists and engineers to work in this area been stymied, but funding instability has also made it difficult to recruit personnel.

Impact of Potential Facility Closures on the CTCP Mission

Efforts to consolidate infrastructure offer tremendous benefits across the nuclear security enterprise, but they also pose potential challenges to the CTCP mission that must be carefully managed. CTCP relies almost exclusively on infrastructure maintained and primarily used by the SSP, including experimental facilities, computational and modeling assets, and explosives facilities and capabilities. While CTCP may use just a small portion of these assets' total capacity, this limited use supports unique and critical national security efforts. Moreover, while similar experimental facilities may exist at multiple locations, there are often important differences in the capabilities of these facilities that are highly relevant for the CTCP mission.

CTCP is coordinating closely within DOE/NNSA to ensure that potential infrastructure consolidation decisions do not adversely impact its mission. This coordination provides improved clarity and transparency regarding the infrastructure base for the CTCP mission.

3.4 Updated Future Program Plan

The multi-year performance goals and other planned milestones for CTCP are described below and graphically represented in Figure 24.

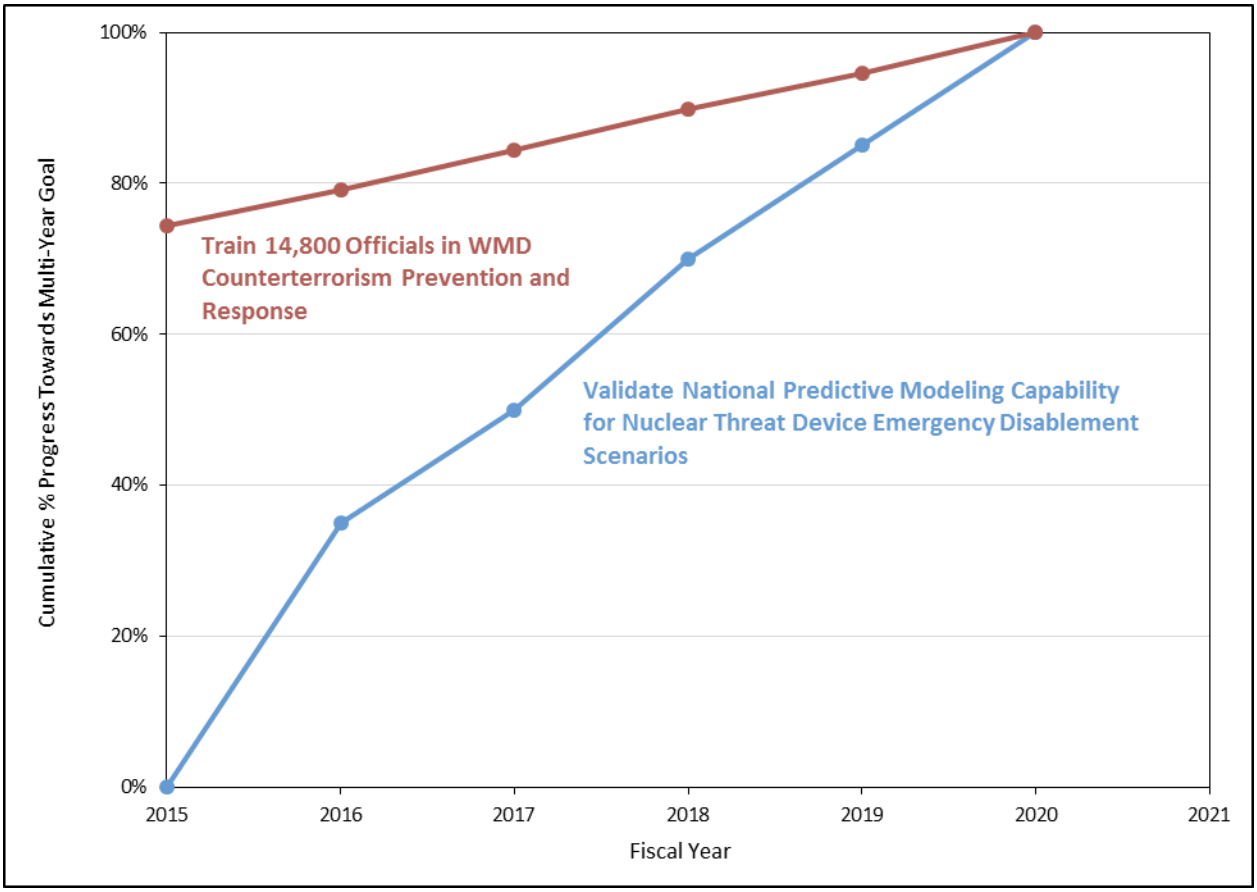

Figure 24. Progress Towards Completing Multi-Year Counterterrorism and Counterproliferation Goals

Explanation of Multi-Year Goals

Train 14,800 Officials in WMD Counterterrorism Prevention and Response: This effort began in 1999. The goal is an intermediate milestone. The projected completion date for the multi-year goal is FY 2020, but this program addresses an enduring need and will continue after this intermediate milestone is completed.

Validate National Predictive Modeling Capability for Nuclear Threat Device Emergency Disablement Scenarios: This effort began in FY 2016. The multi-year goal is to validate the national predictive modeling capability using four different experimental series. The projected completion date is FY 2020, but follow-on projects related to the capability are expected after this multi-year goal is completed.

Other Planned Milestones

- FY 2016 – Restart execution of experimental efforts to build predictive capabilities for render safe after minor delays in FY 2014 and suspension of activities in FY 2015.
- FY 2016 – Cooperate with two additional countries in strengthening their emergency management systems.
- FY 2017–2021 – Annually, conduct eight domestic *Silent Thunder* WMD counterterrorism tabletop exercises, at least four foreign *Eminent Discovery* tabletop exercises or WMD Threat Awareness workshops, and at least two classified Counterterrorism Security Dialogues to address evolving and emerging terrorism threats to nuclear materials and facilities.
- FY 2017–2021 – Continue planned activities for threat device modeling and experiments and develop and test render safe tools.
- FY 2017–2021 – Continue to execute innovative standoff disablement exploration activities, with accelerated experimentation continuing through FY 2018.
- FY 2017–2021 – Continue to monitor, assess, and respond to open source information concerning nuclear threat devices and other malicious uses of nuclear materials.

This page left blank intentionally.

Chapter 4: Respond
Responding to Nuclear/Radiological Threats and Terrorism

4.1 Program Description

Under DOE/NNSA's nuclear threat reduction mission, the CTCP and the Office of Emergency Operations have primary responsibility for the "respond" functional area. Together, these offices coordinate efforts to reduce the risk of nuclear and radiological terrorism and enhance the Department's overall emergency preparedness. These organizations strive to diminish the value of nuclear or radiological weapons and devices to terrorists and proliferant states through the capability to respond to, manage, avert, and contain the consequences of nuclear and radiological incidents in the United States and elsewhere in the world.

The Department's emergency response capability includes a number of specialized assets—maintained by CTCP—that are equipped and trained to identify, characterize, render safe, and dispose of nuclear and radiological devices or mitigate the consequences of a nuclear or radiological incident. The Department's capability also includes the broader Emergency Management Enterprise in which these response assets are embedded.

Emergency preparedness includes the ability to manage other types of emergencies, such as natural disasters impacting DOE/NNSA labs, plants, and sites. The Department's Emergency Management Enterprise is undergoing a series of process improvements that will culminate in the achievement of an enterprise-wide, all-hazards initial operational capability during the first quarter of FY 2017. The DOE/NNSA Office of Emergency Operations is the Department's emergency management lead pursuant to DOE Order 151.1C. In this role, it will provide necessary governance and operational support to the Emergency Management Enterprise throughout its phased improvement process, and will ensure the full engagement, coordination, and involvement of the all-hazards emergency management community in this ongoing improvement effort. The Office of Emergency Operations includes the trainings, exercises, policies, procedures, and infrastructure that enable CTCP and other DOE program staff to more effectively carry out their emergency management duties. The responsibility of the Office of Emergency Operations also includes planning and program management related to the DOE/NNSA Continuity Program, as well as associated Continuity of Operations and Continuity of Government activities that ensure our Primary Mission Essential Functions are maintained through any crisis event.

The Department's Emergency Management Enterprise is closely coordinated with federal, state, tribal, and local agencies. This coordination is guided by interagency directives, including Presidential Policy Directive 8. This directive requires the development of National Planning Frameworks, which set national strategy and doctrine for emergency preparedness, as well as Federal Interagency Operational Plans, which integrate and synchronize capabilities across federal agencies.

4.2 Changes to Programs and Capabilities

4.2.1 Realignment of Activities under the Office of Emergency Operations

The realignment in late 2015 that saw several functions previously executed by the Office of Emergency Operations transferred to CTCP also resulted in other significant changes to the former organization. As a result of this reorganization, the Office of Emergency Operations is now focused on leading the Department's new all-hazards, enterprise-wide approach to emergency management with the goal of improving the emergency preparedness posture, maximizing the use of expertise across the complex, and facilitating more effective and comprehensive information sharing throughout the Department, as well as with national leadership. This change will improve the Department's ability to carry out its emergency preparedness responsibilities, including those identified in the Federal Interagency Operational Plans established pursuant to Presidential Policy Directive 8.

The realigned Office of Emergency Operations includes the following offices:

- **The Office of the Emergency Operations Center:** This office is responsible for all coordination, control, and communications nodes supporting DOE Headquarters in Washington, DC. The office serves as the Department's 24/7/365 single point of contact for departmental and interagency notifications regarding situations requiring centralized management. The office also manages the Emergency Communications Network to provide secure and non-secure voice, video, and data information for departmental emergency response and national asset support in coordination with the Office of Plans and Policy. Additionally, the office manages the infrastructure necessary for effective DOE/NNSA continuity programs, which includes alternate and devolution facilities and redundant communications architecture.
- **The Office of Operations and Exercises:** This office coordinates DOE and NNSA's integrated enterprise-wide command structure for emergency operations. During an emergency, it executes a National Incident Management System-compliant Unified Command System and Crisis Action Teams as necessary to address specific response requirements including continuity programs. The office also manages all preparedness functions for the Nuclear Incident Team and Current/Future Operations sections. Finally, the office develops and manages a comprehensive Homeland Security Exercise and Evaluation Program-compliant exercise program for the Department.
- **The Office of Plans and Policy:** This office develops and issues all DOE and NNSA emergency management policy and strategic plans. The office also oversees Emergency Management System implementation for DOE and NNSA sites, facilities, and transportation activities; develops and issues directives, technical guides, technical standards, procedures, and protocols for emergency management planning, preparedness, training, exercise, readiness assurance, recovery, and response; and provides technical assistance to DOE and NNSA sites for emergency planning, information exchange, and continuous improvements in emergency management. Additionally, the office assesses and validates the effectiveness of DOE and NNSA's emergency management capabilities. The office also coordinates the development of corrective action plans, including status, validation, and verification of corrective actions.
- **The Office of Preparedness:** This office manages a comprehensive training and education program for emergency management stakeholders and develops training events for Headquarters personnel. It also develops emergency management guidance, including resource levels, program

priorities, requirements, standards, milestones, and reporting. Finally, the office issues requirements for emergency management training activities and assists staff at DOE/NNSA site offices in meeting emergency management readiness requirements.

4.2.2 Adoption of Enterprise-Wide Approach to Emergency Management

The Department is adopting an enterprise-wide, all-hazards approach to emergency management. This approach includes a unified emergency response strategy directed by departmental leadership, common standards and procedures for emergency preparedness and response, and centralized coordination of the Department's various emergency operations components during all-hazards emergencies. All-hazards emergencies include health-, safety-, and/or security-related events that have the potential to overwhelm the resources or assets of the relevant response organizations; involve multiple sites or programs; or cascade across specific hazards, threats, or locales.

Drivers for Adoption of Enterprise-Wide Approach

The Department's decision was discussed and clarified within the Department's formal response to a September 2014 recommendation by the Defense Nuclear Facilities Safety Board (DNFSB).[4] Recommendation 2014-1 alerted the Secretary to "the need to take actions to improve the emergency preparedness and response capability at DOE's defense nuclear facilities" by the end of 2016.

In April 2015, the Department submitted its implementation plan, committing to "rectify this situation by enforcing line management chain of command and accountability for the implementation of and oversight of the Emergency Management Enterprise." The enterprise-wide approach to emergency management, supported by the newly restructured Office of Emergency Operations, is a key means of addressing this issue.

In addition to the DNFSB recommendation, recent high-profile events also served to confirm the Department's adoption of an enterprise-wide approach to emergency management. These include the Deepwater Horizon oil spill, the Fukushima disaster, Hurricane Sandy, and the truck fire and radioactive material release at the Waste Isolation Pilot Plant. These incidents indicated a need to improve the Department's ability to respond to both natural and manmade events. They also demonstrated the need to strengthen the Department's ability to communicate situational and technical information during emergencies, including communication laterally within the enterprise, vertically to senior policymakers, and externally to key stakeholders.

[4] DNFSB is an independent organization within the executive branch responsible for providing recommendations and advice to the President and the Secretary of Energy regarding public health and safety issues at DOE defense nuclear facilities.

Deepwater Horizon Oil Spill
(April 2010)

Fukushima Earthquake and Tsunami
(March 2011)

Hurricane Sandy
(October 2012)

Waste Isolation Pilot Plant Truck Fire and Radioactive Release
(February 2014)

Figure 25. Recent Incidents Impacting the Department's Approach to Emergency Management

Key Components of Enterprise-Wide Approach

The Department's enterprise-wide approach to emergency management includes two major, new institutional mechanisms: the Emergency Incident Management Council (EIMC) and the Unified Command Group (UCG). The Office of Emergency Operations remains the lead organization in the Department's Emergency Management Enterprise and plays a key role in establishing and supporting the EIMC and the UCG.

The EIMC, established by the Secretary of Energy in July 2015, is responsible for addressing strategic-level aspects of emergency management across the all-hazards spectrum. Specifically, it directs the establishment of specialized working groups to improve the Department's overall emergency management posture, increases preparedness through training and exercises, develops policy and planning, and oversees the completion of corrective actions. In the event of an all-hazards emergency, the EIMC will define the Department's response strategy, authorize the formation of the UCG, advise the Secretary and Deputy Secretary, and provide direction with respect to overall resource allocations and high-level priorities.

The EIMC will not manage or direct emergency operations or incidents, except where required by statutory authorities. Rather, in the event of an emergency requiring a department-wide coordinated response at the operational level, the EIMC will authorize stand-up of the UCG for this purpose. The UCG will be composed of representatives from relevant DOE and NNSA program offices and will provide

strategic-level support to the Department's incident commanders and deployed response assets during emergency operations. It will also provide situational awareness-focused reporting to the EIMC. The UCG will be organized based on the National Incident Management System which all federal departments and agencies are required to adopt. It is expected to be operational by the first quarter of 2017.

Benefits of an Enterprise-Wide Approach

The enterprise-wide approach to emergency management will improve the Department's ability to respond to emergencies across the all-hazards spectrum. It will ensure that DOE/NNSA crisis response and consequence management assets are fully integrated into a unified command structure. Such integration will ensure more effective departmental emergency management in coordination with other national and/or international response elements.

4.2.3 Creation of the CTCP Office of Nuclear Incident Response

As a result of the realignment of DOE/NNSA's emergency operations and CTCP capabilities, the nuclear and radiological crisis operations and consequence management functions have been transferred from the Office of Emergency Operations to CTCP. CTCP has created the Office of Nuclear Incident Response to manage these new missions.

This office is the premier technical leader in responding to and successfully resolving nuclear and radiological accidents and incidents worldwide. Its core competencies include specialized knowledge of U.S. nuclear weapons, radiological dispersal devices, and improvised nuclear devices, as well as expertise in spectroscopy, device modeling and assessment, radiography, atmospheric and radiological environmental modeling, dose assessment, and health physics. The office manages programs and provides on-call personnel and palletized equipment to respond immediately to any type of nuclear or radiological accident or incident worldwide. Its response assets support missions in the areas of preventive nuclear and radiological detection, threat-based nuclear search, render safe, radiological consequence management, and nuclear forensics.

The core missions of the Office of Nuclear Incident Response are crisis operations and consequence management. In the area of crisis operations, the office's goal is to maintain an agile, scalable, and rapidly employable response capability in support of prevention, protection, and associated mitigation functions.

4.3 Update on the Infrastructure and Human Capital Base

4.3.1 Description of the Infrastructure and Human Capital Base

Infrastructure Base

A diverse infrastructure base comprised of specialized facilities, vehicles, and equipment supports the DOE/NNSA emergency response and operations mission. These assets help ensure that the U.S. government has quickly deployable, dedicated resources capable of responding to nuclear or radiological incidents worldwide, as well as the emergency management infrastructure required to coordinate the response effort.

As described in Section 2.3, DOE/NNSA is deploying new tools to track each real property asset in the nuclear security enterprise and identify the missions that they support using a new Mission Dependency Index. Based on this data and other inputs, some of the most distinctive assets supporting the emergency response and operations mission are described below:

- The Aerial Measuring System (Figure 26) is a specialized airborne radiation detection system based at Nellis Air Force Base in Nevada and Joint Base Andrews in Maryland.
- The National Atmospheric Release Advisory Center, located at Lawrence Livermore National Laboratory (Figure 27), develops sophisticated radiological contamination models in the event of a nuclear or radiological incident and rapidly disseminates them to emergency response officials and specialized DOE/NNSA emergency response teams.

Figure 26. Aerial Measuring System Helicopter

- The Radiation Emergency Assistance Center/Training Site, located in Oak Ridge, TN, maintains 24-hour readiness to respond to incidents of radiological exposure by providing medical consultative assistance or deploying personnel and equipment for direct medical care.
- The Emergency Communications Network is a multi-faceted communications system for managing emergency situations that involve DOE assets and interests. The system provides classified and unclassified voice, video, and data communications between DOE Headquarters and approximately 55 remote sites and mobile units via dedicated leased lines and satellite transmission. Emergency Communications Network upgrades are being scheduled over the next several years in concert with DOD and FBI communications improvements.
- The Forrestal Watch Office, located at DOE Headquarters in Washington, DC, serves as the 24-hour single point of contact for collecting, processing, and disseminating time-sensitive emergency notifications. The facility includes an uninterruptible power supply and independent air supply system filtered to protect against biological and radiological agents.
- Emergency Operations Centers, located at laboratories, plants, and sites across the DOE/NNSA complex, are facilities specially designed to support continuous emergency operations for extended periods of time, even under hazardous conditions.
- The Emergency Operations Training Academy, located in Albuquerque, NM, provides state-of-the-art training and education for DOE/NNSA to enhance the readiness of personnel in the emergency operations community.

Figure 27. National Atmospheric Release Advisory Center

Human Capital Base

The expertise of the workforce at DOE/NNSA's laboratories, plants, and sites is the foundation of the emergency response and operations mission. Many of these employees work primarily in support of other

DOE/NNSA missions – especially the stockpile stewardship mission – but also maintain readiness to deploy as part of specialized emergency response teams in the event of a nuclear or radiological incident. In particular, DOE/NNSA relies upon the availability of highly qualified part-time personnel to field and sustain our premier incident response capabilities. Federal, laboratory, plant, and site employees volunteer for this additional responsibility and in some cases serve on multiple teams. For example, DOE/NNSA maintains Radiological Assistance Program (RAP) teams across the country to serve as the nation's premier first-response resource for assessing radiological incidents and advising decision-makers on steps to evaluate and minimize associated hazards. At least three RAP teams are maintained in each of nine different regions of the United States, with each team consisting of a federal lead and five to seven laboratory, plant, and site support personnel. These employees are also a critical part of other response teams, such as the Accident Response Group, which responds to U.S. nuclear weapons accidents; the Search Response Team, which searches for possible radiological devices using both technical and operational expertise; and the Joint Technical Operations Team, which provides specialized technical capabilities in support of lead federal agencies to respond to weapons of mass destruction. The functions of these and other key response assets are summarized in Figure 28.

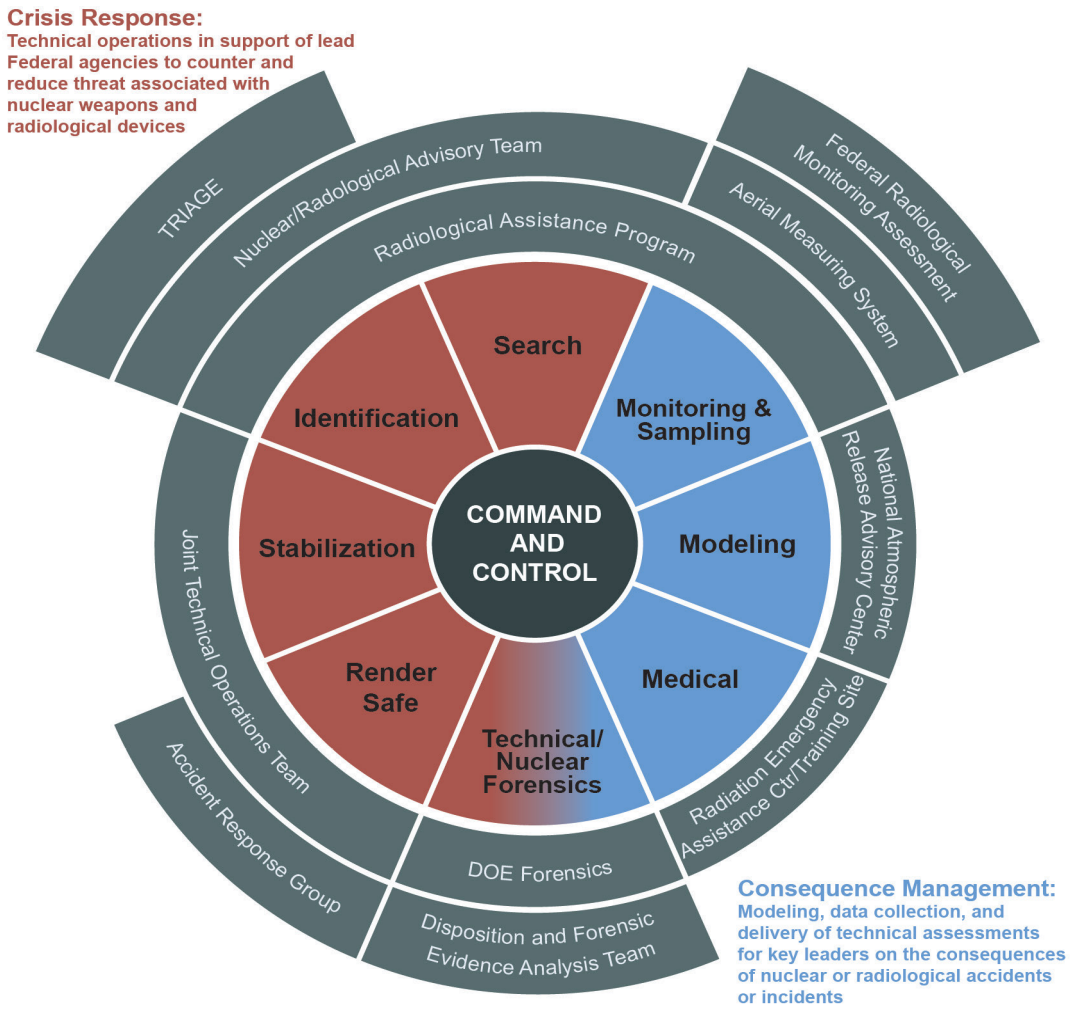

Figure 28. DOE/NNSA Emergency Response Assets

The laboratory, plant, and site workforce supporting the "Respond" mission area is summarized in Figure 29. This graphic includes employees directly supporting the response mission as well as the associated pro-rated share of the "indirect" workforce (i.e., personnel supporting the general operation of the laboratory, plant, or site).

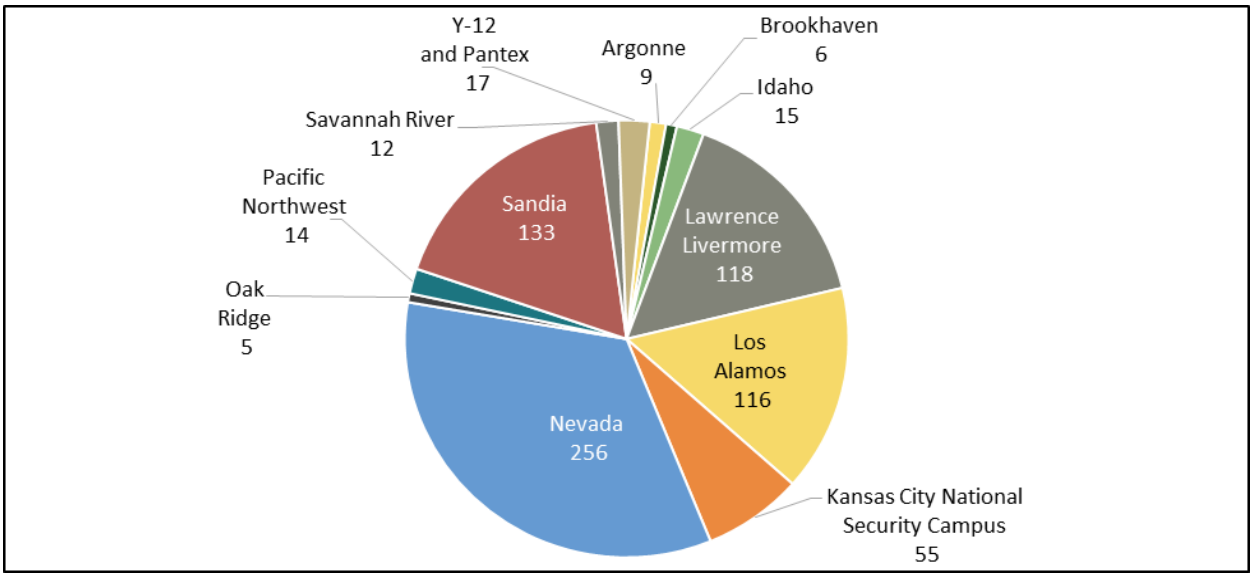

Figure 29. Laboratory, Plant, and Site Workforce Supporting Emergency Response and Management in FY 2015 (FTEs)

A small federal workforce manages and directs efforts in the "Respond" mission area. As shown in Figure 30, safety and security is the largest job function among the federal workforce, but a significant portion of this workforce also support functions such as program management and science and engineering.

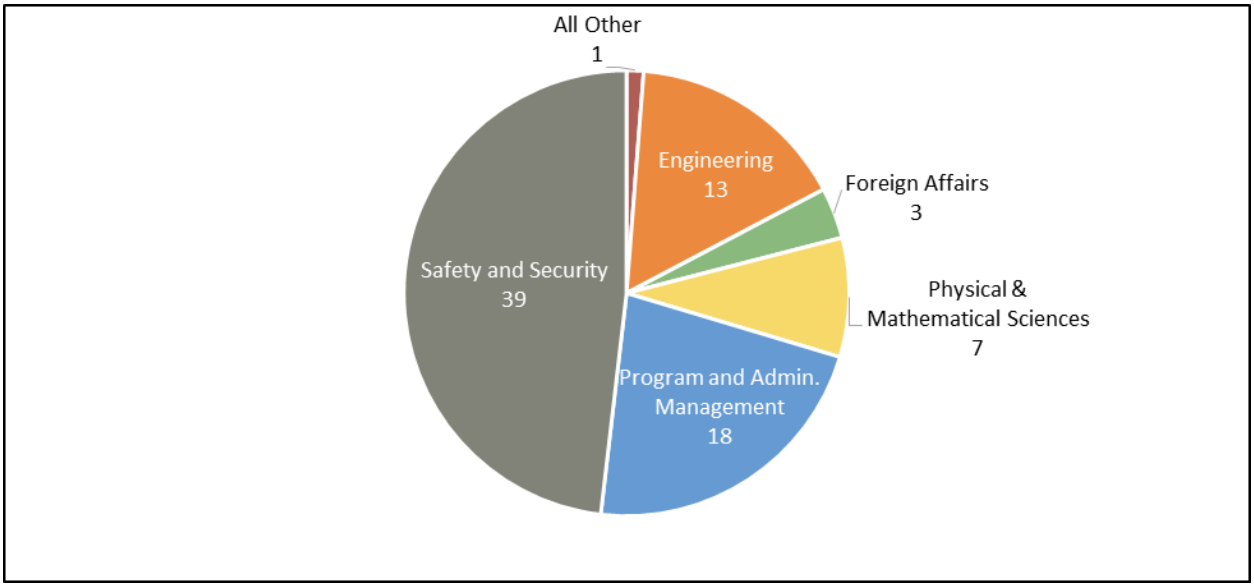

Figure 30. Federal Staff Supporting Emergency Response and Management by Job Series Category in FY 2015 (Headcount)

4.3.2 Key Infrastructure and Human Capital Challenges

Challenge of Managing Matrixed Workforce

Most laboratory, plant, and site employees supporting the emergency response mission do so on a part-time basis with the majority of their time allocated to the nuclear weapons mission of DOE/NNSA's Office of Defense Programs. This approach offers significant benefits, since it provides on-demand access to a wide variety of world-class experts. However, the structure of the emergency response workforce also creates certain challenges that must be carefully managed. In particular, DOE/NNSA relies upon the availability of highly qualified part-time personnel to field and sustain our premier incident response capabilities, including teams such as the Accident Response Group, Search Response Team, and Joint Technical Operations Team. Also, the much larger nuclear weapons stockpile budgets command priority for staff time, and it can be difficult to access experts, such as weapons modelers and radiochemists, to support emergency response functions. For example, the vast majority of scientists with expertise in nuclear forensics spend less than 10 percent of their time supporting this capability. Moving forward, DOE/NNSA will continue to carefully manage the human capital base to ensure that all mission needs are being addressed.

Equipment Recapitalization for Response Assets

The core of DOE/NNSA's emergency response capability is a cadre of deployable personnel who are trained to respond to nuclear or radiological incidents. Effectively equipping these response teams with the necessary, highly specialized equipment can pose a significant challenge. The threat of nuclear and radiological terrorism is inherently dynamic, and changes in the threat environment can drive requirements for new or updated equipment. The evolving nature of the cybersecurity environment and national cybersecurity standards can also drive changes in equipment requirements. Additionally, the emergency response mission is closely coordinated with a number of interagency partners, including the FBI. Equipment interoperability across organizations is therefore critical, especially for communications equipment. Such systems must also be highly mobile, reliable, and secure. Finally, equipment must be periodically replaced as it reaches the end of its useful life. In sum, these demanding requirements for emergency response equipment constitute an important challenge. The DOE/NNSA emergency response program is investing in equipment recapitalization, but it has been necessary to defer some planned procurements to support other funding needs.

4.4 Updated Future Program Plan

The multi-year performance metric goals and other planned milestones for the emergency response mission are described below.

- FY 2016 – Provide technical assistance for planning, executing, and evaluating national-level exercises, including *Marble Challenge* and nuclear weapon accident/incident exercises.
- FY 2016 – Provide technical assistance to complete actions outlined in DNFSB Recommendation 2014-01 on DOE emergency preparedness and response.
- FY 2016 – Execute directed upgrades to the continuous monitoring capabilities of the classified and unclassified networks.
- FY 2016 – Support the Department's stand-up of the Unified Command Group in support of the Emergency Management Enterprise initiative.

- FY 2017 – Support the Department's process improvements to its Emergency Management Enterprise system, and achieve an enterprise-wide, all-hazards initial operational capability during the first quarter of the fiscal year.
- FY 2017 – Install a High Frequency Automatic Link Establishment (HF-ALE) radio capability at the DOE/NNSA Devolution Site.
- FY 2018 – Serve as a lead federal agency for a national-level consequence management exercise.
- FY 2020 – Grow the Emergency Communications Network to over 110 nodes (a 266 percent increase over 2006).
- FY 2017–2021 – Maintain an Emergency Operations Readiness Index of at least 91 out of 100 (the index measures the overall organizational readiness to respond to and mitigate radiological or nuclear incidents worldwide, with higher numbers meaning better readiness).
- FY 2017–2021 – Continue to implement emergency management policy for DOE sites and update and implement departmental policies and procedures.
- FY 2017–2021 – Conduct two Disposition and Forensics Evidence Analysis Team exercises and two Ground Collection Task Force field exercises per year, in support of maintaining nuclear forensic capabilities.
- FY 2017–2021 – Sustain stabilization capability in nine U.S. cities, including training and equipment maintenance.
- FY 2017-2021 – Ensure that DOE/NNSA Devolution Program requirements, to include communications requirements, are included in the design and build out of the proposed new construction at the Albuquerque facility.

Chapter 5: Conclusion

The nuclear and radiological threat environment is highly dynamic. New threats can emerge—especially as a result of technological change—and persistent threats can abruptly become more acute. Sudden breakthroughs can, however, mitigate longstanding challenges. Events of the past year have illustrated the dynamic nature of the threat environment, including the finalization of the JCPOA, sophisticated cyber-attacks, and terrorist threats in Western Europe and the United States.

Reducing the dynamic threats of nuclear proliferation and nuclear and radiological terrorism is one of DOE/NNSA's three mission pillars. DOE/NNSA's strategy to achieve this mission is to address the entire threat spectrum by preventing the acquisition of nuclear weapons or weapons-usable materials, countering efforts to acquire such weapons or materials, and responding to nuclear or radiological incidents.

DOE/NNSA's annual *Prevent, Counter, and Respond* report describes the nuclear and radiological threat environment, as well as DOE/NNSA's strategic approach to achieving threat reduction. This year's edition is a summary update to last year's report, focusing on major changes that have taken place over the past year. These changes include programmatic activities to support JCPOA implementation, the Administration's proposal in the FY 2017 Budget Request to terminate the MOX fuel approach to plutonium disposition and pursue the dilution and disposal approach, an increased focus on threats from cyber-attacks and emerging technologies, the realignment of DOE/NNSA's Office of Counterterrorism and Counterproliferation and Office of Emergency Operations, and the adoption of an enterprise-wide approach to emergency management. The report also provides new information on the infrastructure and human capital base supporting DOE/NNSA threat reduction activities.

Next year's *Prevent, Counter, and Respond* report will provide a full description of DOE/NNSA's threat reduction strategies and activities, as well as an update on changes in the threat environment and DOE/NNSA programs. Specific developments to be captured in next year's report include progress on the dilution and disposal approach to plutonium disposition, developments in the implementation of the JCPOA, accomplishments in the effort to adopt an enterprise-wide approach to emergency management, outcomes of the Nuclear Security Summit in 2016, and plans for sustaining the momentum created by the Nuclear Security Summit process.

This page left blank intentionally.

Appendix A
Requirements Mapping

This *Prevent, Counter, and Respond* report addresses the requirement for NNSA to submit a *Defense Nuclear Nonproliferation Management Plan* in Title 50, Section 4309, of the United States Code (U.S.C), as added by the *FY 2016 National Defense Authorization Act*, Sec. 3132.

The reader can locate the information associated with each report requirement in the following matrix:

50 U.S.C. § 4309	NNSA Response
(a) In General.--- Concurrent with the submission to Congress of the budget of the President…in each fiscal year, the Administrator shall submit to the congressional defense committees 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.	N/A
(b) Elements.---The [plan] shall include, with respect to each defense nuclear non-proliferation program of the Administration, the following:	N/A
(1) A description of the policy context in which the program operates, including---	N/A
(A) a list of relevant laws, policy directives issued by the President, and international agreements; and	Appendix E
(B) nuclear nonproliferation activities carried out by other Federal agencies.	Appendix G
(2) A description of the objectives and priorities of the program during the year preceding the submission of the [plan].	Section 1.1
(3) A description of the activities carried out under the program during that year.	Appendix B
(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.	Appendix B
(5) A description of any gaps that remain that were not or could not be addressed by the program during that year.	Section 2.4, 3.4, and 4.4
(6) An identification and explanation of uncommitted or uncosted balances for the program, as of the date of the submission of the [plan] that are greater than the acceptable carryover thresholds, as determined by the Secretary of Energy.	Appendix F

50 U.S.C. § 4309	NNSA Response
(7) An identification of funds for the program received through contributions from or cost-sharing agreements with foreign governments…during the year preceding the submission of the [plan] and an explanation of such contributions and agreements.	Appendix C
(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 efficiencies and avoid redundancies.	Appendix G
(9) Plans for activities of the program during the five-year period beginning on the date on which the [plan] is submitted, including activities with respect to the following:	N/A
(A) Preventing nuclear and radiological proliferation and terrorism, including through—	N/A
(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);	Section 2.4.1
(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;	Section 2.4.2
(iii) nonproliferation and arms control, including nuclear verification and safeguards;	Section 2.4.3
(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,	Section 2.4.4
(v) nonproliferation construction programs, including activities associated with Department of Energy Order 413.1 (relating to program management controls).	Section 2.4.5
(B) Countering nuclear and radiological proliferation and terrorism.	Section 3.4
(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.	Section 4.4

50 U.S.C. § 4309	NNSA Response
(10) A threat assessment, carried out by the intelligence community…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 [plan] is submitted and, as appropriate, in the longer term.	*Threat Assessment:* To be submitted separately by the DOE Office of Intelligence and Counterintelligence *Activity Descriptions:* Sections 2.4, 3.4, and 4.4
(11) A plan for funding the program during that five-year period.	Appendix D
(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 2.4, 3.4, and 4.4
(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).	*Description of Activities:* Sections 2.4, 3.4, and 4.4 *Description of Prioritization:* Section 1.1
(14) A description of funds for the program expected to be received during that five-year period through contributions from or cost-sharing agreements with foreign governments…	Contributions in future years are possible but cannot be projected in advance.
(15) 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.	Appendix G
(16) Such other matters as the Administrator considers appropriate.	N/A
(c) Form of Report - The plan required by subsection (a) shall be submitted to the congressional defense committees in unclassified form, but may include a classified annex if necessary.	N/A

This page left blank intentionally.

Appendix B
FY 2015 Accomplishments and Challenges

"Accomplishments and Challenges in the "Prevent" Functional Area

FY15 Key Accomplishments	Challenges
Global Material Security	
International Nuclear Security	
• Completed equipment procurement for the China Center of Excellence on nuclear security. • Completed a signed Statement of Intent between the Department of Energy's National Nuclear Security Administration (DOE/NNSA) and the China Atomic Energy Authority on "Further Strengthening of Cooperation in the Field of Nuclear Security" as a follow-on agreement to the Memorandum of Understanding that governs cooperation on China's Center of Excellence.	• Lack of interest or political support in some countries to engage with the United States on sensitive nuclear security topics. • Challenges in achieving acceptance throughout the international community of the credibility of the insider threat, the importance of material accounting and control as an element of an effective nuclear security program, and the need for active enhancement of nuclear security culture.
Radiological Security	
• Completed security upgrades at a cumulative total of 1,958 buildings worldwide with high priority radiological sources. • Recovered more than 2,000 radiological sources from locations in the United States, resulting in the cumulative total of more than 37,000 sources removed. • Continued development of advanced detection, delay, and tracking tools to support the radiological security mission at home and abroad.	• Balancing the need for appropriate security at locations where radiological materials are used and stored with the need for regular access to these materials for legitimate commercial purposes. • Potential for domestic and international sites to fail to understand the security implications of high-activity sources and thus fail to volunteer for security assistance, resulting in inability to engage certain high priority sites. • Challenges in achieving sustainment of effective radiological security regimes by international partners, particularly when those partner countries suffer from a lack of personnel and resources. • Limited availability of disposal pathways for disused radiological sources. • Challenges in balancing the expanding use of radiological sources worldwide in medical, industrial, and research fields with promotion of alternative, non-isotopic technologies where economically and technically feasible.

FY 2015 Key Accomplishments	Challenges
Nuclear Smuggling Detection and Deterrence (NSDD)	
• Deployed fixed radiation equipment to 25 high-priority sites and provided 20 additional mobile and man-portable systems for use at land borders and internal checkpoints. • Continued to build capacity through more than 130 operator and maintenance trainings; supported over three dozen workshops, exercises and drills; and transitioned 75 sites to indigenous sustainability. • Initiated engagement to build nuclear forensic capability with Kazakhstan, a major new foreign partner.	• Evolving smuggling threats, including emerging adversary groups such as the Islamic State of Iraq and the Levant, and evolving geopolitical realities, such as the U.S. relationship with Russia and the advent of Customs' Unions in areas where NSDD has completed deployments. • Challenges in achieving sustainment of counter-nuclear-smuggling efforts by international partners, particularly when those partner countries suffer from a lack of personnel and resources. • Shortage of technical experts available to support capacity-building efforts in nuclear forensics.
Material Management and Minimization	
Nuclear Material Removal	
• Removed or confirmed the disposition of an additional 169 kilograms of highly enriched uranium (HEU) and plutonium in FY 2015 for a cumulative total of 5,376 kilograms of HEU and plutonium removed since 1996.	• Challenges in achieving political engagement on material removal plans with some countries.
Conversion	
• Converted research reactors in China and Jamaica from HEU to low enriched uranium (LEU) fuel and verified the shutdown of a reactor in Switzerland for a cumulative total of 94 research reactors converted or verified as shutdown worldwide.	• Potential impact of political issues on implementation of key programs (particularly with Russia, where the majority of remaining civilian HEU research reactors are operating). • Technical challenges in developing and qualifying new high-density LEU fuels needed to convert high-performance research reactors. • Difficulty for private investors to commit funding to domestic production of the medical isotope molybdenum-99 given economic conditions in the current market for the isotope. • Potential challenges related to implementation of the Iran Joint Comprehensive Plan of Action.

FY 2015 Key Accomplishments	Challenges
Material Disposition	
• Achieved a cumulative 150 metric tons (MT) of surplus U.S. HEU down-blended or shipped for down-blending, out of a total of 186 MT currently declared as excess and planned for down-blending. • Continued plutonium oxide production in support of the U.S. plutonium disposition program. • Completed the design, cost, and schedule baseline for the HB-Line Ventilation project necessary to reduce off-site risk in the event of a seismic event. • Completed construction for the Waste Solidification Building and placed the facility in a lay-up configuration.	• Impact of limited disposition pathways (both in the United States and abroad) on efforts to eliminate vulnerable HEU and plutonium in foreign countries. • Prolonged operational delays at the Los Alamos National Laboratory plutonium processing facility, PF-4, which disassembles nuclear weapon pits and converts plutonium metal into an oxide form for ultimate disposition.
Nonproliferation and Arms Control	
Nuclear Verification	
• Monitored shutdown of Russian plutonium production reactors, under terms of the U.S.-Russian Plutonium Production Reactor Agreement, to ensure the reactors remain shut down and that the plutonium oxide produced from the last three operating Russian production reactors is not used in weapons. • Supported successful implementation of the New Strategic Arms Reduction Treaty with Russia, including leading working group activities during biannual meetings of the Treaty's Bilateral Consultative Commission. • Supported the planning and execution of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) large-scale onsite inspection ***Integrated Field Exercise 2014*** in Jordan and Vienna, Austria, which was the largest CTBT field exercise to date and demonstrated significant progress in CTBT onsite inspection readiness.	• Russia's continued violation of its obligations under the Intermediate-Range Nuclear Forces (INF) Treaty.

FY 2015 Key Accomplishments	Challenges
Nuclear Controls	
• Conducted approximately 5,600 technical reviews of U.S. export licenses and completed approximately 3,000 technical analyses supporting U.S. detection and interdiction of weapons of mass destruction (WMD)-related commodity transfers to foreign programs of concern.	• Challenges in augmenting the ability of some international partners to absorb bilateral and multilateral export control engagement, while enhancing their ability to independently sustain effective implementation of export controls and related export enforcement norms. • External challenges to the nonproliferation regime, including technological advancement, political unpredictability, and countries of concern actively pursuing WMD. • Emergence of suppliers outside the multilateral export control regimes (e.g., North Korea). • Expansion from state-based, sanctioned, or complicit transfers to "privatized" suppliers, brokers, front companies, and franchises in states with weak controls.
Nuclear Safeguards	
• Continued to build nuclear safeguards capacity by conducting more than 60 training courses and technical exchanges with foreign partners related to nuclear safeguards. • Completed six physical protection assessments at foreign facilities holding U.S.-obligated material. • Conducted over eight field trials and demonstrations of advanced nuclear safeguards technologies and tools in partner facilities. • Tested and transferred five safeguards tools to the International Atomic Energy Agency (IAEA) and foreign partners to make safeguards measurements more effective and efficient.	• Potential resource demands that could be imposed by sudden, transformative events. • The fundamental difficulty in detecting undeclared (covert) nuclear facilities and activities at an early stage. • Growing number of nuclear facilities and increasing amount of nuclear materials under IAEA safeguards outpacing the IAEA's resources in an era of a flat (or zero-growth) budget. • Inherent difficulty and expense of safeguarding enrichment plants and reprocessing facilities (the two main pathways to acquiring fissile material to produce nuclear weapons). • Accelerated retirement of the nonproliferation/safeguards workforce.

FY 2015 Key Accomplishments	Challenges
Nonproliferation Policy	
• Concluded negotiations and achieved entry into force for a new civil nuclear cooperation agreement (123 Agreement) with Vietnam. Also concluded negotiations on successor 123 Agreements with China and the Republic of Korea, which have since entered into force. • Concluded a three-year comprehensive revision of Title 10, Part 810 of the Code of Federal Regulations governing the transfer of nuclear technology and assistance abroad and to foreign persons, clarifying and streamlining the authorization process while continuing to address proliferation risks. • Continued to implement a Part 810 process improvement plan and e810 online authorization system to further improve and modernize the 810 process. • Executed social media and Track 1.5 engagement activities in Myanmar and South Asia to address emerging challenges and opportunities in nonproliferation and arms control.	• Challenges in managing the balance between the nonproliferation objectives of Title 10, Part 810 of the Code of Federal Regulations, governing unclassified nuclear technology and assistance exports and the benefits of U.S. commercial participation in foreign civil nuclear power programs. • External challenges to the nonproliferation regime, including global change, technological advancement, political unpredictability, and countries of concern actively pursuing WMD.
Defense Nuclear Nonproliferation Research and Development (DNN R&D)	
Proliferation Detection	
• Successfully executed experiments with the Defense Threat Reduction Agency in a joint nonproliferation test bed. • Developed advanced sensors and models to characterize material production operations.	• Challenges in integrating operationally focused emergency response and counter nuclear terrorism missions into the DNN R&D mission, resulting in the expansion of the program's performer base at the national laboratories to include more contributions from outside the "global security" organizations and requiring the reassessment and realignment of policies and procedures given the sensitive nature of the work.
Nuclear Detonation Detection	
• Integrated the second Space and Atmospheric Burst Reporting System-2 payload on a host satellite and supported the Air Force Space and Missile Systems Center with producing and delivering a Global Burst Detector payload (GBD III-3) and launching and on-orbit testing three other Global Positioning System IIF satellites (IIF-8, -9, and -10). • Successfully executed the fourth source physics experiment, which supports increased U.S. confidence in monitoring underground nuclear explosions at lower explosive yields.	• Challenges in sustaining a nuclear detonation detection sensor production rate and capability that aligns with DOD's changing satellite launch schedule and long-term procurement plans and requirements. • Challenges in identifying a long-term satellite host platform that addresses the requirement to maintain current nuclear detonation detection capabilities at geosynchronous altitude.

Accomplishments and Challenges in the "Counter" Functional Area

FY15 Key Accomplishments	Challenges
Nuclear Counterterrorism and Incident Response	
Nuclear Counterterrorism Assessment Program	
• Sustained threat device modeling and experiments and developed and tested render safe tools. • Continued to manage the monitoring, assessment, and response to open source nuclear threat device information.	• Challenges in maintaining, in the current budget environment, the availability of key nuclear security enterprise experimental facilities for the duration of current nuclear and energetic materials roadmap needs.
Counterterrorism Response and Capacity Building	
• Developed, designed, organized, and conducted specialized emergency management training courses and programs to meet the specific emergency management needs of partner nations. • Provided enhanced communication and radiation monitoring equipment, technical assistance, and training to IAEA and foreign government emergency programs to address nuclear and radiological incidents and accidents, including lost radiological sources.	• Challenges in synchronizing and executing internal activities and coordinating effectively with both interagency and key international partners in order to meet current or emerging demands imposed on the DOD Combatant Commands, the DOD and FBI National Mission Force, and other government agencies. • Challenges in maintaining support from U.S. government and international partners to sustain program results.

Accomplishments and Challenges in the "Respond" Functional Area

FY15 Key Accomplishments	Challenges
Nuclear Counterterrorism and Incident Response	
Emergency Response	
• Sustained render safe capabilities for an identified critical mission area in support of Principal Operational Partner. This effort includes predictive capability. • Sustained capability for seven stabilization cities (including training and equipment maintenance), rolled out eighth stabilization city, and began training for ninth stabilization city.	• Difficulty in developing, training, and maintaining a cadre of individuals with expertise in the areas necessary to support emergency response operations, especially given the fact that limited funding levels prohibit having a personnel resource pool to immediately fill vacant positions resulting from retirements, promotions, and other departures. • Challenges with infrastructure replacements at the Nuclear Response Group Readiness Operations Complex to ensure a safe, effective, and sustainable facility for deployment, equipment maintenance, and storage.
National Technical Nuclear Forensics	
• Maintained capability and readiness to respond to pre- and post-detonation events. • Planned and participated in pre- and post-detonation nuclear forensics exercises.	• Challenges in maintaining laboratory staff expertise, capability, and readiness, as well as supporting measurement proficiency testing. • Challenges with infrastructure improvements at the Nevada National Security Site to ensure a safe, effective, sustainable facility for disposition operations.
Emergency Management and Operations Center	
• Conducted activities to promote consistent emergency management practices at DOE sites and implement emergency planning for severe events. • Continued maintenance and operation of the Emergency Communications Network in order to meet the National Security Mission requirements and to support the DOE/NNSA Network vision.	• Difficulties associated with communications networks and capabilities that are fragmented, outdated, and cumbersome in the ability to move data and keep multiple organizations informed of activities from field-level to executive-level. Differing levels of classification, along with organizational rules on use of communications systems, also make it difficult to move data from one system to another.

This page left blank intentionally.

Appendix C
Foreign Contributions and Cost-Sharing Agreements

DOE is authorized to accept international contributions for any programs within DNN. During FY 2015, DNN received a total of $4,496,310 (U.S. dollar equivalent) from six international contributors. Additional contributions in future years are possible but cannot be projected in advance. Foreign contributions for FY 2015 are shown under DNN's previous budget and organizational structure because that is the structure that was in place at the time the contributions were received. Contributions will be received and tracked under DNN's revised budget and organizational structure starting in FY 2016.

Foreign Government Contributions Received

FY	Program for Cooperation	Partner	Contributions (whole dollars)
2015	Global Threat Reduction Initiative (GTRI)	Netherlands	499,970
2015	GTRI	Norway	499,960
2015	GTRI	South Korea	200,000
2015	GTRI	United Kingdom	1,000,000
2015	International Material Protection and Cooperation (IMPC)	Finland	318,808
2015	IMPC	New Zealand	245,340
2015	IMPC	Norway	999,960
2015	IMPC	United Kingdom	732,272
Total FY 2015			**4,496,310**

Amount and Use of Foreign Contributions

International Contributor	Amount/Date Received	Use
Global Threat Reduction Initiative		
Norway	$499,960 12/29/14	Funds were used to support projects to remove dangerous sources to a secure location in Ukraine.
South Korea	$200,000 12/30/14	Funds were used to support projects to remove dangerous sources to a secure location in Ukraine.
United Kingdom	$1,000,000 3/19/15	Funds will support nuclear and radiological security activities in Central Asia, Myanmar, Vietnam, and Iraq.
Netherlands	$499,970 6/18/15	Funds were used to support GTRI assistance to the Republic of Kazakhstan to categorize, secure, and remove unwanted radiological materials.
International Material Protection and Control		
Norway	$999,960 10/28/14	Funds were used to support deployment of radioactive detection systems in Ukraine to combat illicit trafficking in nuclear and radiological materials.
Finland	$318,808 1/26/15	Funds were used to install radiation portal monitors on the Ukraine-Moldova and the Ukraine-Belarus borders.
United Kingdom	$732,272 3/19/15	Funds were used to support ongoing physical security upgrades at the Kurchatov Institute in the Russian Federation.
New Zealand	$245,340 6/30/15	Funds will be used for nuclear security assistance to Latin American, Southeast Asian, and African nations in deploying radiation detection and related communications equipment to secure their land borders, seaports, and airports.

Amounts Retained

All funds were obligated and encumbered as of September 30, 2015.

Appendix D
FY 2017 Future Years Nuclear Security Program Plan

The following section comes directly from the Department of Energy FY 2017 Congressional Budget Request, Volume 1: National Nuclear Security Administration.

Table 1. Defense Nuclear Nonproliferation FY 2015-2017 Funding (Non-Comparable*)

(Dollars in Thousands)

	FY 2015 Enacted	FY 2015 Current	FY 2016 Enacted	FY 2017 Request	FY 2017 vs FY 2016
Defense Nuclear Nonproliferation Appropriation					
Defense Nuclear Nonproliferation					
Material Management and Minimization					
HEU Reactor Conversion	0	0	115,000	128,359	+13,359
Nuclear Material Removal	0	0	115,000	68,902	-46,098
Material Disposition	0	0	86,584	143,833	+57,249
Total, Material Management and Minimization	**0**	**0**	**316,584**	**341,094**	**+24,510**
Global Material Security					
International Nuclear Security	0	0	130,527	46,027	-84,500
Radiological Security	0	0	153,749	146,106	-7,643
Nuclear Smuggling Detection	0	0	142,475	144,975	+2,500
Total, Global Material Security	**0**	**0**	**426,751**	**337,108**	**-89,643**
Nonproliferation and Arms Control	**0**	**0**	**130,203**	**124,703**	**-5,500**
Defense Nuclear Nonproliferation R&D	**393,401**	**386,308**	**419,333**	**393,922**	**-25,411**
Nonproliferation Construction					
99-D-143 Mixed Oxide (MOX) Fuel Fabrication Facility, SRS	**0**	**0**	**340,000**	**270,000**	**-70,000**
Total, Nonproliferation Construction	**0**	**0**	**340,000**	**270,000**	**-70,000**
Global Threat Reduction Initiative					
Highly Enriched Uranium (HEU) Reactor Conversion	**119,383**	**119,383**	**0**	**0**	**0**
International Nuclear and Radiological Material Removal and Protection	**117,737**	**120,337**	**0**	**0**	**0**
Domestic Radiological Material Removal and Protection	**88,632**	**88,632**	**0**	**0**	**0**
International Contributions	**0**	**2,200**	**0**	**0**	**0**
Total, Global Threat Reduction Initiative	**325,752**	**330,552**	**0**	**0**	**0**

* Table shows funds as requested and appropriated; a revised budget structure is being implemented starting in FY 2016

	(Dollars in Thousands)				
	FY 2015 Enacted	FY 2015 Current	FY 2016 Enacted	FY 2017 Request	FY 2017 vs FY 2016
Nonproliferation and International Security	**141,359**	**141,359**	**0**	**0**	**0**
International Material Protection and Cooperation	**270,911**	**270,607**	**0**	**0**	**0**
Fissile Materials Disposition (FMD)					
U.S. Surplus FMD (Operations and Maintenance)					
U.S. Plutonium Disposition	**60,000**	**60,000**	**0**	**0**	**0**
U.S. Uranium Disposition	**25,000**	**35,000**	**0**	**0**	**0**
Subtotal, U.S. Surplus FMD Operations and Maintenance	**85,000**	**95,000**	**0**	**0**	**0**
Construction	**345,000**	**345,000**	**0**	**0**	**0**
Total, U.S. Surplus Fissile Materials Disposition	**430,000**	**440,000**	**0**	**0**	**0**
Total, Fissile Materials Disposition	**430,000**	**440,000**	**0**	**0**	**0**
Total, Defense Nuclear Nonproliferation Programs	**1,561,423**	**1,568,826**	**1,632,871**	**1,466,827**	**-166,044**
Nuclear Counterterrorism Incident Response Program	**0**	**0**	**234,390**	**271,881**	**+37,491**
Legacy Contractor Pensions	**102,909**	**102,909**	**94,617**	**83,208**	**-11,409**
Subtotal, Defense Nuclear Nonproliferation Appropriation	**1,664,332**	**1,671,735**	**1,961,878**	**1,821,916**	**-139,962**
Use of Prior Year Balances	**-22,963**	**-32,963**	**-21,576**	**-14,000**	**+7,576**
Recission of Prior Year Balances	**-26,121**	**-26,121**	**0**	**0**	**0**
Total, Defense Nuclear Nonproliferation Appropriation	**1,615,248**	**1,612,651**	**1,940,302**	**1,807,916**	**-132,386**

Table 2. Defense Nuclear Nonproliferation FY 2015-2017 Funding (Comparable*)

(Dollars in Thousands)

	FY 2015 Enacted	FY 2015 Current	FY 2016 Enacted	FY 2017 Request	FY 2017 vs FY 2016
Defense Nuclear Nonproliferation Appropriation					
Defense Nuclear Nonproliferation					
Material Management and Minimization					
HEU Reactor Conversion	119,383	119,383	115,000	128,359	+13,359
Nuclear Material Removal	68,536	68,536	115,000	68,902	-46,098
Material Disposition	85,000	95,000	86,584	143,833	+57,249
Total, Material Management and Minimization	**272,919**	**282,919**	**316,584**	**341,094**	**+24,510**
Global Material Security					
International Nuclear Security	134,875	134,875	130,527	46,027	-84,500
Radiological Security	137,833	137,833	153,749	146,106	-7,643
Nuclear Smuggling Detection	151,536	151,536	142,475	144,975	+2,500
International Contributions	0	4,496	0	0	+0
Total, Global Material Security	**424,244**	**428,740**	**426,751**	**337,108**	**-89,643**
Nonproliferation and Arms Control	**125,859**	**125,859**	**130,203**	**124,703**	**-5,500**
Defense Nuclear Nonproliferation R&D	**393,401**	**386,308**	**419,333**	**393,922**	**-25,411**
Nonproliferation Construction					
99-D-143 Mixed Oxide (MOX) Fuel Fabrication Facility, SRS	345,000	345,000	340,000	270,000	-70,000
Total, Nonproliferation Construction	**345,000**	**345,000**	**340,000**	**270,000**	**-70,000**
Nuclear Counterterrorism Incident Response Program	**224,033**	**224,033**	**234,390**	**271,881**	**+37,491**
Legacy Contractor Pensions	**102,909**	**102,909**	**94,617**	**83,208**	**-11,409**
Subtotal, Defense Nuclear Nonproliferation Appropriation	**1,888,365**	**1,895,768**	**1,961,878**	**1,821,916**	**-139,962**
Use of Prior Year Balances	**-22,963**	**-32,963**	**-21,576**	**0**	**+21,576**
Recission of Prior Year Balances	**-26,121**	**-26,121**	**0**	**-14,000**	**-14,000**
Total, Defense Nuclear Nonproliferation Appropriation	**1,839,281**	**1,836,684**	**1,940,302**	**1,807,916**	**-132,386**

*FY 2015 funding was appropriated under DNN's previous budget structure, but this table shows that funding under DNN's revised budget structure

Table 3. Defense Nuclear Nonproliferation FY 2018-2021 Funding

	(Dollars in Thousands)			
	FY 2018 Request	FY 2019 Request	FY 2020 Request	FY 2021 Request
Defense Nuclear Nonproliferation				
Material Management and Minimization	**424,195**	**419,200**	**436,007**	**447,261**
Global Material Security	**409,132**	**434,420**	**446,245**	**537,101**
Nonproliferation and Arms Control	**137,681**	**140,099**	**142,867**	**145,545**
Defense Nuclear Nonproliferation R&D	**476,677**	**486,517**	**492,123**	**496,367**
Nonproliferation Construction				
99-D-143 Mixed Oxide (MOX) Fuel Fabrication Facility, SRS	**221,000**	**221,000**	**221,000**	**221,000**
Total, Nonproliferation Construction	**221,000**	**221,000**	**221,000**	**221,000**
Total, Defense Nuclear Nonproliferation Programs	**1,668,685**	**1,701,236**	**1,738,242**	**1,847,274**
Nuclear Counterterrorism Incident Response Program	**253,024**	**252,260**	**257,653**	**257,822**
Legacy Contractor Pensions	**52,640**	**29,296**	**29,296**	**29,296**
Subtotal, Defense Nuclear Nonproliferation Appropriat	**1,974,349**	**1,982,792**	**2,025,191**	**2,134,392**
Use of Prior Year Balances	**0**	**0**	**0**	**0**
Recission of Prior Year Balances	**0**	**0**	**0**	**0**
Total, Defense Nuclear Nonproliferation Appropriation	**1,974,349**	**1,982,792**	**2,025,191**	**2,134,392**

This page intentionally left blank.

Appendix E
Relevant Laws, Policy Directives, and International Agreements

The nuclear and radiological threat reduction activities of the DOE/NNSA operate within the context of a large number of laws, Presidential Policy Directives (PPD), and international agreements and 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 (Jan. 2. 2013).
- *Atomic Energy Act of 1954, As Amended*, 42 U.S.C. §§ 2011 *et seq*.
- *Atomic Energy Defense Act, As Amended*, Pub. L. 107-314, Div. D., as renumbered by Pub. L. 108-136, Div. C., Title XXXI (Nov. 24, 2003).
- *The Export Administration Act of 1979*, Pub. L. 96-72 (Sept. 29, 1979), as Continued by the President under the *International Emergency Economic Powers Act* pursuant to Executive Order 13222 as Amended by Executive Order 13637, as well as Executive Order 12981.
- *Henry J. Hyde United States-India Peaceful Atomic Energy Cooperation Act of 2006*, Pub. L. 109-401, Title I (Dec. 18, 2006).
- National Defense Authorization Acts (Various).
- *National Nuclear Security Administration Act, As Amended*, Pub. L. 106-65, Div. C., Title XXXII (Oct. 5, 1999).
- *Nuclear Non-Proliferation Act of 1978*, As Amended, Pub. L. 95-242 (Mar. 10, 1978).

Presidential Policy Directives

- National Security Presidential Directive (NSPD) 28 (classified directive).
- NSPD 51/Homeland Security Presidential Directive 20.
- PPD-8: National Preparedness.
- PPD-25 (classified directive).

International Agreements and Other International Instruments

- 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 Defence Purposes.

- 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* (Various).
- Amendment to the Convention on the Physical Protection of Nuclear Material. (Note: This Amendment has not entered into force.)
- Comprehensive Nuclear-Test-Ban Treaty. (Note: The United States has signed this treaty but has not ratified it. Also, the treaty has not entered into force.)
- Convention on the Physical Protection of Nuclear Material.
- International Convention on the Suppression of Acts of Nuclear Terrorism.
- Joint Comprehensive Plan of Action.
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
- Nuclear Security Summit Communiques from 2010, 2012, and 2014.
- Treaty Between the United States of America and the Russian Federation on Measures for Further Reduction and Limitation of Strategic Offensives 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 Elimination Of Their Intermediate-Range And Shorter-Range Missiles (INF Treaty).
- Treaty on the Non-Proliferation of Nuclear Weapons (NPT).
- United Nations Security Council Resolution 1540.
- U.S.-France Agreement for Cooperation in the Operation of Atomic Weapons Systems for Mutual Defense Purposes, as amended, and the 1996 Memorandum of Agreement on Cooperation Concerning Nuclear Safety and Security (MOA).
- U.S.-Russia Agreement Concerning Cooperation Regarding Plutonium Production Reactors, and the Amendment thereto.
- U.S.-Russia Agreement 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).

Appendix F
Analysis and Explanation of FY 2015 Uncommitted Balances

Background

When Congress appropriates annual funding for DOE programs, it generally specifies that the appropriated funds shall "remain available until expended." This means that any funds that have not been costed by the end of the fiscal year are carried over into the following fiscal year.

These uncosted balances are necessary and unavoidable given the nature of the Department's work, but they must be carefully managed and tracked as part of the Department's financial management system. Accordingly, DOE established percentage thresholds specifying levels of uncosted balances (as a percentage of total obligated funds) for specific types of financial and contractual arrangements. These thresholds allow the Department to evaluate its performance based on the variance between thresholds and actual uncosted balances. A threshold is defined as an analytical reference point beyond which uncosted obligation balances should be given greater scrutiny. Balances in excess of these thresholds require a more detailed explanation or justification to determine their cause and to identify the expectation for full costing. The target thresholds are 13 percent for contractor operating costs; 17 percent for federal operating costs; and 50 percent for Capital Equipment, General Plant Projects, and Accelerator Improvement Projects.

As per the requirements in the *FY 2016 National Defense Authorization Act*, Sec. 3132(b)(6), DNN is required, starting in 2015, to report to Congress annually on any uncommitted (i.e., unencumbered) balances that exceed these thresholds. Funds are encumbered through the award or issuance of subcontracts or purchase orders by M&O's to third parties, the award of direct contracts to non-M&O contractors, or certain other encumbering actions by M&O's. DNN measures its financial performance in terms of the percentage of funds that have been costed or encumbered, rather than just the percentage of funds that have been costed, because a great deal of the program's work 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 therefore not provide an accurate picture of the program's progress.

Overview of DNN Unencumbered Balances

At the end of FY 2015, the aggregate program costs plus encumbrances for DNN were 80.9 percent of total costing authority, leaving 19.1 percent unencumbered. This unencumbered balance was primarily driven by the following DNN congressional controls which had unencumbered balances in excess of the established thresholds:

- The HEU Reactor Conversion, International Nuclear and Radiological Material Removal and Protection, and Domestic Radiological Material Removal and Protection subprograms within the Global Threat Reduction Initiative (GTRI) program
- The Nonproliferation and International Security program
- The International Material Protection and Cooperation (IMPC) program

- The U.S. Surplus Fissile Materials Disposition subprogram within the Fissile Material Disposition (FMD) program

Details on the unencumbered balances for each of these budget elements, explanations for the balances, and a table showing FY 2015 budget execution data in detail are provided below. Budget execution data is shown under DNN's previous budget and organizational structure because that is the structure that was in place at the time that the FY 2015 budget was executed. Budget execution data will be tracked and reported under DNN's revised budget and organizational structure starting in FY 2016.

Global Threat Reduction Initiative

As of the end of FY 2015, the GTRI program had total costs plus encumbrances totaling $629.5 million, or 83.6 percent of its total FY 2015 available funds. The remaining $123.8 million in uncosted unencumbered balances (16.4 percent of the available FY 2015 funds) exceeded the DOE threshold by $32.4 million. The amounts by which each GTRI subprogram exceeded the threshold are as follows: $18.8 million for HEU Reactor Conversion, $10.8 million for International Nuclear and Radiological Material Removal and Protection, and $2.8 million for Domestic Radiological Material Removal and Protection.

For the HEU Reactor Conversion subprogram, this was mostly due to delays in placing Cooperative Agreements under the molybdenum-99 (Mo-99) program. The Mo-99 contracts and cooperative agreements were placed in late September and will be costed in FY 2016 to support initial domestic Mo-99 production. In addition, some of the balances will be encumbered in FY 2016 to support the TREAT reactor conversion project. For the International Nuclear and Radiological Material Removal and Protection subprogram, the unencumbered funds will primarily support infrastructure improvements at the Savannah River Site to support future nuclear material removals, including key deliverables for the 2016 Nuclear Security Summit. For the Domestic Radiological Removal and Protection subprogram, additional funding was received in FY 2015 to complete upgrades at all U.S. Category I radiological sites, which is one of the U.S. commitments made in the Nuclear Security Summit process. About half of this funding was carried over into FY 2016 to projects for which assessments are complete but contract negotiations for the security upgrades are still underway.

Nonproliferation and International Security

As of the end of FY 2015, the Nonproliferation and International Security program had costs plus encumbrances totaling $156.0 million, or 82.9 percent of its total FY 2015 available funds; the remaining $32.3 million in uncosted unencumbered balances (17.1 percent, of the available FY 2015 funds) exceeded the DOE threshold by $7.4 million. The $32.3 million in FY 2015 uncosted unencumbered balances are due primarily to unavoidable delays originating from the host countries for several projects (e.g., Tunisia, Cambodia, Laos, Thailand, and South Korea), procurement delays at the national laboratories, and projects that will be performed during the first quarter of FY 2016 for which funding must be in place at the national laboratories to support implementation (e.g., monitoring under the Plutonium Production Reactor Agreement and Chemical Weapons Convention laboratory certification). Finally, there were information technology security delays associated with continued implementation of the Part 810 electronic review system; the Part 810 electronic system will contain large amounts of highly sensitive proprietary information and personally identifiable information and, accordingly, must go through an intense security testing process, which is ongoing. All unencumbered balances have been assigned and planned for specific projects. It is anticipated that all unencumbered funds with either be encumbered or costed by the end of the first quarter in FY 2016.

International Material Protection and Cooperation

As of the end of FY 2015, IMPC had costs plus encumbrances totaling $590.2 million, or 67.1 percent of its total FY 2015 available funds; the remaining $289.3 million in uncosted unencumbered balances (32.9 percent of available FY 2015 funds) exceeded the DOE threshold by $165.4 million. The uncosted unencumbered balance of $289.3 million in FY 2015 reflects the decrease in U.S.-Russian nuclear security cooperation. Other IMPC uncosted unencumbered balances are related to implementation delays with other foreign partners. The remaining uncosted unencumbered balances will be used by the national laboratories to ensure that priority global nuclear material security projects are appropriately supported in FY 2016 and FY 2017.

Fissile Material Disposition

As of the end of FY 2015, FMD had costs plus encumbrances totaling $734.8 million, or 86.4 percent of its total FY 2015 available funds; the remaining $115.7 million in uncosted unencumbered balances totaled 13.6 percent of available FY 2015 funds. Within the FMD program, the U.S. Surplus Fissile Material Disposition subprogram had uncosted unencumbered balances of $89.3 million, which exceeded the DOE threshold by $48.3 million.

The $89.3 million in FY 2015 uncosted unencumbered balances for the U.S. Surplus Fissile Material Disposition subprogram will support other project costs for the settlement of the request for equitable adjustment related to the Waste Solidification Building that is required to be paid in January 2016 ($9.2 million), as well as other costs associated with plutonium disposition activities at the Savannah River Site ($3.0 million). In addition, these funds will continue to support the oxide production campaign at Los Alamos National Laboratory ($22.9 million), the oxide campaign at the Savannah River Site ($21.8 million), procurements of shipping containers for surplus pits ($6.7 million) and integration of program elements such as integrated program execution plan and schedule, program risk management plan, and interface control documents ($11.8M). Other FMD uncosted unencumbered balances are related to the U.S. Uranium Disposition program. The unencumbered balance ($13.9 million) is projected to be costed in the first quarter of FY 2016 to continue the level of effort needed to down-blend surplus HEU to low-enriched uranium. This down-blending advances a number of important goals, including providing support for the tritium program.

Cost + Encumbrance Status, End of Fiscal Year 2015		A	B	C	D B + C	E D / A	F A - D	G F / A
Expense Typ	Program	Costing Authority (Obligated Funds)	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								
	Elimination of Weapons Grade Plutonium Production	1,136,448	33,570	1,102,301	1,135,870	99.9%	577	0.1%
	Nonproliferation and International Security	69	0	69	69	100.0%	0	0.0%
	Russian Surplus Fissile Materials Disposition	1,838,006	936,706	1,438,629	2,375,335	129.2%	-537,329	-29.2%
	Global Threat Reduction Initiative	144,928,028	83,754,354	52,058,022	135,812,376	93.7%	9,115,652	6.3%
	Congressionally Directed Projects - Defense Nuclear Nonproliferation	23,161	0	23,161	23,161	100.0%	0	0.0%
	Legacy Contractor Pensions-DNN	102,909,050	102,909,050	0	102,909,050	100.0%	0	0.0%
	International Material Protection and Cooperation (IMPC)	879,498,654	319,651,572	270,510,405	590,161,977	67.1%	289,336,677	32.9%
	Nonproliferation and International Security (NIS)	188,225,430	134,706,993	21,264,207	155,971,200	82.9%	32,254,229	17.1%
	Highly Enriched Uranium (HEU) Reactor Conversion	220,352,313	100,911,346	70,111,139	171,022,485	77.6%	49,329,827	22.4%
	International Nuclear and Radiological Material Removal and Protection	257,333,418	108,763,757	103,266,971	212,030,729	82.4%	45,302,690	17.6%
	Domestic Radiological Material Removal and Protection	130,611,645	64,016,593	46,579,388	110,595,981	84.7%	20,015,665	15.3%
	Defense Nuclear Nonproliferation Research and Development (DNN R&D)	623,313,075	455,000,414	80,160,076	535,160,490	85.9%	88,152,585	14.1%
	Fissile Materials Disposition	275,408,485	137,368,057	48,708,008	186,076,064	67.6%	89,332,421	32.4%
Operating Total		2,825,577,783	1,508,052,412	695,222,376	2,203,274,788	78.0%	622,302,995	22.0%
Construction								
	99D143000, Mixed Oxide Fuel Fabrication Facility, Savannah River, SC	542,081,393	335,818,609	204,967,798	540,786,407	99.8%	1,294,986	0.2%
	99D141020, Waste Solidification Building, Savannah River, SC	31,116,161	5,540,620	110	5,540,730	17.8%	25,575,431	82.2%
Construction Total		573,197,554	341,359,229	204,967,908	546,327,137	95.3%	26,870,417	4.7%
Grand Total		3,398,775,336	1,849,411,641	900,190,283	2,749,601,925	80.9%	649,173,411	19.1%

Appendix G
Coordination within DOE and the U.S. Interagency

With the largest global nuclear security program in the U.S. government, DOE/NNSA plays a primary role in implementing the U.S. nuclear nonproliferation agenda. DOE/NNSA coordinates closely with other elements of DOE, especially the Office of Environmental Management (EM), Office of Nuclear Energy, and Office of Science. DOE/NNSA also works in partnership with other U.S. government agencies involved in nuclear nonproliferation and nuclear counterterrorism, especially DOS and DOD. Key DOS programs in this area are located in the Bureau of International Security and Nonproliferation and include the Nonproliferation and Disarmament Fund as well as the Offices of Cooperative Threat Reduction, Counterproliferation Initiatives, Export Control Cooperation, and WMD Terrorism. At DOD, programs in this area are primarily located in the Defense Threat Reduction Agency and include the Global Nuclear Security Program and Proliferation Prevention Program. Other agencies that work closely with DOE/NNSA on nuclear nonproliferation and nuclear counterterrorism include DHS, the Department of Justice (DOJ), and the NRC.

Key DOE/NNSA nuclear and radiological threat reduction activities that are coordinated with other offices within DOE and other federal agencies include:

- Radiological source disposal activities (coordinated with DOE-EM, which maintains disposal facilities that are used for certain types of radiological sources);
- Nuclear Smuggling Detection and Deterrence activities (coordinated with DOS, FBI, and DHS);
- Research and development for nuclear detonation detection (coordinated with DOD, DOS, FBI, DHS, and other government agencies);
- Proliferation detection research and development activities (coordinated with DHS, DOS, DOD, DOE Office of Nuclear Energy, NRC, and other government agencies);
- Nuclear material removal disposition activities (coordinated with DOE-EM, which maintains infrastructure for the receipt, storage, and disposition of nuclear material);
- Reactor conversion and nuclear material removal and transportation activities within the United States (coordinated with the NRC, which is responsible for licensing some of the converted reactors for operation and helping ensure the safe transport of nuclear materials within the United States);
- Activities to establish reliable supplies of the medical isotope molybdenum-99 produced without highly enriched uranium (coordinated with DOS, NRC, and the Department of Health and Human Services);
- Negotiating and implementing the U.S.-Russia Plutonium Management and Disposition Agreement (coordinated with DOS);
- Export control outreach and training activities (coordinated with DOS, DHS, and DOC);

- Reviewing requests for authorization to transfer unclassified nuclear technology (pursuant to Part 810 of Title 10, Code of Federal Regulations) and assisting with foreign atomic energy activities (coordinated with DOS, DOD, NRC, DOC, and the Office of the Director of National Intelligence, all of which play a role in reviewing these requests as per statutory requirements);
- Negotiating agreements for civil nuclear cooperation with foreign countries pursuant to Section 123 of the *U.S. Atomic Energy Act* (coordinated with DOS and NRC; DOE provides technical assistance on the negotiations, while DOS leads the negotiations and NRC provides concurrence);
- Management of access, dissemination, and use of improvised nuclear device information (coordinated with DOE Office of Classification, DOD, DOJ, DHS, DOS, NRC, and the Intelligence Community);
- Domestic nuclear forensic activities (coordinated with DHS, which manages the National Technical Nuclear Forensics Center);
- International outreach on nuclear forensic activities (coordinated with DOS);
- Domestic and international counterterrorism training activities (coordinated with the FBI, which collaborates with DOE/NNSA to administer these trainings);
- Capabilities for radiological environmental monitoring and assessment in the event of a nuclear or radiological incident (coordinated with DOD, the Environmental Protection Agency, HHS, and other federal agencies, which collaborate through the Federal Radiological Monitoring and Assessment Center);
- Responding to nuclear or radiological incidents (coordinated with the FBI, which leads the federal response to such incidents domestically; DOD, which leads the response to such incidents abroad; and DOS, which has the overall responsibility for the U.S. response to international terrorist events); and,
- Capabilities to respond to accidents or incidents involving U.S. nuclear weapons (coordinated with DOD.

In addition to coordinating specific programs and activities, DOE/NNSA also works with other agencies to ensure effective overall coordination of nuclear and radiological threat reduction activities. Through a "Bridge Meeting" process, DOE/NNSA and the Office of the Secretary of Defense hold Assistant Secretary-level coordination meetings regarding their cooperative nuclear nonproliferation activities and discuss areas where DOE/NNSA and DOD program strengths and unique capabilities may complement each other. A similarly focused coordination forum was created among DOS, DOD, and DOE to "map" their nuclear nonproliferation program plans in specific foreign countries to better coordinate the three departments' activities. In addition, DOE/NNSA's emergency management priorities (including response to nuclear proliferation and terrorist threats) are informed by, and aligned with, national security priorities as defined by counterterrorism and incident management lead agencies. These national security priorities include interagency strategic and operational plans developed by the FBI, DHS's Federal Emergency Management Agency, DOS, and DOD.

As part of the whole-of-government policy development progress, DOE/NNSA also actively participates in White House-led Interagency Policy Committee (IPC) and Sub-IPC meetings on nuclear nonproliferation, counterterrorism, and emergency response, which are routinely held to develop consistent interagency policy positions and implementation strategies. Moreover, Presidential initiatives, such as the sustained effort to secure or eliminate vulnerable nuclear weapon materials, may involve additional coordination mechanisms, such as program-level interagency working groups.