U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

Fiscal Year 2016 Stockpile Stewardship and Management Plan

Report to Congress
March 2015

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

Administrator's Letter of Transmittal

This strategic document is the U.S. Department of Energy National Nuclear Security Administration *Fiscal Year 2016 Stockpile Stewardship and Management Plan*. It addresses the statutory requirements of Title 50 of the *United States Code*, Section 2523, and related congressional requests. This fiscal year (FY) 2016 document presents the current detailed plan for maintaining the Nation's nuclear weapons stockpile.

The FY 2016 SSMP builds upon last year's SSMP in balancing NNSA's investments in maintaining and modernizing the stockpile, revitalizing its physical infrastructure and workforce, and sustaining its research, development, testing, and evaluation programs. The joint DOE and Department of Defense "3+2 Strategy" for stockpile modernization through life extension programs implemented by this SSMP provides the opportunity to continue the Administration's commitment to maintaining a safe, secure, and effective deterrent while reducing the size of the stockpile.

For example, once the B61-12 life extension program is completed in FY 2025 and confidence is gained in the B61-12 weapons in service, the B83-1, the last megaton-class weapon in America's nuclear arsenal, will be retired. The combination of these actions will result in a 50 percent reduction in the number of nuclear gravity bombs in the stockpile, the removal of a megaton-class weapon, an 80 percent reduction in amount of special nuclear material in the bomb portion of the air leg, and a reduction in the safety and security risks associated with the stockpile.

Furthermore, consistent with life extension program plans, NNSA's investments in plutonium will allow war-reserve-quality production of 30 plutonium pits per year by FY 2026 and 50 to 80 pits per year by 2030. Similarly, our Uranium Strategy will allow us to recapitalize critical enriched uranium operations that currently reside in outdated facilities. The plans described in this document for these essential capabilities are consistent with the requirements outlined in the FY 2015 National Defense Authorization Act.

To support this plan, NNSA has, for the sixth consecutive year, increased the budget request for Weapons Activities. If adopted by Congress, this budget request will increase funding by $891 million from the comparable FY 2015 enacted level. Much of this 11.2 percent increase will be devoted to stockpile life extension programs and recapitalization of critical plutonium and uranium capabilities. In addition, the schedule for the W80-4 life extension program has been moved up 2 years, and a conventional high-explosive refresh has been added to the W88 Alteration.

With this plan and the support of Congress, the nuclear deterrent will support the Nation's current and future defense posture while meeting its New Strategic Arms Reduction Treaty agreements and enable progress toward a world without nuclear weapons.

Pursuant to the statutory requirements, this report is being provided to the following members of Congress:

- **The Honorable Thad Cochran**
  Chairman, Senate Committee on Appropriations
- **The Honorable Barbara Mikulski**
  Ranking Member, Senate Committee on Appropriations
- **The Honorable John McCain**
  Chairman, Senate Committee on Armed Services

- **The Honorable Jack Reed**
  Ranking Member, Senate Committee on Armed Services
- **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 Jeff Sessions**
  Chairman, Subcommittee on Strategic Forces
  Senate Committee on Armed Services
- **The Honorable Joe Donnelly**
  Ranking Member, Subcommittee on Strategic Forces
  Senate Committee on Armed Services
- **The Honorable Harold Rogers**
  Chairman, House Committee on Appropriations
- **The Honorable Nita M. Lowey**
  Ranking Member, House Committee on Appropriations
- **The Honorable Mac Thornberry**
  Chairman, House Committee on Armed Services
- **The Honorable Adam Smith**
  Ranking Member, House Committee on Armed Services
- **The Honorable Mike Simpson**
  Chairman, Subcommittee on Energy and Water Development, and Related Agencies
  House Committee on Appropriations
- **The Honorable Marcy Kaptur**
  Ranking Member, Subcommittee on Energy and Water Development, and Related Agencies
  House Committee on Appropriations
- **The Honorable Mike Rogers**
  Chairman, Subcommittee on Strategic Forces
  House Committee on Armed Services
- **The Honorable Jim Cooper**
  Ranking Member, Subcommittee on Strategic Forces
  House Committee on Armed Services

If you have any questions or need additional information, please contact me or Mr. Clarence Bishop, Associate Administrator for External Affairs, at (202) 586-8343.

Sincerely,

Frank G. Klotz

Message from the Secretary

Maintaining a safe, secure, and effective nuclear weapons stockpile in the absence of nuclear explosive testing remains one of the Department of Energy's (DOE) fundamental responsibilities to our Nation. The *Fiscal Year 2016 Stockpile Stewardship and Management Plan* (SSMP) lays out a comprehensive plan for achieving this mission. The DOE's National Nuclear Security Administration (NNSA) will continue to maintain effective stewardship of the nuclear deterrent, *via* stockpile maintenance and life extension programs, while leveraging cross-cutting initiatives in science, engineering and technology capabilities, and rightsizing the infrastructure needed to meet national security requirements. All of this will be achieved through effective and efficient program and project management and a continued emphasis on safe and secure operations, which remains a priority for the Department.

The challenge of extending the life of the nuclear weapons in the stockpile without testing is one that NNSA has successfully met through concerted investments in the people, the infrastructure, and the technology to support this work. The program outlined in the FY 2016 SSMP is an excellent example of how NNSA will continue these stewardship and management efforts consistent with DOE's broader management strategy, including in the area of building strategic partnerships with the national laboratories to support our nuclear and broader national security missions. DOE efforts across all of our missions are heavily grounded in science, and the national laboratories are a major asset in executing our missions in collaboration with all of NNSA's productions plants and sites.

There are a number of ways in which strengthening our partnerships with the national laboratories has already yielded benefits. Joint investments by DOE's Office of Science and NNSA in achieving exascale computing will directly support modeling and experiments as part of NNSA's stockpile stewardship program, while helping to ensure continued U.S. leadership of this critical capability. These partnerships have also helped DOE and NNSA improve our efforts in project management and performance, including for the Uranium Processing Facility at the Y-12 National Security Complex, where NNSA is developing a disciplined modular approach that will remove risks early in the process and build to a more rigorously managed budget and schedule. This improved process will be an important and recurring project management theme at the NNSA and across the Department.

Specifically, the FY 2016 SSMP outlines two critical areas of our infrastructure modernization plans, which ultimately support a reduced stockpile while ensuring a responsive infrastructure: our Plutonium and Uranium Strategies. The Plutonium Strategy will allow war-reserve-quality production of 30 plutonium pits per year by FY 2026 and 50 to 80 pits per year by 2030. Similarly, our Uranium Strategy will allow us to recapitalize critical enriched uranium operations that currently reside in outdated facilities. The plans described in this document for these essential capabilities are consistent with the requirements outlined in the FY 2015 National Defense Authorization Act.

The FY 2016 SSMP provides a coherent strategy for achieving one of DOE's critical national security mission areas in line with Departmental priorities. This plan will ensure the nuclear deterrent supports our national security now and into the future, while simultaneously helping to achieve progress toward a world without nuclear weapons.

Sincerely,

Ernest J. Moniz

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Executive Summary

The *Fiscal Year 2016 Stockpile Stewardship and Management Plan* (SSMP) is the DOE NNSA's 25-year strategic program of record for maintaining the safety, security, and effectiveness of the nuclear stockpile. The SSMP is published annually, in response to statutory requirements, in report or summary form, to support the President's Budget submission to Congress for Weapons Activities. It is also used to provide, where possible, NNSA's formal response to other congressional reporting requirements in order to present a single, integrated picture of current and future activities funded by the Weapons Activities account in support of the nuclear deterrent. Beyond meeting these specific requirements, the document contains information, descriptions, and explanations to provide greater transparency and understanding of what the nuclear security enterprise does and how it works in support of the Nation's stockpile.

The program of record described in this year's SSMP represents a continuation of the program approved by the Nuclear Weapons Council and described in the FY 2015 SSMP, with the following significant changes:

- The W88 Alteration (Alt) 370 effort now includes a conventional high explosive (CHE) refresh and retains the original schedule for the first production unit in FY 2020.
- The cruise missile warhead life extension program (LEP) is now designated as the W80-4 LEP, following the Nuclear Weapons Council downselect among warhead families. The first production unit has also been moved ahead by two years to FY 2025 to align with revised U.S. Air Force plans for the carrier missile.
- Additional resources have been devoted to executing the plutonium strategy, which will enable cessation of programmatic operations in the Chemistry and Metallurgy Research (CMR) Building at Los Alamos National Laboratory (LANL) by FY 2019 and support the ramp-up to a war reserve production capacity of 50 to 80 plutonium pits per year by FY 2030.

Balancing the program among the near-term needs of managing the stockpile; sustainment and recapitalization of an aging infrastructure; investment in the research, development, testing, and evaluation (RDT&E) that underpins stockpile stewardship; and maintaining and refreshing the skilled workforce of NNSA's management and operating (M&O) partners continues to be difficult and requires some hard choices. One such choice NNSA made is a two year delay in the plutonium experiment capability upgrades to confirm pit reuse approaches to implement the 3+2 Strategy that will drive the future composition of the stockpile. Another tradeoff is a reduction in surveillance activities for legacy B61 and B83 warheads to support the CHE refresh in the W88.

In response to these pressures, NNSA continues to work on improving its business operating processes and tools. Many of the SSMP chapters provide descriptions of these efforts such as the Systems Integration Framework, which is intended to achieve higher technology readiness levels for warhead technologies in advance of entry into the life extension *Phase 6.x Process* (see Chapter 2). Additive Manufacturing, which holds the promise of increasing production agility and reducing production costs, is discussed in both Chapters 2 and 3. New infrastructure planning tools that make best use of the resources available for maintenance and recapitalization are described in Chapter 4. Chapter 4 also reports NNSA's assignment of managers to key mission-critical nuclear commodities to develop and oversee strategies for ensuring continued production and processing for uranium, tritium, and plutonium capabilities.

Similarly, in the spirit of improvement, greater understanding, and transparency, the FY 2016 SSMP includes new or expanded content. Chapter 2 includes a number of workload charts that display the planned workload against the nuclear security enterprise capacity as examples of the tools being used to plan NNSA's program. The description in Chapter 4 of NNSA's activities to maintain its general purpose and programmatic infrastructure has been expanded from previous SSMPs. Chapters 5 and 6 describe activities to ensure the security of the programs' physical, personnel, and information technology assets. Chapter 7, "Sustaining the Workforce," has been expanded to describe the current workforce and how it is managed in response to workload and funding changes. The associated Appendix D includes a brief primer regarding each of NNSA's M&O partners, including descriptions of their individual missions, mission capabilities, FY 2016 funding requests, physical infrastructure, and workforce composition.

NNSA has great confidence in its ability to execute the program described in this document if funded at the requested levels. The LEPs underway are on schedule and, with minor exceptions, on budget. NNSA's RDT&E programs continue to report accomplishments that demonstrate the world-class quality of the workforce. NNSA continues to work closely with the U.S. Department of Defense (DOD) through the Nuclear Weapons Council and, for the last several years, the interagency budget process to respond to changes in the stockpile and to reflect changes in DOD plans. With Congress' support, the safety, security, and effectiveness of the stockpile can be maintained, and the Nation's stewardship sustained.

Fiscal Year 2016 Stockpile Stewardship and Management Plan

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List of Acronyms and Abbreviations

3D	Three-Dimensional
AC	Analytical Chemistry
AF&F	Arming, Fuzing, and Firing
ALCM	Air-launched Cruise Missile
Alt	Alteration
ARES	Advanced Radio Enterprise System
ASC	Advanced Simulation and Computing
ATDM	Advanced Technology Development and Mitigation
CD	Critical Decision
CFF	Contained Firing Facility
CHE	Conventional High Explosive
CME	Component and Material Evaluations
CMF	Component Maturation Framework
CMR	Chemistry and Metallurgy Research
CMRR-NF	Chemistry and Metallurgy Research Replacement Nuclear Facility
CNI	Capabilities for Nuclear Intelligence
COCS	Common Occupational Classification System
CSAs	Canned Subassemblies
DANCE	Device for Advanced Neutron Capture Experiments
DARHT	Dual-Axis Radiographic Hydrodynamic Test
DNS	Defense Nuclear Security
DOD	Department of Defense
DOE	Department of Energy
DPAC	Defense Programs Advisory Committee
EMAC	Enterprise Modeling and Analysis Consortium
FFRDC	Federally Funded Research and Development Center
FIMS	Facilities and Infrastructure Management System
FTE	Full-time Equivalent
FXR	Flash X-Ray
FY	Fiscal Year
FYNSP	Future Years Nuclear Security Program
GTS	Gas Transfer System
HANM	H Area New Manufacturing Facility
HE	High Explosives
HEAF	High Explosives Applications Facility
HED	High Energy Density
HERMES	High-Energy Radiation Megavolt Electron Source
HEU	Highly Enriched Uranium

HEUMF	Highly Enriched Uranium Material Facility
HPC	High Performance Computing
ICBM	Intercontinental Ballistic Missile
ICF	Inertial Confinement Fusion Ignition and High Yield
IDC	Integrated Design Codes
IHE	Insensitive High Explosive
IT	Information Technology
ISA	Integrated Surety Architectures
ISST	Integrated Surety Solutions for Transportation
IW	Interoperable Warhead
JASPER	Joint Actinide Shock Physics Experimental Research
JC3	Joint Cybersecurity Coordination Center
JTA	Joint Test Assembly
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
LEED	Leadership in Energy and Environmental Design
LEP	Life Extension Program
LEU	Low-Enriched Uranium
LLCs	Limited Life Components
LLNL	Lawrence Livermore National Laboratory
LOB	Laboratory Operations Board
LRSO	Long Range Standoff
M&O	Management and Operating
MaRIE	Matter-Radiation Interactions in Extreme
MC	Materials Characterization
MESA	Microsystems and Engineering Sciences Applications
MDI	Mission Dependency Index
MGT	Mobile Guardian Transporter
Mod	Modification
MRL	Manufacturing Readiness Level
MTAD	Multi-application Transportation Attachment Device
MTP	Management, Technology, and Production
NDE	Non-Destructive Evaluation
NDSE	Neutron-Diagnosed Subcritical Experiments
NEA	Nuclear Enterprise Assurance
New START	New Strategic Arms Reduction Treaty
NG	Neutron Generator
NIF	National Ignition Facility
NMMSS	Nuclear Materials Management and Safeguards System
NNSA	National Nuclear Security Administration
NPAC	Office of Nonproliferation and Arms Control
NPR	Nuclear Posture Review

NSC	National Security Campus
Pantex	Pantex Plant
PCF	Predictive Capability Framework
PF-4	Plutonium Facility
PHELIX	Precision High-Energy-density Liner Implosion eXperiment
PIDAS	Perimeter Intrusion Detection and Assessment System
PPD	Presidential Policy Directive
PRIDE	Product Realization Integrated Digital Enterprise
R&D	Research and Development
RDT&E	Research, Development, Testing, and Evaluation
RLUOB	Radiological Laboratory Utility Office Building
RTBF	Readiness in Technical Base and Facilities
SAR	Selected Acquisition Report
SFIs	Significant Finding Investigations
SGT	Safeguards Transporter
SIEM	Security Information and Event Management System
SIF	Systems Integration Framework
SLBM	Submarine-Launched Ballistic Missile
SNL	Sandia National Laboratories
SNM	Special Nuclear Material
SRS	Savannah River Site
SSiFR	Sandia Silicon Fabrication Revitalization
SSMP	Stockpile Stewardship and Management Plan
STA	Secure Transportation Asset
ST&E	Science, Technology, and Engineering
STEM	Science, Technology, Engineering, and Mathematics
TA	Technical Area
TPBARs	Tritium-Producing Burnable Absorber Rods
TRIM	Tritium Responsive Infrastructure Modifications
TRL	Technology Readiness Level
U1a	U1a Complex
Y-12	Y-12 National Security Complex
Z	Z Pulsed Power Facility

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Legislative Language

The National Nuclear Security Administration (NNSA) is required to report on how it plans to maintain the nuclear weapons stockpile. Specifically, Title 50 of United States Code section 2523 (50 U.S.C. 2523), requires that "the NNSA Administrator, in consultation with the Secretary of Defense and other appropriate officials of the departments and agencies of the Federal Government, shall develop and annually update a plan for sustaining the nuclear weapons stockpile. The plan shall cover, at a minimum, "stockpile stewardship, stockpile management, stockpile surveillance, program direction, infrastructure modernization, human capital, and nuclear test readiness." Pursuant to previous statutory requirements, NNSA was required to submit reports on the plan. Except in 2012,[1] a version of the document has been submitted to Congress annually since 1998. However, starting in 2013, reports on the plan are only required every odd-numbered year, with summaries of the plan provided in even-numbered years.

The majority of the *Fiscal Year 2016 Stockpile Stewardship and Management Plan* (SSMP) is captured in a single, top-level, unclassified document. In addition, one classified Annex to the SSMP is also provided. The Annex contains supporting details concerning U.S. nuclear stockpile and stockpile management issues and describes the research, development, testing, and evaluation base for the stewardship and management of the stockpile.

[1] *In 2012, an FY 2013 SSMP was not submitted to Congress because analytic work conducted by the Department of Defense/NNSA to evaluate the out-year needs for nuclear modernization activities across the nuclear security enterprise was ongoing and not yet finalized.*

Chapter 1
Overview

Although its heritage can be traced back to the Manhattan Project in World War II, Congress established the NNSA relatively recently (in 2000) as a separately organized agency within the DOE. NNSA's mission is to enhance national security through the military application of nuclear weapons science, with responsibilities encompassing several areas:

- maintaining the safety, security, and effectiveness of the Nation's nuclear deterrent without nuclear testing;
- strengthening key science, technology, and engineering (ST&E) capabilities and modernizing the national security infrastructure;
- reducing global nuclear security threats; and
- providing safe and effective integrated nuclear propulsion systems for the U.S. Navy.

This *Fiscal Year 2016 Stockpile Stewardship and Management Plan* (SSMP) is NNSA's 25-year strategic program of record for the first and second mission areas mentioned above. The SSMP has two primary purposes. First, it documents NNSA's plans to maintain and extend the life of the nuclear stockpile and modernize the supporting infrastructure, as well as to sustain the skilled workforce. Second, it provides NNSA's formal response to statutory reporting requirements. Inclusion of detailed budget information for the FY 2016 Future Years Nuclear Security Program (FYNSP) period, along with life extension program (LEP) schedules, construction priority lists, and estimated resource requirements to FY 2040, provide the transparency to Congress and NNSA's Department of Defense (DOD) partners as it works to ensure the Nation's nuclear deterrent.

> *"Expert nuclear scientists and engineers help improve our understanding of foreign nuclear weapons activities, which is critical for managing risks on the path to zero. And, in a world with complete nuclear disarmament, a robust intellectual and physical capability would provide the ultimate insurance against nuclear break-out by an aggressor."*
>
> *- Nuclear Posture Review, 2010*

1.1 Policy Framework

A number of documents provide the policy framework for the current NNSA stockpile mission. These are the President's *National Security Strategy* (February 2015); the Nuclear Posture Review (DOD 2010); the New Strategic Arms Reduction Treaty (New START); the 2013 Presidential Policy Directive, *Nuclear Weapons Employment Guidance* (PPD-24); and the 2003 National Security Presidential Directive 28, *U.S. Nuclear Weapons Command and Control, Safety, and Security* (NSPD-28).

Drawing on the President's national security priorities, the Nuclear Posture Review outlined the following guidelines relative to maintaining a safe, secure, and effective nuclear deterrent. Though four years have passed since the Nuclear Posture Review was released, these directives still provide the foundation for the NNSA stockpile mission.

- *The United States will not conduct nuclear testing and will pursue ratification and entry into force of the Comprehensive Nuclear Test Ban Treaty.*
- *The United States will not develop new nuclear warheads. LEPs will use only nuclear components based on previously tested designs and will not support new military missions or provide for new military capabilities.*
- *The United States will study options for ensuring the safety, security, and reliability of nuclear warheads on a case-by-case basis. The full range of LEP approaches will be considered: refurbishment of existing warheads, reuse of nuclear components from different warheads, and replacement of nuclear components.*
- *In any decision to proceed to engineering development for warhead LEPs, the United States will give strong preference to options for refurbishment or reuse. Replacement of nuclear components will be undertaken only if critical Stockpile Management Program goals could not otherwise be met and if specifically authorized by the President and approved by Congress.*
- *The United States will retain the smallest possible nuclear stockpile consistent with our need to deter adversaries, reassure our allies, and hedge against technical or geopolitical surprise.*

In addition, based on the recognition that,

> *In order to remain safe, secure, and effective, the U.S. nuclear stockpile must be supported by a modern physical infrastructure – comprised of the national security laboratories and a complex of supporting facilities – and a highly capable workforce with the specialized skills needed to sustain the nuclear deterrent. As the United States reduces the numbers of nuclear weapons, the reliability of the remaining weapons in the stockpile – and the quality of the facilities needed to sustain it – become more important.*

The Nuclear Posture Review stated the need for:

- *Strengthening the science, technology, and engineering base needed for conducting weapon system LEPs, maturing advanced technologies to increase weapons surety, qualification of weapon components and certifying weapons without nuclear testing, and providing annual stockpile assessments through weapons surveillance. This includes developing and sustaining high-quality scientific staff and supporting computational and experimental capabilities.*
- *Increased investments in the nuclear infrastructure and a highly skilled workforce …to ensure the safety, security, and effectiveness of our nuclear arsenal and to support the full range of nuclear security work, to include nonproliferation, nuclear forensics, nuclear counterterrorism, emergency management, intelligence analysis, and treaty verification.*

On June 19, 2013, President Obama announced a new Presidential Policy Directive (PPD-24) that aligns U.S. nuclear policies to the 21st century security environment. The President's new guidance to the nuclear stockpile mission:

- affirmed that the United States would maintain a credible deterrent to convince its adversaries that the consequences of attacking the Nation or its allies and partners would far outweigh any potential benefit to be gained through an attack,
- modified the principles for hedging against technological or geopolitical risk to create more effective management of the stockpile, and
- reaffirmed that the United States would maintain a safe, secure, and effective deterrent for itself and its allies and partners for as long as nuclear weapons exist.

The NSPD-28, issued in June 2003, provided explicit guidance and standards on nuclear command, control, and communications and on nuclear weapons safety and security. Of particular relevance to the SSMP, NSPD-28 mandated that NNSA conduct a broad range of research and development (R&D) activities concerning the safety, security, and reliability of the stockpile. That 2003 mandate has influenced the design and production decisions for LEPs and the funding for R&D efforts.

Within NNSA, the Weapons Activities account funds specific activities, such as Stockpile Stewardship, Stockpile Management, Infrastructure, Security, and the Secure Transportation Asset (STA), that are required to support these and other policy directives. The sections in the remainder of this chapter briefly describe these activities, along with the skilled workforce necessary to accomplish the NNSA mission. These activities are then discussed in detail in the upcoming chapters.

1.2 Introduction to the Stockpile

The size and composition of the nuclear stockpile has evolved as a consequence of the global security environment and the national security needs of the United States. As of 1967, the stockpile peaked at 31,255 weapons; in September 2013, the stockpile consisted of 4,804 weapons—the smallest since the Eisenhower Administration. New START between the United States and Russia, which entered into force February 5, 2011, will reduce the operationally deployed stockpile even further by 2018.

In addition, no new nuclear weapons have been developed since the closing days of the Cold War. The average age of weapons in the stockpile is now the highest it has ever been. Weapons that were originally produced on average from 25 to 30 years ago are now well past their original design life.

While the stockpile is reduced in absolute numbers and the United States maintains the policy of no new nuclear testing or weapon designs, confidence in the existing stockpile and the effectiveness of the deterrent must remain high. For this reason, there is a strong need to continue to modernize the existing stockpile through LEPs.

The current stockpile consists of active weapons, which are maintained in an operational, ready-for-use configuration, and inactive weapons, which are maintained in a nonoperational status. A portion of the stockpile is maintained as a "hedge" to mitigate against the risk of technological surprise or unexpected geopolitical challenges. Retired weapons are not considered in the count of stockpile weapons; these are non-operational as they await dismantlement.

Table 1–1 summarizes the major characteristics of the current stockpile, which is composed of two types of submarine-launched ballistic missile (SLBM) warheads, two types of intercontinental ballistic missile (ICBM) warheads, multiple types of bombs, and a cruise missile warhead delivered by aircraft.

Table 1–1. Current U.S. nuclear weapons and associated delivery systems

Warheads—Strategic Ballistic Missile Platforms					
Type [a]	***Description***	***Delivery System***	***Laboratories***	***Mission***	***Military***
W78	Reentry vehicle warhead	Minuteman III intercontinental ballistic missile	LANL/SNL	Surface to surface	Air Force
W87	Reentry vehicle warhead	Minuteman III intercontinental ballistic missile	LLNL/SNL	Surface to surface	Air Force
W76-0/1	Reentry body warhead	Trident II D5 submarine-launched ballistic missile	LANL/SNL	Underwater to surface	Navy
W88	Reentry body warhead	Trident II D5 submarine-launched ballistic missile	LANL/SNL	Underwater to surface	Navy
Bombs—Aircraft Platforms					
B61-3/4/10	Non-strategic bomb	F-15, F-16, certified NATO aircraft	LANL/SNL	Air to surface	Air Force/Select NATO forces
B61-7	Strategic bomb	B-52 and B-2 bombers	LANL/SNL	Air to surface	Air Force
B61-11	Strategic bomb	B-2 bomber	LANL/SNL	Air to surface	Air Force
B83-1	Strategic bomb	B-52 and B-2 bombers	LLNL/SNL	Air to surface	Air Force
Warheads—Cruise Missile Platforms					
W80-1	Air-launched cruise missile strategic weapons	B-52 bomber	LLNL/SNL	Air to surface	Air Force

LANL = Los Alamos National Laboratory
LLNL = Lawrence Livermore National Laboratory
NATO = North Atlantic Treaty Organization
SNL = Sandia National Laboratories

[a] The suffix associated with each warhead or bomb type (*e.g.*, "-0/1" for the W76) represents the modification associated with the respective weapon.

1.3 Stockpile Stewardship and Management

Before 1992, developing and maintaining the nuclear deterrent was largely accomplished by a continual cycle of weapon design, weapon testing, and the incorporation of lessons learned in the next design. A critical step in this process was conducting nuclear explosive tests. From 1945 through 1992, the United States conducted 1,054 nuclear explosive tests, the majority of which tested design concepts, physics, and engineering details such as safety and radiation effects. But perhaps of equal importance, these explosive tests also tested the competence of the designers, engineers, "manufacturing plants" (now called nuclear weapons production facilities), and indeed the entire nuclear infrastructure in carrying out the mission. Since 1992, the United States has observed a self-imposed moratorium on nuclear explosive testing.

1.3.1 Stockpile Stewardship

The challenge for NNSA is maintaining confidence in the nuclear weapons in the stockpile without producing new weapons or conducting nuclear explosive tests. The solution has been to field a suite of innovative experimental platforms, diagnostic equipment, and supercomputers that build on past test data to simulate the internal dynamics of nuclear weapons. Armed with this understanding, the effects of changes to the current stockpile—through either aging or component replacement—may be modeled. This is referred to as the Stockpile Stewardship Program. A complete description of the Stockpile Stewardship Program can be found in Chapter 3, "Research, Development, Testing, and Evaluation Activities."

1.3.2 Stockpile Management

Stockpile Management is the program of surveillance, maintenance, and modernization efforts such as LEPs, alterations (Alts), and modifications (Mods) that sustain current weapons in the stockpile. That program includes the following:

- **Assessments.** Assessments determine warhead performance, safety, and reliability based on physics and engineering analyses, experiments, and computer simulations. Specific assessments may also evaluate performance deterioration caused by aging and quantify performance thresholds, uncertainties, and margins.
- **Surveillance.** Surveillance is the process whereby individual weapons undergo inspections and various tests of the overall weapon, weapon components, and materials to determine whether they are meeting performance expectations. Information collected during the surveillance process is used to support the assessment process and to inform life extension decisions.
- **Maintenance.** This process includes limited life component (LLC) exchanges, which are periodic exchanges of components as they reach the end of their lives. Tritium gas transfer systems (GTSs), neutron generators (NGs), and power sources are examples of LLCs that age and are replaced on a regular schedule.
- **Significant finding investigations (SFIs)**. These are evaluations and investigations of anomalies that are identified through experiments, assessments, surveillance, or other activities. Each SFI is evaluated to determine the impact of the anomaly on weapon performance, reliability, security, and safety.
- **Modernization:** Alts, Mods, and LEPs.
  - **Alterations (Alts)** are limited-scope changes that typically affect the assembly, testing, maintenance, and/or storage of weapons. An ALT may address identified defects and component obsolescence, but does not change a weapon's operational capabilities.
  - **Modifications (Mods)** are more comprehensive modernization programs that change the operational capabilities of the weapon. A Mod may enhance weapons' margins against failure, increase safety, improve security, extend limited life component life cycles, and/or address identified defects and component obsolescence.
  - **Life extension programs (LEPs)** are modifications that refurbish warheads by replacing aged components with the intent of extending the service life of the weapon. LEPs can extend the life of a warhead 20 to 30 years, while increasing safety, improving security, and addressing defects.
- **Dismantlement and disposition**. This is the process whereby the major components of weapons are disassembled and earmarked for reuse, storage, recycling, surveillance, or disposal.

These activities and those that directly support their performance are described in Chapter 2, "Stockpile Management."

1.4 Partnership with the Department of Defense

NNSA and DOD play critical roles in implementing the Administration's agenda for maintaining strategic stability with other major nuclear powers, deterring potential adversaries, and reassuring the Nation's allies and partners as to its national security commitments. NNSA's role is to ensure that nuclear weapons remain safe, secure, and reliable, and DOD's role is to ensure they can be delivered effectively. Their respective efforts are coordinated through the congressionally mandated Nuclear Weapons Council, which is comprised of senior officials from both organizations who work together to determine the options and priorities that shape national policies and budgets for developing, producing, and retiring both nuclear weapons and weapon delivery platforms.

In addition, the influence of the Budget Control Act of 2011 and the Bipartisan Budget Act of 2013 have generated more cooperation between DOD and NNSA in the interagency budget process. For the last several years, this annual process serves as a two-agency affirmation of the NNSA program and costs.

Since the Nuclear Posture Review was released in the spring of 2010, NNSA and DOD have worked together to develop approaches to hedge against technological and geopolitical surprise with a smaller stockpile. The resulting plan, called the 3+2 Strategy, was introduced in the FY 2014 SSMP and remains the guidance of the Nuclear Weapons Council. The 3+2 Strategy underlies the NNSA FY 2016 program of record in this report.

> *The Nuclear Posture Review reaffirmed the Nation's commitment to its Nonproliferation Treaty Article VI obligation to make progress towards nuclear disarmament.*
>
> *The 3+2 Strategy is important to that commitment: it allows the United States to minimize the number of warheads, which are a significant portion of the stockpile, and hedge against technological or geopolitical surprise by providing operational flexibility.*

Over time, as each of the 12 warhead or bomb variants within the seven deployed warhead families enters an LEP, the strategy would transition the stockpile to three interoperable ballistic missile warheads (each type would have a common nuclear explosive package and common or adaptable non-nuclear components) deployed on both the SLBM and ICBM legs of the triad and on two air-delivered warheads or bombs (see **Figure 1–1**).

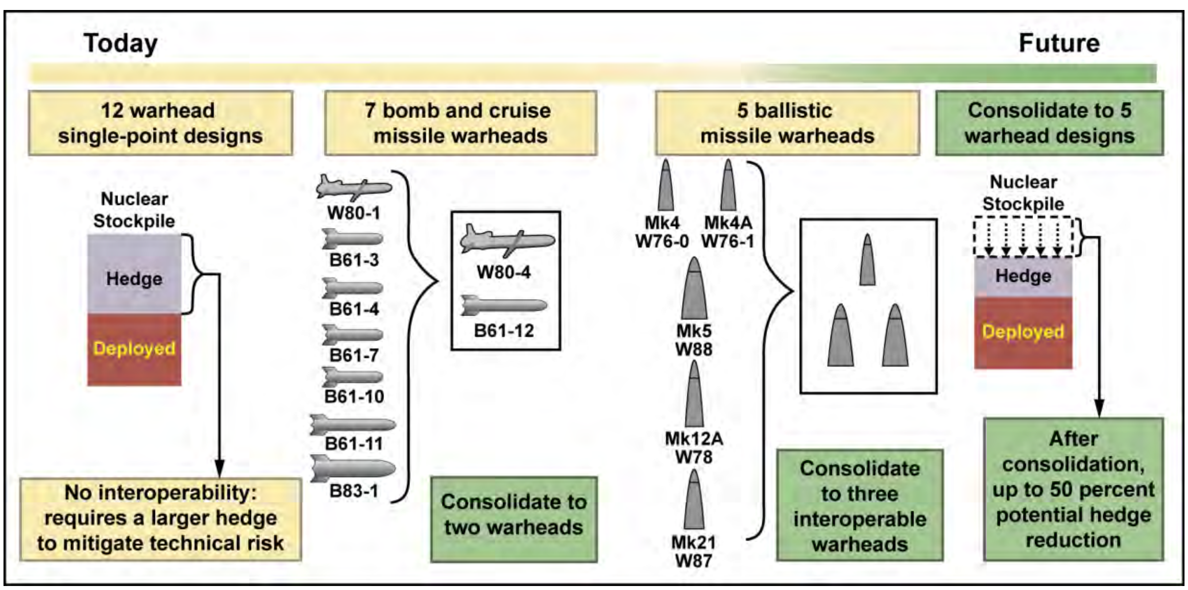

Figure 1–1. The 3+2 Strategy

The 3+2 Strategy meets military and Administration policy objectives by allowing for a smaller stockpile, increasing interoperability, and reducing the number of warhead types, while providing the flexibility required to hedge against geopolitical surprise. Because it will require decades, implementing the 3+2 Strategy requires a constant, cyclical process of testing, modernizing (*via* life extension), and replacing warheads within the active stockpile to maintain confidence not only in the reliability of each warhead, but also in its safety and security. This process is accomplished through several programs and activities conducted throughout the nuclear security enterprise, as described in the following chapters.

Modernize to Downsize – Implementing the 3+2 Strategy

The planned Stockpile Stewardship and Management activities described in this report support the President's goal of "pursuing the security of a world without nuclear weapons."[1] The W76-1 sea-based warhead is currently in production. Over half of the W76 LEP production has been completed, and the remainder will be completed by the end of FY 2019. When complete, this program will have enabled the reduction of the number of W76 warheads by a factor of two.

While the 3+2 Strategy will take 30 or more years to implement fully, implementation has begun with the B61-12 LEP. The B61-12, now nearing the end of the second year of full-scale engineering development, will enable the consolidation of four families of the B-61 bomb (the -3, -4, -7, and -10 variants) and will improve both the safety and security of the oldest weapon system in the U.S. arsenal. The B61-12 is currently scheduled for a first production unit in FY 2020. Once the B61-12 LEP is completed, following roughly a four-year build and once confidence is gained with B61-12 weapons in service, the B83—the last megaton-class weapon in America's arsenal—will be retired. The combination of these events will result in (1) a reduction in the number of bombs by a full factor of two, (2) the removal of a megaton-class weapon, (3) a reduction in special nuclear material of more than 80 percent in the bomb portion of the air leg, and (4) a reduction in the overall destructive power by a commensurate factor.

> *"As long as nuclear weapons exist, the United States must invest the resources necessary to maintain-without testing-a safe, secure, and effective nuclear deterrent that preserves strategic stability. However, reducing the threat requires us to constantly reinforce the basic bargain of the Nuclear Non-Proliferation Treaty, which commits nuclear weapons states to reduce their stockpiles while non-nuclear states remain committed to using nuclear energy only for peaceful purposes. For our part, we are reducing the role and number of nuclear weapons through New START and our own strategy."*
>
> *National Security Strategy (February 2015)*

The W88 Alt 370, a new arming, fuzing, and firing unit (AF&F) for the W88 warhead, is now in full-scale engineering development (Phase 6.3). The W88 Alt 370, an adaptable configuration, is planned to form the basis of the AF&F for the current W88 system, as well as for the current W87 arming and fuzing assembly. In November 2014, the Nuclear Weapons Council directed that the CHE main charge in the W88 weapon be replaced concurrently with the Alt 370 work.

Next, the 3+2 Strategy calls for a replacement of the current air-launched cruise missile (ALCM). In July 2014, the Nuclear Weapon Council selected the W80 nuclear package for this effort. The program, designated the W80-4 LEP, has entered Phase 6.1 (Conceptual Studies). Given the sizeable investment to develop modern non-nuclear components for the B61-12 LEP, it makes economic sense to reuse and reapply as much of that component set as possible to the ALCM replacement, or long-range stand-off

[1] *Remarks by President Obama at the Brandenburg Gate, Berlin, Germany, June 19, 2013.*

(LRSO) weapon. Current schedules within the nuclear security enterprise call for a first production unit in FY 2025 to align with a revised Air Force schedule for the missile carrier.

The first ballistic missile warhead LEP in the 3+2 Strategy is the W78/88-1 warhead. The Nuclear Weapons Council's objective for this LEP is to deploy an interoperable nuclear explosive package for use in both the Mk21A and the Mk5 SLBM aeroshells, with adaptable non-nuclear components. Hence, this LEP constitutes the first interoperable warhead (IW) option, the IW-1. Initial production for this program will be for use on Air Force ballistic missiles.

Consolidation of the present four ballistic systems into three interoperable systems will enable an eventual reduction in the number of weapons retained as a hedge against technical failure. In today's stockpile, if a technical problem is experienced in a bomb, cruise missile warhead, or ballistic warhead type, there can be a period when one of two arms in one leg of the deterrent is "out of commission" while the problem is solved. In the future, with two or three warhead types available for insertion into either ICBM or SLBM aeroshells, interleg technical hedging will be possible. When analyzed in detail, this capability can be shown to remove the need for a significant part of the technical hedge, but only when fully implemented.

In summary, when fully implemented, the 3+2 Strategy will reduce the number of weapon types, reduce the number of weapons in the deployed stockpile, simplify maintenance requirements, and reduce the number of weapons retained as a hedge against technical failure.

It is the intent of NNSA and DOD to improve the safety and security features of each weapon type and to extend the life of these weapons while not creating new nuclear weapon capabilities. In doing so, NNSA expects to sustain a highly specialized technical workforce and to develop and sustain the capabilities, the facilities, and the infrastructure essential for meeting stockpile requirements.

1.5 The Nuclear Security Enterprise

The nuclear security enterprise, also called the nuclear weapons complex, is composed of NNSA Headquarters, the NNSA field offices, nuclear weapons production facilities, national security laboratories, and the Nevada National Security Site (see **Figure 1–2**). At these locations a highly trained workforce—consisting of Federal employees, M&O contractors, and assigned members of the military—works to ensure the success of the NNSA mission. NNSA Headquarters develops the strategy and manages and coordinates activities to ensure they are being accomplished in an efficient and fiscally responsible manner.

This overview provides a brief description of the national security laboratories, nuclear weapons production facilities, and the sites, as well as some of the supporting functions funded by the Weapons Activities account, such as secure transportation and security. More information on these areas can be found in Chapter 4, "Revitalize Physical Infrastructure," Chapter 5, "Secure Transportation Asset," and Chapter 6, "Security." Additional information on the eight individual M&O sites can be found in Appendix D, "Workforce and Site-Specific Information."

Figure 1–2. The nuclear security enterprise

1.5.1 National Security Laboratories

Lawrence Livermore National Laboratory (LLNL). LLNL is one of the two national security laboratories within the nuclear security enterprise that designs the nuclear components of the Nation's weapons. The LLNL mission is to develop and sustain design, simulation, modeling, and experimental capabilities and competencies to ensure stockpile confidence without nuclear testing. LLNL is responsible for nuclear design activities in support of the B83, W80, W84, and W87 legacy systems and for nuclear design of the W78/88-1 and the cruise missile warhead LEP (recently designated the W80-4). LLNL's additional core capabilities include plutonium R&D; tritium operations and R&D; high explosives (HE) R&D; and nuclear counterterrorism and nonproliferation.

Los Alamos National Laboratory (LANL). LANL is the second of the two national security laboratories within the nuclear security enterprise that designs the nuclear components of the Nation's weapons. The LANL mission is to develop and sustain design, simulation, modeling, and experimental capabilities and competencies to ensure stockpile confidence without nuclear testing. LANL is responsible for the nuclear design and engineering of the B61, W76, W78, and W88 legacy systems, as well as the W76-1 and B61-12 LEPs. In addition, LANL provides the only fully functioning plutonium facility used for R&D and the only pit manufacturing capability within the nuclear security enterprise. LANL's additional core missions include tritium and HE R&D; detonator, power supply, and other non-nuclear component production and testing; special nuclear material (SNM) accountability, storage, protection, handling, and disposition; and nuclear counterterrorism and counterproliferation.

Sandia National Laboratories (SNL). SNL is the national security laboratory uniquely responsible for the systems engineering and integration of the nuclear weapons in the stockpile and for the design, development, qualification, sustainment, and retirement of non-nuclear components for nuclear weapons. SNL's additional core missions include neutron generator and other non-nuclear component production; HE and energetic materials R&D; counterterrorism and counterproliferation; and engineering, design, and technical systems integration for the NNSA Office of Secure Transportation.

1.5.2 Nuclear Weapons Production Facilities

National Security Campus (NSC) at Kansas City. NSC, formerly called the Kansas City Plant, is the main production site for non-nuclear weapon components. NSC manufactures and procures many of NNSA's most intricate and technically demanding components, including radar systems, mechanisms, programmers, reservoirs, joint test assemblies, engineered materials, and mechanical cases. These components make up approximately 85 percent of the elements that constitute a nuclear weapon.

Pantex Plant (Pantex). Pantex manufactures and tests HE components (the main charge and other components) and assembles, disassembles, refurbishes, repairs, maintains, and surveills stockpile weapons and weapon components; fabricates joint test assemblies and performs postmortems; assembles and disassembles test beds; conducts interim staging and storage of nuclear components from dismantled weapons; and performs pit requalification, surveillance, and packaging.

Savannah River Site (SRS). SRS supplies the radioactive hydrogen gas, tritium, for nuclear weapons. That activity, which is an integral part of the Nation's nuclear defense, has been central to the SRS mission for more than 50 years. SRS's primary mission activities include extracting tritium from irradiated target rods, managing the tritium inventory for the nuclear stockpile, loading tritium and deuterium into the GTSs of nuclear weapons, performing surveillance of GTSs to support certification of the stockpile, recovering helium-3, which is a byproduct of tritium's radioactive decay, for use in Government and commercial industry, and conducting R&D of tritium gas processing and GTSs.

Y-12 National Security Complex (Y-12). Y-12 serves as NNSA's Uranium Center of Excellence. Y-12 manufactures uranium components for nuclear weapons, cases, and other nuclear weapons components and evaluates and tests these components for surveillance purposes. In addition, Y-12 serves as the main storage facility for Category I/II quantities of highly enriched uranium (HEU); conducts dismantlement, storage, and disposition of HEU; and supplies HEU for use in naval reactors.

1.5.3 Nevada National Security Site

The primary mission of the Nevada National Security Site is to provide facilities, infrastructure, and personnel that the national security laboratories and other organizations can use to conduct nuclear and non-nuclear experiments essential to maintaining the stockpile. It is the primary location within the nuclear security enterprise where experiments using radiological and other high-hazard materials are conducted. It is the only location where HE-driven plutonium experiments can be conducted. Additional mission areas include development and deployment of state-of-the-art diagnostics and instrumentation, data analysis, storage of programmatic materials, conduct of criticality experiments, counterterrorism, and counterproliferation.

1.6 Secure Transportation

STA provides safe, secure transport of nuclear weapons, weapons components, and SNM for the nuclear security enterprise. STA supports LEPs, LLC exchanges, surveillance, dismantlement, nonproliferation initiatives, and experimental programs for the NNSA mission. STA also provides secure transport for DOD and other Government agencies on a reimbursable basis.

1.7 Security of the Nuclear Security Enterprise

Two NNSA programs ensure the security of the Nation's nuclear materials, infrastructure, workforce, and sensitive information. These are the Defense Nuclear Security (DNS) Program and the Information Technology and Cybersecurity Program. DNS ensures protection, control, and accountability of nuclear materials, as well as the physical security of NNSA's sites and the personnel security of its workforce. Information Technology and Cybersecurity ensures protection of classified and sensitive information about the Nation's nuclear weapons stockpile and sensitive information about the men and women who are the stewards of that stockpile.

1.8 Federal and Contractor Workforce

Underpinning the nuclear security enterprise is a highly skilled and diverse workforce comprised of Federal employees, management and operating contractors, and assigned members of the military. The future of the nuclear security enterprise depends on a skilled and diverse workforce with experience across a broad array of science, technology, engineering, and manufacturing expertise. NNSA employs many of the top scientists and engineers in the United States because of the cutting edge nature of the work to support the nuclear weapons stockpile. Maintaining, refreshing, and developing people in essential areas of expertise are critical to ensuring the integrity of the nuclear deterrent well into the future. These activities are documented in Chapter 7, "Sustaining the Workforce."

1.9 Budgetary Requirements and Business Processes and Procedures

The FY 2016 SSMP documents NNSA's strategic 25-year program of record for maintaining the safety, security, and effectiveness of the Nation's nuclear weapons stockpile. It describes the primary activities funded by the Weapons Activities account. Detailed budget information for the FY 2016 FYNSP, as well as the forecasted requirements out to FY 2040, is in Chapter 8, "Future Years Nuclear Security Program Budget, Requirements Estimates, and Operations and Business Improvements."

1.10 Additional Information

The conclusions to the FY 2016 SSMP are in Chapter 9; additional information can be found in the four appendices and in an accompanying classified Annex.

The FY 2016 SSMP consolidates a number of statutory reporting requirements and related congressional requests. Title 50 U.S.C. 2523 requires that NNSA develop and annually update a plan for sustaining the nuclear weapons stockpile; that plan is required to cover, at a minimum, stockpile stewardship, stockpile management, stockpile surveillance, program direction, infrastructure modernization, human capital, and nuclear test readiness. Appendix A, "Requirements Mapping," provides a comprehensive list of the reporting requirements that this report satisfies and indicates the chapters and sections in the FY 2016 SSMP that relate to those requirements. Appendix B, "Research, Development, Testing, and Evaluation Subprograms," contains detailed information about the subprograms that support activities related to stockpile stewardship. Appendix C, "Exascale Computing," provides information about the strategy to acquire advanced high performance computing technologies to support stockpile stewardship. Appendix D, "Workforce and Site-Specific Information," contains detailed information about NNSA's individual M&O partners, as well as each one's workforce. Appendix E, "Glossary," contains definitions for terms that may provide clarification.

The three chapters and two appendices in the classified Annex provide extensive details about key elements of nuclear weapons. Those chapters form a companion set to Chapters 2 and 3 in the FY 2016 SSMP, as well as to this chapter.

Chapter 2
Stockpile Management

Stockpile management encompasses the activities of the Directed Stockpile Work Program. These include assessment, surveillance, and maintenance of active weapons in the stockpile, LEPs, and dismantlement and disposition of retired weapons, as well as plans for preserving the capabilities to accomplish these efforts. Chapter 2 presents an overview of these activities. In conjunction with Chapter 2 in the classified Annex, this chapter also provides an overview of the Nation's stockpile in terms of weapon types, quantities, and age. It also presents the plans for weapon maintenance and life extension of specific weapons systems during the next 25 years, while reducing the stockpile size and enhancing safety and security features.

FY 2014 Stockpile Management Accomplishments

- *Selected warhead family (W80) for next cruise missile warhead.*
- *Tested B61-12 system design in flight and ground environments.*
- *Selected nuclear explosive package for first interoperable warhead.*
- *Completed full recovery of FY 2013 production shortfall for W76-1 LEP; exceeded FY 2014 production baseline, achieving halfway point in production in September 2014.*
- *Exceeded targets for warhead disposition at Pantex and canned subassembly dismantlement at Y-12 by more than 5 percent.*

2.1 Introduction

Chapter 1 describes the policy framework for the Nation's nuclear weapon stockpile. NNSA's Stockpile Management satisfies many of these policy requirements through various specialized activities. The overall state of the stockpile is determined through annual cycles of surveillance activities; discovered anomalies in the stockpile are managed through the Surveillance Program. In addition to determining the status of the stockpile, NNSA works with DOD to perform regular required maintenance of stockpile weapons. Finally, informed by surveillance activities and enabled through technology maturation, a weapon type or family may be modernized through an Alt or Mod, either of which can be executed *via* an LEP. In general, these life extension activities offer opportunities to improve the safety and security of stockpile weapons. As per the 2010 Nuclear Posture Review, LEPs do not support new military missions or provide for new military capabilities. LEPs are based on refurbishment or reuse; any replacement of nuclear components required the authorization of the President and approval by Congress.

The B61 family of bombs is the oldest in the stockpile. An LEP is well underway to add 20 more years of life, consolidate four of the existing five bomb variants (leaving only two), reduce the amount of SNM in deployed weapons, and still meet all military requirements. The resulting bomb will be the B61-12.

2.1.1 Surveillance

NNSA's Surveillance Program provides data to evaluate the condition of the stockpile in support of annual assessments of reliability, safety, security, and performance. In addition, the cumulative body of surveillance data supports decisions regarding weapon alterations, weapon modifications, repairs and rebuilds, and life extensions. The Surveillance Program has the following goals:

- Identify defects (*e.g.*, manufacturing and design defects) affecting safety, security, performance, or reliability.
- Calculate margins between design requirements and performance at the component and material levels.
- Identify aging-related changes and trends at the component and material levels.
- Further develop the capabilities for predictive assessments of stockpile components and materials.
- Provide critical data for the semi-annual Weapons Reliability Report and the annual Report on Stockpile Assessment.

The Surveillance Program is comprised of two elements: the Stockpile Evaluation Program and the Enhanced Surveillance subprogram within the Engineering Program. The Stockpile Evaluation Program is mostly funded within Directed Stockpile Work by both Stockpile Systems and Stockpile Services. It conducts surveillance evaluations of both the existing stockpile (stockpile returns) and new production (*i.e.*, Retrofit Evaluation System Test units). The Enhanced Surveillance subprogram provides diagnostics, processes, and other tools to the Stockpile Evaluation Program to enable prediction and detection of initial or age-related defects, reliability assessments, and component and system lifetime estimates. These two program elements work closely together to execute the current Surveillance Program and develop new surveillance capabilities at the system, component, and material levels.

System-level tests occur jointly with the Air Force or Navy and use either existing weapons or "new production" units, which are modified into Joint Test Assemblies (JTAs). Some JTAs contain extensive telemetry instrumentation, while others contain high-fidelity mock nuclear assemblies to recreate as closely as possible the mass properties of war reserve weapons. These JTAs are flown on the respective DOD delivery platform to gather the requisite information to assess the effectiveness and reliability of both the weapon and the launch or delivery platform and the associated crews and procedures. Stockpile laboratory tests conducted at the component level assess major assemblies and components and, ultimately, the materials that compose the components (*e.g.*, metals, plastics, ceramics, foams, and explosives). This surveillance process enables detection and evaluation of aging trends and anomalous changes at the component or material level.

The following provides a more detailed description of the stockpile evaluation elements:

- **Disassembly and inspection**. Weapons sampled from the production lines or returned from DOD are inspected during disassembly. Weapon disassembly is conducted in a controlled manner to identify any abnormal conditions and preserve the components for subsequent evaluations. Visual inspections during dismantlement can also provide state-of-health information.
- **Flight testing.** After disassembly and inspection, selected weapons are reconfigured into JTAs and rebuilt to represent the original build to the extent possible. However, all SNM components are replaced with either surrogate materials or instrumentation. The JTA units are flown by the DOD operational command responsible for the system. JTA configurations vary from high-

fidelity units that essentially have no onboard diagnostics to fully instrumented units that provide detailed information on component and subsystem performance.

- **Stockpile laboratory testing.** Test bed configurations are built to enable prescribed function testing of single parts or subsystems using parent unit hardware from stockpile weapon returns. The majority of this testing occurs at the Weapons Evaluation Test Laboratory, which is operated by SNL at Pantex and involves electrical and mechanical testing of the systems. The Air Force's Joint Interface Laboratory Test facility at Hill Air Force Base in Utah also conducts evaluations of joint test beds to obtain information regarding delivery platform-weapon interfaces.
- **Component testing and material evaluation.** Components and materials from the disassembly and inspection process undergo further evaluations to assess component functionality, performance margins and trends, material behavior, and aging characteristics. The testing can involve both nondestructive evaluation techniques (*e.g.*, radiography, ultrasonic testing, and dimensional measurements) and destructive evaluation techniques (*e.g.*, tests of material strength and explosive performance, as well as chemical assessments).

The number of disassembly and inspections and major component tests completed in FY 2014 and planned for FY 2015 are shown in **Table 2–1**.

Table 2–1. Fiscal year 2014 actual and fiscal year 2015 projected major Directed Stockpile Work Program stockpile evaluation activities (as of January 31, 2015)

Warheads	D&Is		JTA Flights		Test Bed Evaluations		Pit NDE		Pit D-Tests		CSA NDE		CSA D-Tests		GTS Tests		DCA Tests		Program Totals	
	Fiscal Year																			
	14	15	14	15	14	15	14	15	14	15	14	15	14	15	14	15	14	15	14	15
B61	12	17	8	7	3	3	27	32	0	1	4	6	5	4	2	8	15	20	91	102
W76-0	10	4	3	0	0	4	13	14	0	0	6	14	0	2	13	10	5	7	62	61
W76-1	22	25	6	3	22	17	38	45	0	1	0	7	5	3	7	10	4	19	120	140
W78	11	6	1	2	0	9	49	12	0	1	7	9	2	2	9	8	8	9	96	61
W80-0/1	13	9	4	4	2	2	19	28	0	0	0	2	0	2	3	8	8	0	53	59
B83	4	4	2	2	2	2	56	36	0	2	0	0	1	2	24	17	8	4	103	71
W87	9	10	1	2	10	15	11	16	1	1	0	1	2	2	7	11	4	4	48	63
W88	10	7	5	5	0	4	13	12	0	1	1	1	1	1	18	12	7	7	63	54
Totals	**91**	**82**	**30**	**23**	**39**	**56**	**226**	**195**	**1***	**7**	**18**	**40**	**16**	**18**	**83**	**84**	**59**	**70**	**636**	**611**

CSA = canned subassembly
D&I = disassembly and inspection
DCA = detonator cable assembly
D-tests = destructive tests
GTS = gas transfer system
JTA = Joint Test Assembly
NDE = nondestructive evaluation

*A pause in plutonium operations in PF-4 has caused postponement of most FY 2013 through FY 2015 pit D-test requirements.

Table 2–2 shows planned Directed Stockpile Work Program stockpile evaluation activities for FY 2015 through FY 2020. This table is based on the assessment requirements of the stockpile today and will evolve as updated information is processed and new diagnostics are deployed.

Table 2–2. Major surveillance evaluations completed in FY 2014 and planned for FY 2015, as well as planning requirements for the Future Years Nuclear Security Program (FYs 2016 through 2020) (as of January 31, 2015)

Major Activity	FY 2014 Actual	FY 2015 Plan	FY 2016 Requirements	FY 2017 Requirements	FY 2018 Requirements	FY 2019 Requirements	FY 2020 Requirements	FYNSP Total [a]
D&I	91	82	69	77	71	73	81	453
JTA Flight	30	25	30	27	27	28	27	164
Test Bed Evaluation	39	56	52	58	44	51	54	315
Pit NDE	226	195	235	284	272	257	150	1,393
Pit D-Test	1	7	8	7	5	6	7	40
CSA NDE	18	40	42	49	42	49	42	264
CSA D-Tests	16	18	15	15	16	15	14	93
DCA Test	59	70	91	68	110	64	81	484
GTS Tests	83	84	88	72	71	73	72	460
HE D-Tests [b]	33	34	38	38	38	34	34	216
TOTALS	**638**	**582**	**702**	**742**	**743**	**673**	**607**	**3,467**

CSA = canned subassembly
D&I = disassembly and inspection
DCA = detonator cable assembly
D-Tests = destructive tests
FY = fiscal year
FYNSP = Future Years Nuclear Security Program
GTS = gas transfer system
HE = high explosives
JTA = Joint Test Assembly
NDE = nondestructive evaluation

Notes:

[a] FYNSP-forecasted quantities do not reflect reductions that may result from the lowering of stockpile readiness proposed for certain weapons.

[b] Beginning in FY 2015, HE D-Tests are being counted as a Major Activity.

Surveillance requirements, as determined by the national security laboratories for the weapon systems, in conjunction with the Air Force and Navy for joint testing, result in defined experiments to acquire the data that support the Surveillance Program. The national security laboratories, in conjunction with NNSA and the nuclear weapons production facilities, continually refine these requirements, based on new surveillance information, annual assessment findings, and analysis (or reanalysis) of historical information using modern assessment methodologies and computational tools. An agile and continuous cycle of surveillance, as depicted in **Figure 2–1,** provides the flexibility for adjusting program priorities to address critical issues. Key outcomes of this process include:

- collections of data to quantify performance margins,
- identification of knowledge gaps in NNSA's understanding of stockpile health,
- technology updates,
- establishment of priorities among competing surveillance activities, and
- continuous improvement of surveillance processes.

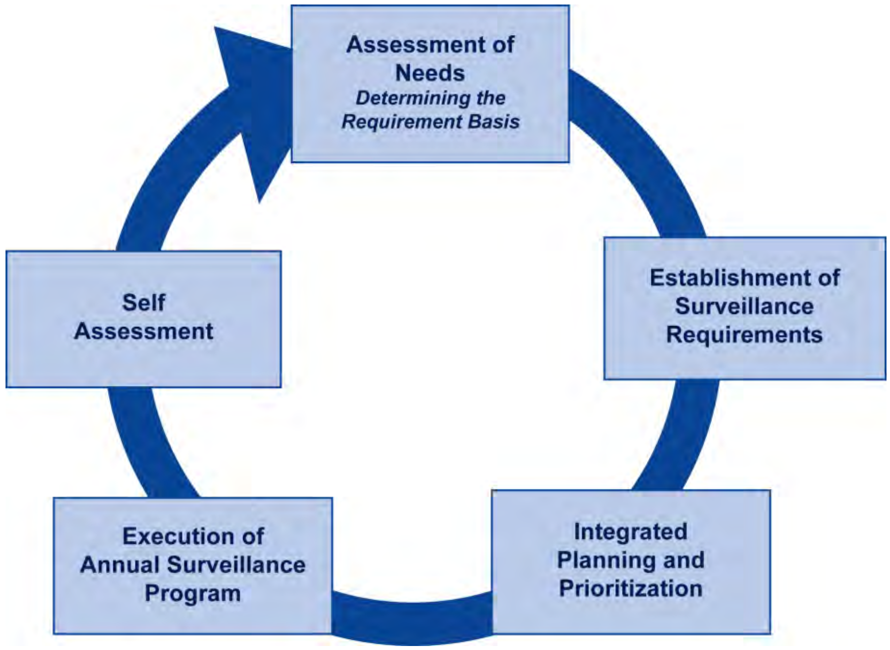

Figure 2–1. Continuous cycle of Surveillance Program activities

NNSA instituted the nuclear weapons surveillance governance model to ensure rigor in planning and execution (see **Figure 2–2**). Under this governance model, a Senior Technical Advisor for Surveillance manages and integrates all elements of the Surveillance Program and reports directly to the Assistant Deputy Administrator for Stockpile Management. The Senior Technical Advisor for Surveillance ensures:

- key activities are coordinated so that the most appropriate diagnostics are developed and used for surveillance evaluations,
- system-specific surveillance requirements are up to date and achieve a balance in priorities, and
- all systems requirements are integrated into an executable plan.

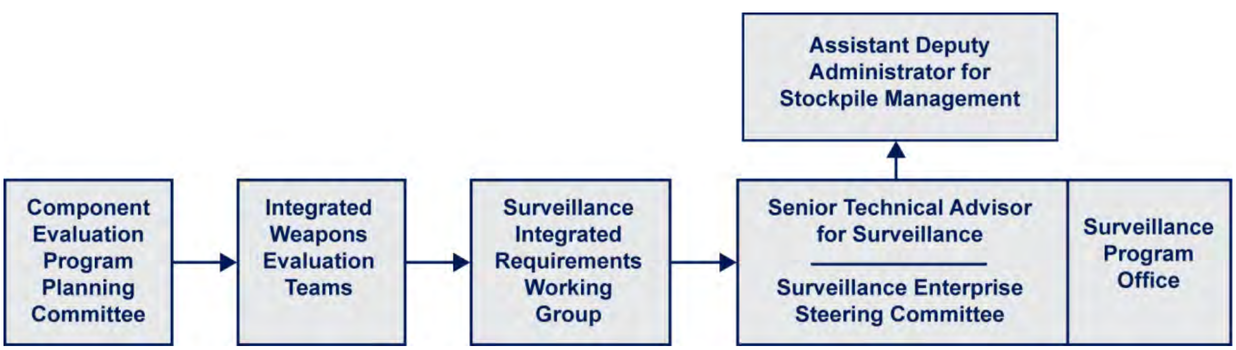

Figure 2–2. Nuclear weapons stockpile surveillance governance model

This approach forms an annual surveillance schedule and ensures that requirements are defined and communicated to the nuclear security enterprise and appropriate resources are available. The plan includes proposed schedules and funding throughout the FYNSP. Furthermore, the integration of all surveillance elements ensures that emerging issues and aging characterization will be addressed using the most cost-efficient and effective diagnostics.

Near-term surveillance activities include the following:

- Continue to use new and improved component and material evaluation (CME) tests as part of the Stockpile Evaluation Program.
- Meet priority stockpile surveillance commitments.
- Continue installing and testing equipment to double NNSA's capacity for high-resolution, computed tomography of pits.
- Continue to use advanced nondestructive evaluation techniques (*e.g.*, laser gas sampling).
- Develop and deploy methods to make surveillance data available for national security laboratories and nuclear weapons production facility stakeholders.
- Initiate process improvements identified by the Surveillance Community to increase efficiency.
- Begin to implement additional surveillance metrics that assess the state of the Surveillance Program and identify and prioritize the additional information needed to address shortcomings.

The following long-term and ongoing activities are related to surveillance:

- Continue assessment of recent and historical test data to compare the state of each stockpile weapon with its original certified design and inform future surveillance and LEP planning.
- Improve and extend aging models for all major materials and components at risk.
- Improve, extend, and deploy improved surveillance diagnostics in order to replace and augment destructive techniques with advanced nondestructive evaluation techniques.
- Adjust the program to handle stockpile commonality and develop, improve, and extend capabilities to augment flight testing.

2.1.2 Significant Finding Investigations

The B61 family of bombs has more SFIs than any other warhead family. SFIs were a significant factor in justifying the need for the B61-12 LEP.

SFIs are conducted when anomalies that can significantly affect safety, security, reliability, or performance are discovered during surveillance or are identified during numerous activities, including weapons production, DOD operations, reacceptance and rebuild, and dismantlement. The SFI process includes determining the cause; ascertaining the impact on weapon system performance, reliability, security, and safety; and developing any recommended corrective actions. A tracking and reporting system monitors progress from the initial discovery of an anomaly through its closure report, as well as the status of any corrective actions. The closure report identifies the assessed impacts, if any, and provides recommendations for follow-on activities. In addition, a prioritization process ensures that the most serious and oldest SFIs are receiving appropriate resources. Depending on its nature, an SFI may be resolved solely as part of Stockpile Management, or a broader evaluation scope may be required that includes experiments, advanced code analysis, *etc.,* as well as the participation of Research, Development, Testing, and Evaluation (RDT&E) experts. Most SFIs are closed out without impact to the stockpile. Some impacts involve only a subpopulation of a particular stockpile system, which may result in a minor, acceptable reduction in reliability. If the finding has a significant impact, it can result in a change to the reported reliability, *e.g.,* the issuance of an exception to the Major Assembly Release until appropriate remedial action, such as an Alt, Mod, or LEP.

Figure 2–3 shows the total number of SFIs opened and closed during calendar years 2001 to 2014 and the number that resulted in an impact to the stockpile. The variation in the number of SFIs opened during these years is a result of many factors including:

- the number of surveillance evaluations conducted,
- the pending LEP activities in which additional warheads were evaluated,
- the use of improved diagnostics to identify additional areas of concern, and
- DOD activities conducted during the period of interest.

To ensure that any issue that may affect system performance, safety, security, or reliability is identified, the threshold for the initial assessment of an anomaly is set intentionally low. Once notified of an anomaly by the nuclear weapons production facility, the national security laboratory has 15 days to disposition (close or promote) the anomaly. If promoted, the anomaly status changes to a Significant Finding Notification, and investigation continues for up to another 45 working days. At the end of that period, the national security laboratory dispositions the Significant Finding Notification by either closing it or by opening a formal SFI.

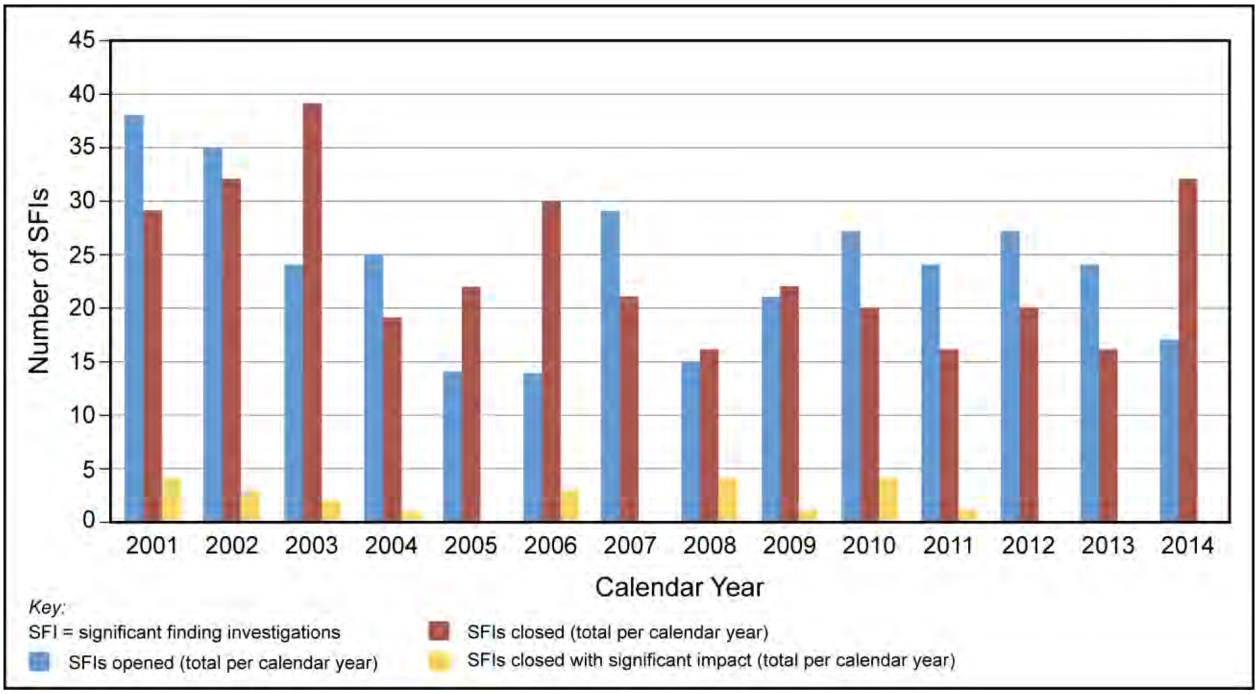

Figure 2–3. Historical number of Significant Finding Investigations opened and closed during calendar years 2001 to 2014 and the number that resulted in an impact to the stockpile

2.1.3 Maintenance

> *The B61-12 is designed to have much less frequent LLC exchanges than the Mods it replaces (B61-3, -4, -7, and -10).*

A number of nuclear warhead components (*e.g.*, tritium GTSs, NGs, and power sources) require periodic replacement to sustain system functionality. NNSA and DOD jointly manage delivery and installation of replacements before warhead performance or personnel safety is adversely affected. Typically, GTSs are replaced in the field at the respective DOD weapon maintenance facility; however, more-invasive LLC exchanges may require returning the warhead to Pantex to complete maintenance activities. In addition to LLC exchanges, maintenance includes certain minor alterations to stockpile weapons to address specific concerns that do not rise to the level of a system modification or an LEP activity. These minor alterations respond to an emerging issue and are addressed on a priority basis, depending on stockpile impact. Unlike LLC activities, alterations are scheduled on an as-needed basis.

Current or ongoing maintenance activities include the following:

- Support NG production at a rate of 700 to 1,000 generators per year from FY 2016 to FY 2020. (The change from the FY 2015 SSMP was directed in the applicable Program Control Document because of increased uncertainty in specific requirements for the out-years.)
- Support ongoing NG replacements on the W76-1, W87, and W78 warheads as well as planned replacements on the W80-1 and W88 warheads and B61 bombs. (The NG production schedule is in the classified Annex in Chapter 2.)
- Complete the first production unit for the W87 GTS (Alt 360) by FY 2019.
- Complete the first production unit for the 3rd generation W88 GTS by FY 2019.
- Mature the technologies to support on-time delivery of all LLC exchanges (*e.g.*, GTSs and electronic NGs).

2.1.4 Life Extension Programs

Weapon systems are being maintained well beyond their original design lifetime. As these systems age, NNSA continues to detect anomalies that may ultimately degrade performance of some nuclear weapons to unacceptable levels.

> *The B61-12 LEP includes refurbishment of both the nuclear and non-nuclear components to address aging, assure extended service life, and improve the bomb's safety, effectiveness, and security. With the addition of new Air Force components, the LEP will consolidate and replace the B61-3 -4,-7, and -10 bombs.*

The drivers for life extension activities are addressing aging and performance issues, enhancing safety features, and improving security, while meeting strategic deterrence requirements with a reduced stockpile size and retaining reliability and improving performance margins. Additional goals are to reduce, to the extent possible, materials that are hazardous, costly to manufacture, degrade prematurely, or react with other materials in a manner that affects performance, safety, or security. For example, when feasible, insensitive high explosives (IHE) will replace CHE to improve safety, security, use control, and production efficiency. A well-planned and well-executed stockpile life extension strategy will improve safety and security, while enabling DOD to implement a deployment and hedge strategy consistent with the Administration's goal of a smaller, yet still effective, deterrent. In addition, because of production constraints, NNSA is pursuing both refurbished and reused components from legacy systems, as described in the Nuclear Posture Review (DOD 2010). Changing materials, using components from legacy systems in new LEPs, and remanufacturing legacy component designs present significant challenges to today's stockpile stewards, as outlined below.

- **System Certification.** The ability to certify designs that include new or updated material combinations or surety features is a challenge for stockpile life extension programs in the absence of underground testing. The Stockpile Stewardship Program, established in 1994, develops computational, modeling and experimental capabilities that enable certification of modernized weapon components and architectures. In recognition of the importance of system certification for life extension programs, the national security laboratories developed the

Predictive Capability Framework (PCF) to increase the focus for primary and secondary physics, weapon engineering, and surety activities. This is discussed further in Chapter 3, Section 3.4.2.

- **Nuclear Components – Pits and Canned Subassemblies (CSAs)**. Stockpile life extension approaches may include nuclear component refurbishments, remanufacturing, and reuse to extend the life of the weapon system and allow for modern surety architectures. As part of life extension, the ability to certify the resulting nuclear package and any associated weapon changes is key to providing optimal design options for LEPs. Fundamental understanding of physics package interactions has significantly improved over the last decade because of greater computing power, advanced simulations, and enhanced laboratory experiments. These capabilities have allowed NNSA to consider a much broader range of LEP options than previously possible. These improvements support the ability to certify to pertinent environments. See Chapter 3 for further details about the RDT&E activities that underpin these advanced assessment processes.
- **Non-Nuclear Components**. Many non-nuclear components today use legacy technologies that are more than 35 years old and have not been supported for many years. Moreover, future LEPs must address new safety and security objectives that are not achievable in many older designs because of component size or weight restrictions with currently available technologies. Using the Component Maturation Framework (CMF), as discussed in Section 2.2.2 below, NNSA has identified the key required technologies and components to transform the stockpile over the next two decades. NNSA is establishing plans to mature these technologies sufficiently in advance of planned insertion points to cost-effectively minimize risk. The CMF provides the path to address the issues identified in the *Technical Basis for Stockpile Transformation Planning*, as discussed in Section 2.2.1 below.

2.1.4.1 Life Extension Program Planning and Execution Process

LEP planning is a joint NNSA and DOD process to balance a number of goals, objectives, and constraints. Key to this process is preventing any operational gaps in the Nation's nuclear deterrence, while enhancing the safety, security, use control, and reliability of the stockpile by selectively integrating new, appropriately mature, and cost-effective technologies. Furthermore, consistent with the Nuclear Posture Review (DOD 2010), LEP activities support reduction in warhead types and stockpile size by formulating options for IWs[1] that could be flexibly deployed across different delivery platforms, along with balancing the number of warheads carried on each of the ballistic missile systems. The objectives essential to the long-term sustainability of the nuclear security enterprise include the following:

- Sustain a highly specialized workforce for nuclear warhead design and manufacturing.
- Mature and insert modern technologies to improve safety and security.
- Maintain a robust supply chain to meet DOD requirements.
- Improve responsiveness to mitigate geopolitical surprise and the risk of operational gaps.
- Enable multiple, concurrent design and manufacturing LEP activities through sustainable steady-state operations.

[1] *IWs are warheads with a common nuclear explosives package integrated with non-nuclear systems that maximize the use of common and adaptable components. IWs can be deployed on multiple delivery platforms.*

In addition to these goals and objectives, the following critical constraints must be addressed:

- Deliver warheads to DOD on schedule.
- Execute LEPs within budget.
- Manage production capabilities, primarily related to pits, CSAs, and non-nuclear components, while undergoing significant facility revitalization to maintain adequate production capacity and throughput.
- Maintain a robust RDT&E program to ensure capabilities are available to certify the aging stockpile without nuclear testing and to mature technologies and components for insertion into the stockpile.

NNSA manages the LEP planning and execution process by implementing the *NNSA Supplemental Directive 452.3-1 Defense Programs Business Requirements and Processes Manual*. The Federal requirements for the phase-gate product realization process are described in R001, *"*Product Realization*,"* and the *Phase 6.x Process* is described in R006, "*6.x Process.*" R006 complies with the original seven-phase Joint Nuclear Weapons Life Cycle Process that covers the phases of a weapon's life from initial feasibility studies through development, production, deployment, and retirement. Phase 6 encompasses production, maintenance, and evaluation of the stockpile. The 6.x phases (*i.e.,* Phases 6.1 through 6.6) are "mirror images" of Phases 1 through 6 and are conducted for a warhead or bomb in Phase 6 of its life cycle. The *Phase 6.x Process* is focused on life extension of the system and improvements to safety, security, and use control. DOD's Deputy Assistant Secretary of Defense for Nuclear Matters is finalizing the results of an interagency effort to update the shared description of the *6.x Process*. When the update has been completed, NNSA will review and possibly modify the Federal requirements in both R001 and R006 to ensure continued compliance.

As mentioned here, NNSA issued R001 and R006 to improve the effectiveness of the *Phase 6.x Process* by establishing a systems engineering, risk-informed approach. The Product Realization Process uses a standard set of deliverables and reviews (*i.e.*, phase gates) to advance to the next stage of product development. This process ensures that issues and risks are addressed at the earliest possible time and all key product stakeholders agree to proceed to the next stage of LEP development. Creating standard gate checklists also provides consistency and a roadmap for future stockpile stewards to follow in the product development life cycle. Product Realization Process requirements overlay on the LEP planning and execution activities. **Figure 2–4** shows the integration of the *6.x Process* with the major gate reviews required by the Product Realization Process through Phase 6.5. Subsequently, the LEP system enters full-scale production (Phase 6.6). A revised *6.x Process* with updated gate reviews is in development to refine the process further and improve the alignment of deliverables to the various gates.

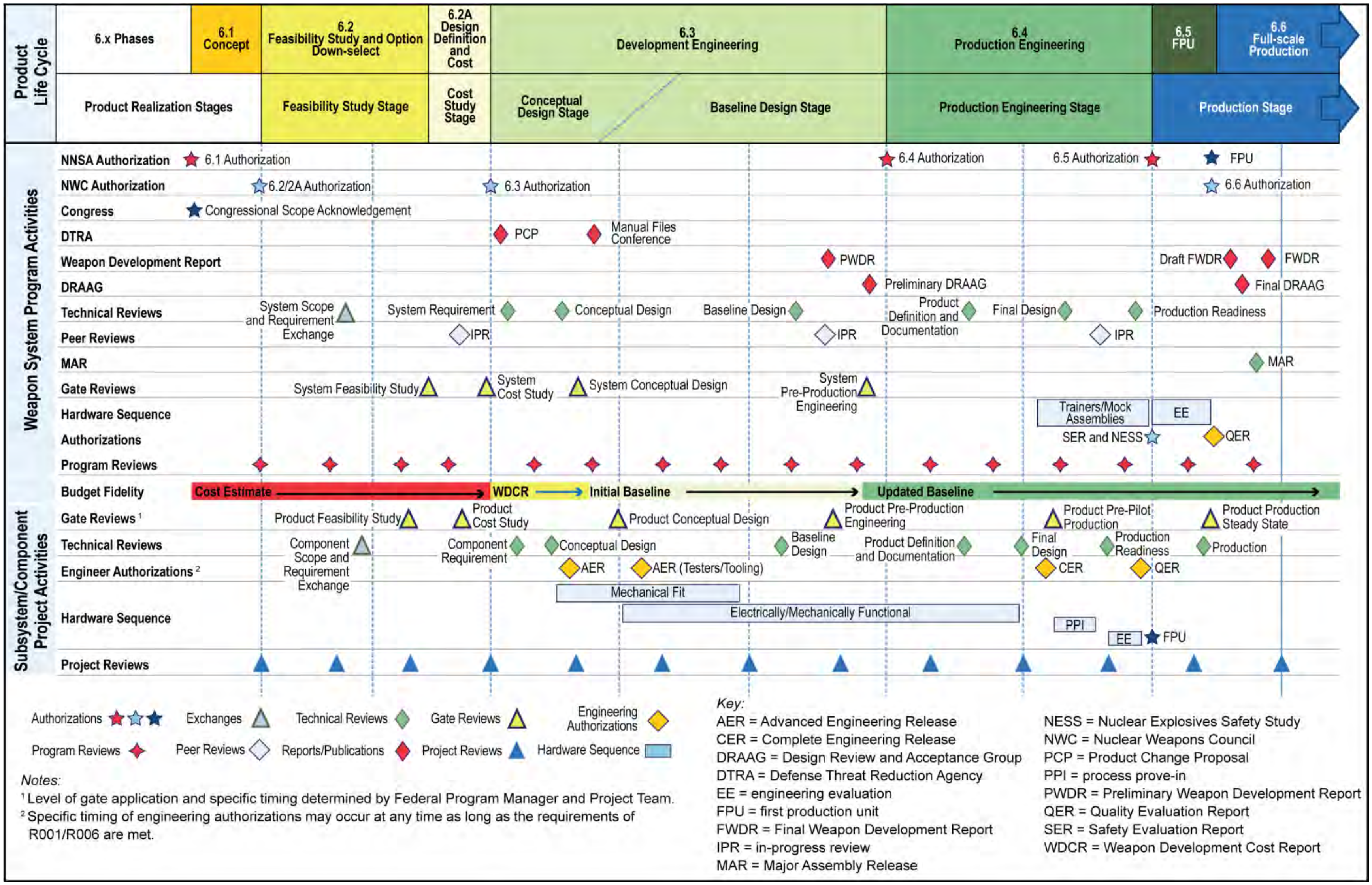

Figure 2–4. Schematic of *6.x Process* integrated with key gate reviews required by the Product Realization Process

2.1.4.2 Baseline Life Extension Program Plan

The Baseline Life Extension Plan has been approved by the Nuclear Weapons Council and was developed in coordination with DOD; changes to the plan will be coordinated with DOD. An overview of that plan is described in Section 2.3.

NNSA's current baseline plan contains gaps in production activity and potential workforce management issues that would result from those gaps. The plan will likely change at least annually because of funding impacts, but the need to anticipate and mitigate manufacturing gaps wherever they appear is an important part of the planning and management responsibility. Among the methods that may be used to manage production gaps are building components ahead of schedule, assembling complete units ahead of schedule, extending production schedules, or rescheduling work that competes for resources (*e.g.*, dismantlement).

The Enterprise Modeling and Analysis Consortium (EMAC) provides plant throughput information to help decision-makers assess the feasibility of proposed changes to the Baseline Life Extension Plan. EMAC provides a broad range of decision-making support by analyzing nuclear weapon enterprise capabilities and capacities and the infrastructure life-cycle planning associated with stockpile management alternatives. EMAC activities assist senior leaders within NNSA to understand and evaluate alternative pathways to meet deterrence objectives.

The four figures below (**Figures 2–5** through **2–8**) are examples of the tools NNSA uses for capacity and resource planning. These figures depict the planning for the projected workloads of various product lines before any mitigation strategies are applied. Workload uncertainty in the figures is caused by variability in the scope and schedule for system elements. The data are used to develop mitigation strategies for optimal site and nuclear security enterprise output.

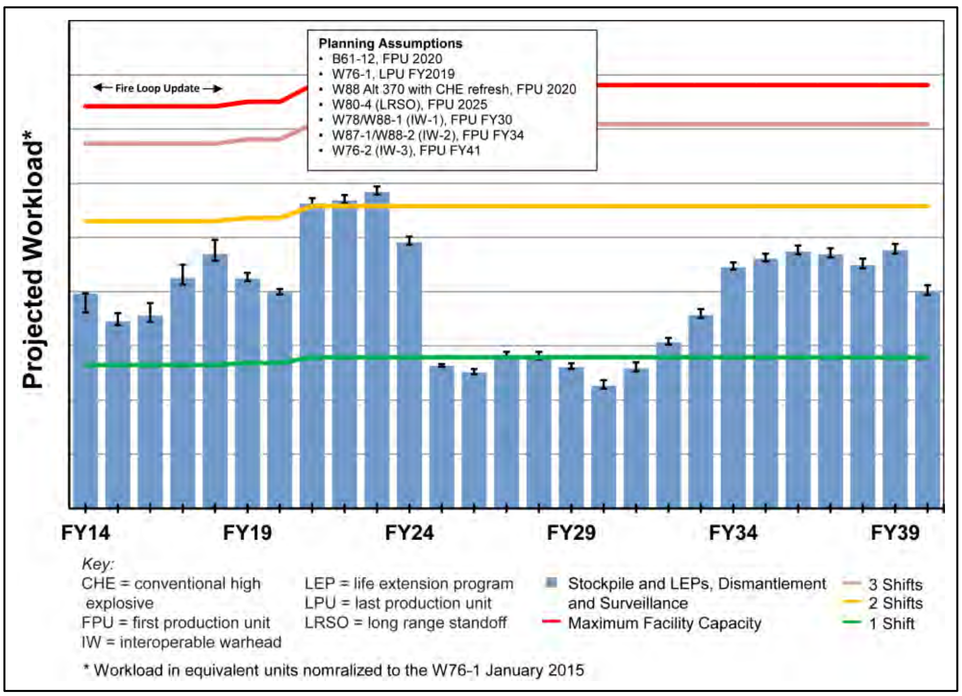

Figure 2–5. Weapon assembly and disassembly – notional projected workloads for the Pantex Plant[2]

[2] *By planning workloads across all areas at Pantex, NNSA intends to avoid a significant gap in dismantlement activities.*

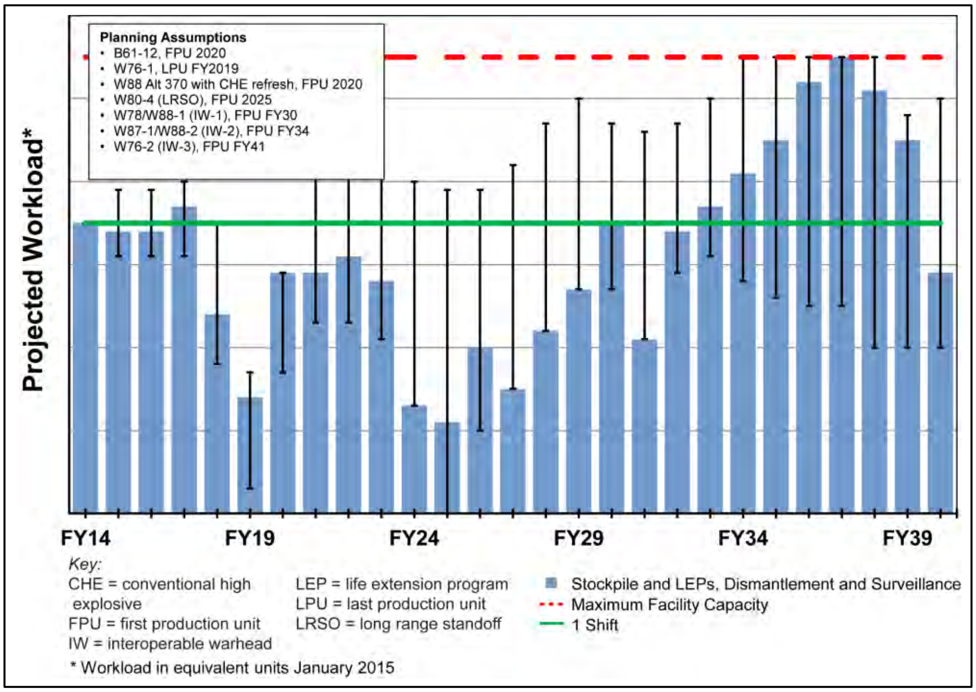

Figure 2–6. Canned subassembly – notional projected workloads for the Y-12 National Security Complex

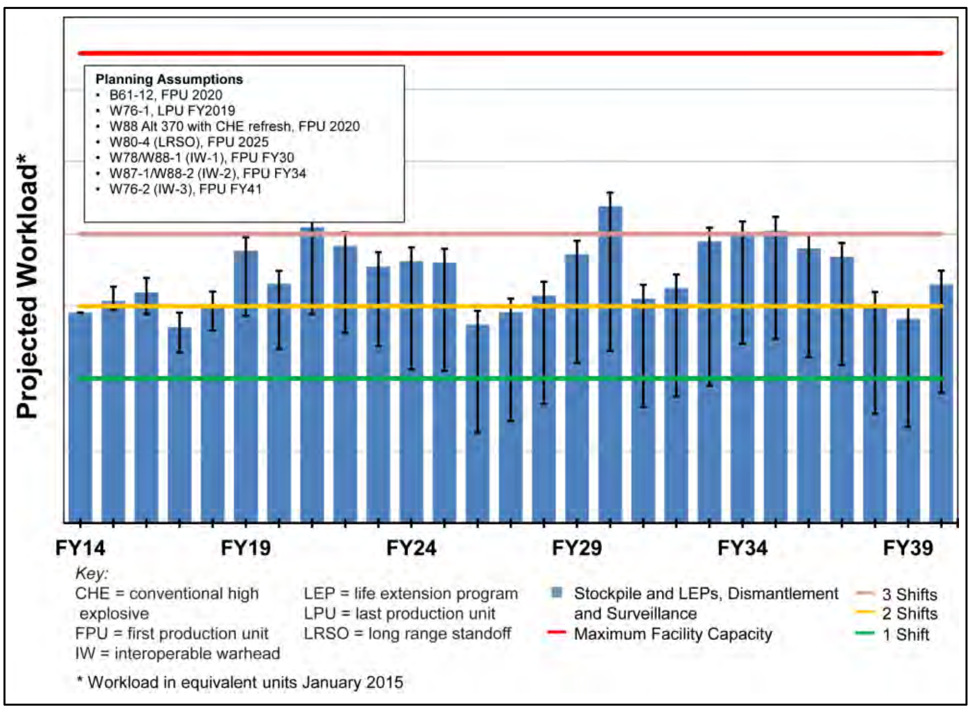

Figure 2–7. Arming, fuzing, and firing and/or equivalent electronics – notional projected workloads for the National Security Campus in Kansas City

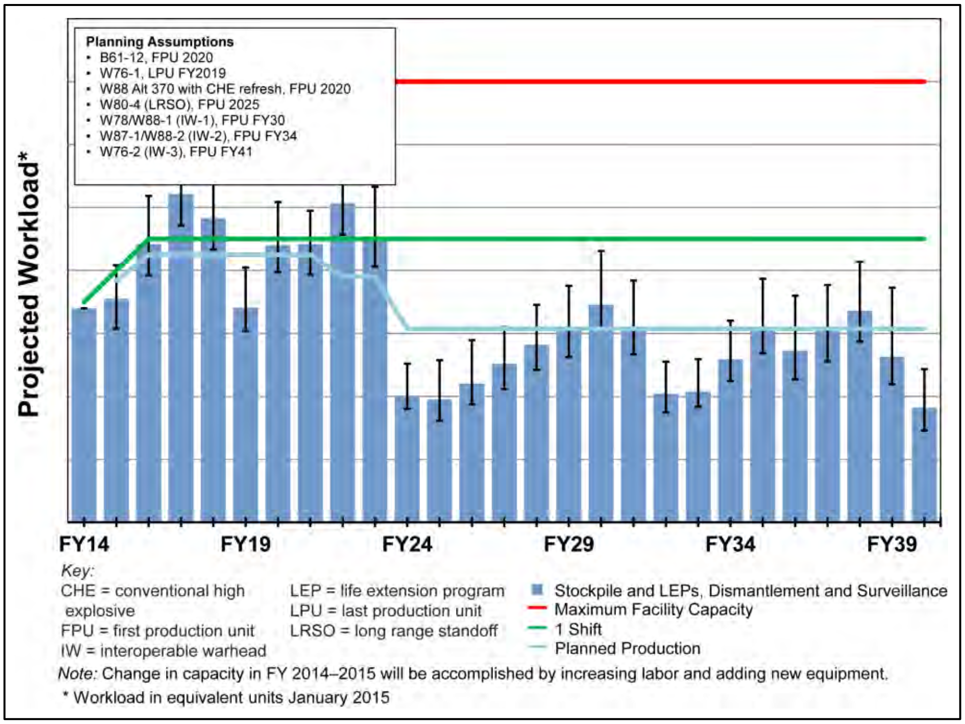

Figure 2–8. Neutron Generator – notional projected workloads for Sandia National Laboratories

2.1.5 Weapon Dismantlement and Disposition

Weapons are retired as a result of changes to strategic requirements or as a result of surveillance evaluations. The dismantlement and disposition process involves four major activities: safety analysis, disassembly, characterization, and disposition. **Figure 2–9** illustrates the processes involved in dismantlement and disposition of nuclear weapons.

Many components for the B61-12 LEP will come from disassembly of current stockpile bombs, a process known as "Disassembly for LEP" or "DisLEP."

Weapons and their components are categorized before dismantlement to identify the associated hazards and disposition streams. Disassembly operations separate the warhead into its major components and materials. Weapon components are characterized and earmarked for reuse, storage, recycle, or disposal. Disposition may include steps that demilitarize components so they cannot be used as originally intended, as well as alteration of parts to declassify them for shipment to offsite salvage locations in accordance with Federal regulations and DOE Orders. Proper characterization and disposition ensure that the nuclear weapons production facilities dispose of material in accordance with environmental regulations.

NNSA is 17 percent ahead of its current schedule for eliminating those weapons retired prior to FY 2009.

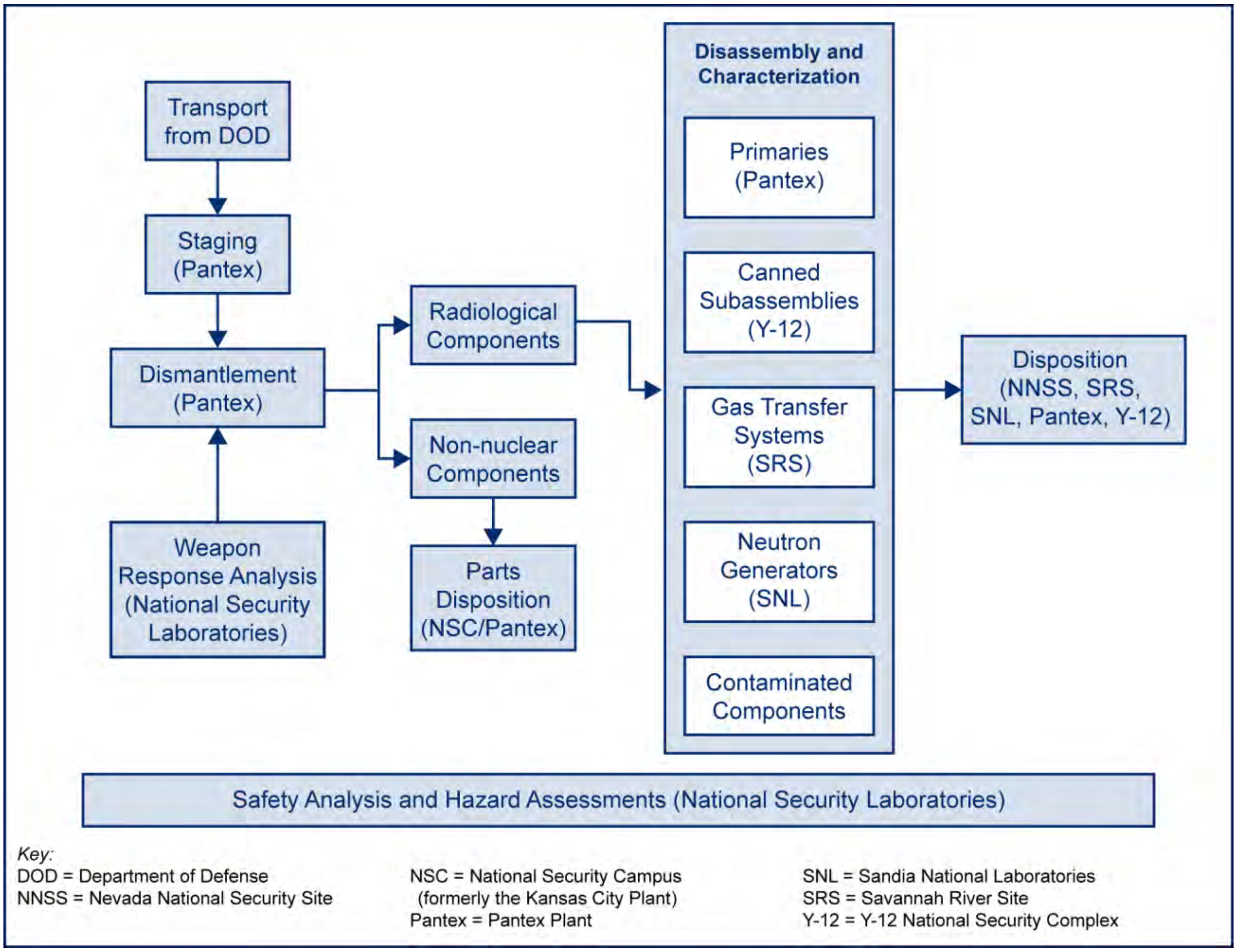

Figure 2–9. Process flow of activities involved in the safe dismantlement and disposition of nuclear warheads

2.1.6 Technology Maturation

Technology maturation enables development and delivery of design-to-manufacturing capabilities to meet current and future nuclear weapons needs for the Nation's stockpile. Planning for technology maturation allows NNSA to meet DOD requirements while maintaining the capability to provide quick response to evolving national security requirements. Technology maturation focuses on maintaining the base capability to support the current stockpile, establishing manufacturing capability for the first user, and adapting the capability for follow-on uses.

As part of the technology maturation process, NNSA, in conjunction with the national security laboratories and the nuclear weapons production facilities, actively consolidates multi-system technology maturation scopes. This consolidation improves prioritization and management of activities to ensure components are ready for insertion, while minimizing costs. Technology maturation component development activities are funded through Directed Stockpile Work (*i.e.*, Stockpile Services, Research and Development Support, and Research and Development Certification and Safety), as well as through the Enhanced Surety and Enhanced Surveillance subprograms of the Engineering Program. Associated manufacturing development activities are funded within the Advanced Manufacturing Development program.

The national security laboratories and the nuclear weapons production facilities measure technology development using technology readiness level (TRL) and manufacturing readiness level (MRL) metrics. Target TRLs and MRLs are provided with the Integrated Phase Gate and *6.x Process* to maximize successful deployment with respect to cost and schedule.

2.2 Management and Planning

NNSA continues to improve its planning processes by aligning activities with programmatic elements and recent stockpile decisions. This FY 2016 SSMP provides a discussion of the changes to the *Technical Basis for Stockpile Transformation Planning* and the Component Maturation Framework.

2.2.1 Technical Basis for Stockpile Transformation Planning

The *Technical Basis for Stockpile Transformation Planning* was initially developed in 2012 to review the needs of the Nation's stockpile systematically by weapon system and planned LEPs. It was updated and expanded in July 2014 to include a summary of the state of health of the Nation's stockpile. Combined with institutional knowledge gained through prior programs (*e.g.,* the W76-1 and B61-12 LEPs), the *Technical Basis for Stockpile Transformation Planning* has evolved and now emphasizes the importance of early technology development prior to the *Phase 6.x Process*. Accordingly, the three national security laboratories have reviewed the stockpile needs and ongoing LEP planning to identify potential technologies based on the drivers identified in **Table 2–3**. The national security laboratories have added another technology driver, "provisioning," to fully address the primary issues and concerns that affect the stockpile.

Table 2–3. Technology drivers

Technology Driver	*Description*
Confirmed end-of-life due to aging	Need for end-of-life replacement.
Provisioning	Replacement of limited available components that use legacy designs, but require minor technology or manufacturing maturation to maintain stockpile quantities.
Performance	Ability to achieve required yield, ensure sufficient margins, and meet existing or changed stockpile-to-target requirements.
Enhanced surety	Assurance of safety, security, and use control.

The *Technical Basis for Stockpile Transformation Planning*, in conjunction with the CMF, provides the foundation for the technology maturation process to ensure that weapon system needs are identified and addressed in a comprehensive and prioritized manner. Surveillance programs, risk assessments, and output from the Nuclear Weapons Council, among other sources, support the identification of weapon system needs.

2.2.2 Component Maturation and Technology Development

Following development of the *Technical Basis for Stockpile Transformation Planning*, the national security laboratories coordinated with the respective nuclear weapons production facilities to update the CMF. The CMF is a portfolio management tool that is used to integrate preliminary scope, proposed TRLs and MRLs, and planning estimates to help enable decisions on component development, technology maturation, and timely insertions. These decisions must take into account early investment in capabilities (*e.g.*, advanced manufacturing) to address stockpile needs. Being able to develop capabilities in terms of both tooling and personnel that are synonymous with industry standards is key to realizing significant cost savings and eliminating single-point failures. These capabilities apply to any weapon system, ensure flexibility in addressing emerging issues, and facilitate implementation of lessons learned. Technologies are normally transitioned after they reach TRL/MRL 5, but transition details are documented in formal interface agreements. This work starts prior to Phase 6.1 activities and continues until Phase 6.3 on technologies that support LEPs, alterations, and modifications; it includes the following activities:

- Determine resource requirements and identifying funding.
- Link component maturation and technology development activities with the respective LEP integrated master delivery schedules.
- Track maturation of selected technologies through the nine TRLs and MRLs to ensure insertion and document benefits.
- Integrate with programs to design, develop, and qualify components.

NNSA works with the national security laboratories and nuclear weapons production facilities to determine the annual technology maturation scope to be conducted using the available funding.

2.2.2.1 Systems Integration Framework

The Systems Integration Framework (SIF) is a new framework that is currently under development and is intended to complete coverage of the technology maturation development and testing programs. SIF will leverage existing PCF and CMF frameworks, ultimately leading to a more thorough process for component development and insertion into the stockpile. NNSA uses the concept of frameworks to move through the *Phase 6.x Process*, which covers all phases of an existing weapon's life from initial feasibility studies and design through development, production, maintenance, deployment, retirement, and dismantlement. The purpose of SIF is to ensure technology and concept readiness at higher TRLs for inclusion in the *Phase 6.x Process* for LEPs. SIF is a framework that will bridge the gap between CMF and the *Phase 6.x Process* framework and integrate the frameworks to support overall system development activities. SIF will enable testing to be conducted in an operational environment using the Joint Technology Demonstrator Testbed and the Developmental Flight JTAs with the Navy and Air Force. This approach is intended to yield the following benefits:

- Provide opportunities for earlier engagement on future technology familiarization and maturation with DOD.
- Provide optimization of available flight test opportunities.
- Provide opportunities and new approaches to accomplish TRL requirements (such as demonstration in a relevant environment) that involve ground and flight testing and may require DOD assets for greater coordination and integration with DOD's technology maturation program.
- Lead to joint concept exploration with DOD to evaluate modifications to current system interface requirements and approaches that might enable a more reliable, safe, and effective weapon system.
- Produce higher TRL levels in advance of entry into the *Phase 6.x Process*, with DOD involvement; inform DOE and DOD decision-makers of available technologies and concepts; and provide greater confidence in their readiness for inclusion in an LEP.
- Provide a common reference framework for testing in an operational environment that is applicable to component development and addressing significant findings during annual assessments of the stockpile.

- Demonstrate to stakeholders how the disparate program elements must come together and provide opportunities for technology maturation and component development to support ground and flight testing.
- Demonstrate the feasibility of new, pre-6.x technologies and new concepts to meet LEP objectives, such as developing new production and inspection techniques and reducing the cost and cycle time of developing and deploying weapon systems.

2.3 Overview of the Program of Record

In November 2012, the Nuclear Weapons Council selected a baseline plan for life extension of the Nation's stockpile that implements a 3+2 Strategy. The baseline plan was detailed in a Nuclear Weapons Council memorandum dated January 15, 2013. The most recent version of this joint DOE and DOD plan is in the *FY 2015 Requirements and Planning Document* and contains five main elements:

> *The B61-12 is one of the weapons in the 3+2 Strategy. Another is the life-extended cruise missile warhead, the W80-4.*

- align the LEP schedules with the delivery of DOD platform upgrades;
- provide a long-term strategy to maintain the Nation's nuclear deterrent with a smaller stockpile;
- enable a reduction in the number of warheads required in the technical hedge by balancing the deployments in the submarine-launched ballistic missile leg and the ICBM leg;
- stay within NNSA's planned production capabilities and capacities; and
- balance the workload across the nuclear security enterprise.

The NNSA life extension activities to implement the Nuclear Weapons Council plan are illustrated in **Figure 2–10**. The Nuclear Weapons Council plan establishes the framework to develop more-detailed implementation plans for the deployment of IWs. The first IW, IW-1, is planned to be the W78/88-1 life-extended warhead. The Nuclear Weapons Council has not yet specifically determined the second and third IWs (IW-2 and IW-3). The *FY 2015 Requirements and Planning Document* (RPD) also includes information on management of the hedge stockpile, incorporation of reused or remanufactured nuclear components, use of common non-nuclear components, improvement in safety and security, and evaluation of affordability.

Currently, most of the stockpile is in various stages of life extension activities beyond Phase 6.1. The W76-1 is in Phase 6.6 (Full-scale Production); the B61-12 is in Phase 6.3 (Development Engineering); the W78/88-1 (IW-1) is paused in Phase 6.2 (Feasibility Study and Option Downselect); and the W88 Alt 370 is in Phase 6.3 (Development Engineering). The W80-4 has entered Phase 6.1 (Conceptual Studies). Additional details of these activities are described below and in the classified Annex. Not depicted in Figure 2–10 are the technology maturation activities taking place at the national security laboratories and the nuclear weapons production facilities to provide future options for stockpile improvements. Long-range plans also include a refurbishment of the B61-12, which will begin a Phase 6.1 study in approximately 2038 (not shown in the figure).

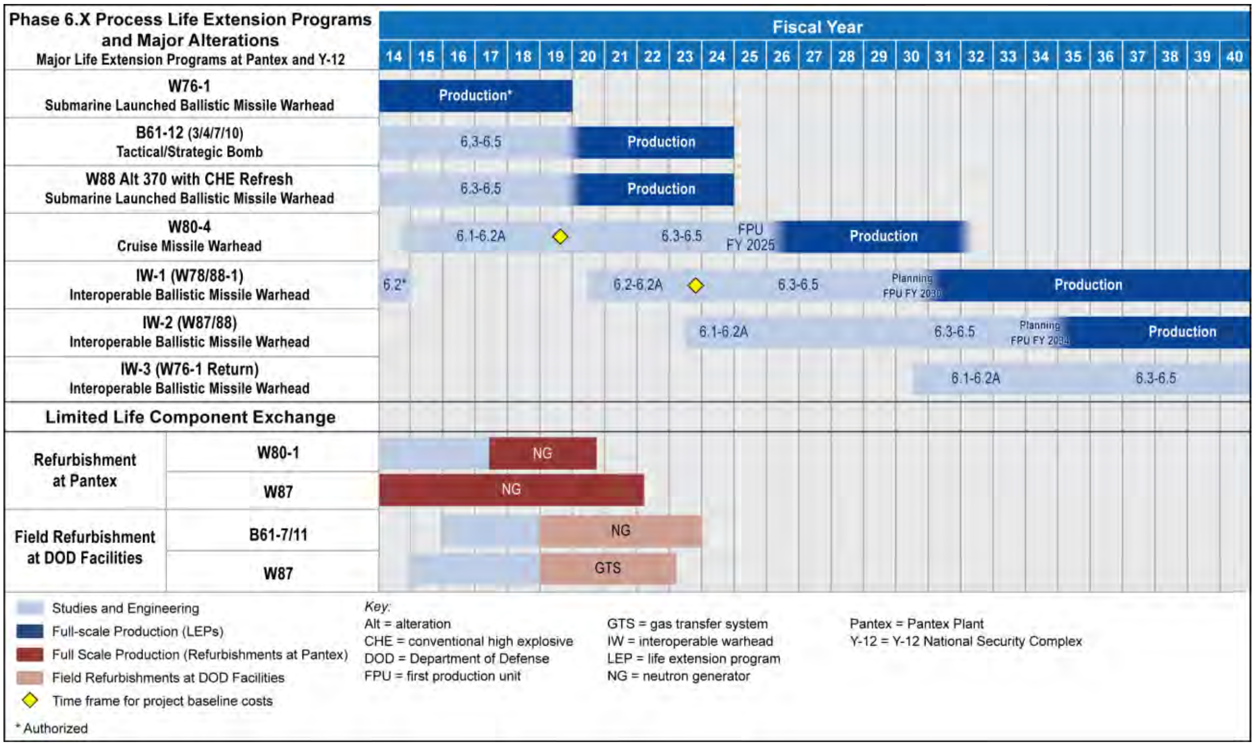

Figure 2–10. National Nuclear Security Administration warhead activities

2.4 Program Details

2.4.1 Life Extension Programs and Major Alterations

2.4.1.1 W76-1 LEP

Short Program Description

The W76-0 warhead is a 1970s-era SLBM system that the Navy first introduced into the stockpile in 1978. The W76 warhead is deployed with the Trident II D5 missile on the Ohio-class nuclear ballistic missile submarines. The primary goals of the W76-1 LEP are to extend the original warhead service life from 20 to 60 years; address identified aging issues; incorporate nuclear surety enhancements; minimize system certification risk in the absence of underground nuclear testing; and refurbish the system in a managed, affordable manner. The refurbishment program's first production unit was achieved in September 2008, and the first delivery of warheads to the Navy for deployment was completed in FY 2009. The current program of record is to complete production of the W76-1 no later than the end of FY 2019.

Accomplishments

In FY 2013, several issues related to safety basis parameters for tools and equipment, facilities, and weapon response changes occurred at Pantex resulting in lower than planned production unit completions. To recover this production shortfall, a schedule was implemented in FY 2014 that recovered the entire FY 2013 production shortfall and exceeded the baseline FY 2014 production quantity requirements. By September 30, 2014, the W76-1 program achieved a major milestone by completing 50 percent of the planned warhead production quantity for the current program of record.

Deliverables, Plans, Schedules, and Milestones

The primary deliverables for the W76-1 LEP in FY 2016 through the end of the program are as follows:

- Achieve or exceed annual refurbished warhead production rates.
- Deliver refurbished warheads on schedule to the Navy for deployment.
- Produce and deliver JTAs for surveillance flight tests.
- Execute Retrofit Evaluation System Test and Stockpile Surveillance activities to facilitate completion of Annual Assessment and Weapon Reliability activities by the national security laboratories.

Trends and Changes from the FY 2015 FYNSP

There are no significant trends or changes to the W76-1 LEP budget profile from the FY 2015 FYNSP profile because of the execution of steady-state rate production.

Risks

The following are among the risks to execution of the W76-1 LEP:

- Congressional continuing budget resolutions, budget sequestrations, and Government shutdowns affect execution of production schedules and create funding uncertainties.
- Funding gaps in Production Support, Safeguards and Security, and Readiness in Technical Base and Facilities (RTBF) affect production capabilities, such as facility infrastructure and production equipment required for execution of LEP production schedules.
- Single-point failures associated with aging equipment that are critical to executing LEP production schedules.

Risk Mitigation

The primary risk mitigation measures being implemented by the W76-1 LEP are as follows:

- Meeting or exceeding annual production requirements to ensure NNSA remains ahead of the Navy's delivery requirements for deployment of refurbished warheads in the submarine fleet.
- Identifying and funding replacement of critical aging equipment to ensure mitigation of perturbations to the LEP production schedule.

2.4.1.2 W88 Alt 370

Short Program Description

The W88 nuclear weapon, which entered the stockpile in late 1988, is deployed on the Navy's Trident II D5 SLBM system. The weapon is in its third decade of life and requires action to address provisioning and aging issues to maintain its current state of readiness until the weapon can undergo a comprehensive life extension process. The W88 Alt 370 replaces the Arming Fuzing & Firing subsystem, enhances nuclear safety, and supports future alternatives for nuclear explosive package LEPs. The Nuclear Weapons Council approved entry of the W88 Alt 370 into Phase 6.3 (Development Engineering) on October 9, 2012. The Alt 370 conversion is scheduled concurrently with the planned LLC exchange for the GTS and NGs. The Alt 370 scope includes design, development, qualification, production, and surveillance of the W88 reentry body with a new AF&F, lightning arrestor connector, trainers, flight test assemblies, and associated handling gear and spares. The W88 Alt 370 first production unit is scheduled for December 2019.

In November 2014, the Nuclear Weapons Council decided to replace the CHE main charge in the W88 weapon concurrently with the Alt 370 work. This new requirement for NNSA was not in the FY 2015 budget submission. The Nuclear Weapons Council decided to partially offset the additional costs of the CHE replacement with reductions in requirements for surveillance and hedge sustainment for legacy B61 and B83 systems.

Accomplishments

In FY 2014, the W88 Alt 370 completed several development, pre-production, and programmatic accomplishments including the following:

- Completed two major flight tests, the Critical Radar Arming and Fuzing Test and the Follow-on Commanders Evaluation Test 50.
- Tested functional component prototypes in stockpile-to-target-sequence environments.
- Completed radar fuzing ground tests.
- Shipped 1,861 (cumulative) pieces of hardware, including prototype hardware by NNSA's NSC (formerly known as the Kansas City Plant) to support Integrated Contractor Orders.
- Established Interface Requirements Agreements with Other Program Money to document deliverables on which the W88 Alt 370 depends.
- Implemented the Earned Value Management System.

Deliverables, Plans, Schedules, and Milestones

The major deliverables for the W88 Alt 370 Program in FY 2016 through the end of the program are as follows:

- Conduct the system-level Baseline Design Review in FY 2016.
- Conduct the Preliminary Design Review and Acceptance Group review in FY 2016.
- Obtain Phase 6.4 (Production Engineering) approval in FY 2016.
- Conduct the system-level Final Design Review in FY 2018.
- Conduct the final flight test qualification (DASO-series tests) in FY 2019.
- Obtain Phase 6.5 (First Production Unit) approval in FY 2019.
- Complete the first production unit by December 2019.
- Conduct the final Design Review and Acceptance Group review in FY 2020.
- Obtain Phase 6.6 (Full Rate Production) approval in FY 2020.

Trends and Changes from the FY 2015 FYNSP

The FY 2016 FYNSP request for FY 2016 reflects a $63.0 million increase to the program compared to the FY 2016 amount in the FY 2015 President's Budget Request. The increase was required because of the impact of FY 2013 sequestration-driven delays in key program activities, reentry-body-level lifetime assessments, and the addition of a more rigorous Earned Value Management System across all NNSA sites. The NNSA FY 2016 budget submission also reflects funding adjustments to partially fund CHE replacement. To cover remaining shortfalls for the CHE replacement, NNSA will annually evaluate its budget submissions to look for ways to fund the remaining CHE replacement costs.

Risks

The high-level risks for the W88 Alt 370 LEP are congressional continuing budget resolutions, budget sequestrations, and Government shutdowns affect execution of production schedules and create funding uncertainties.

Risk Mitigation

The following primary risk mitigation measures are being implemented by the W88 Alt 370 program:

- NNSA is carefully managing annual work packages and using risk-based contingency to minimize the effects of short-term budget gaps. NNSA will continue to engage with Congress to communicate the need for consistent funding and support for the W88 Alt 370.
- NNSA has implemented formal tracking and interface agreements between LEPs and other programs to assure that technology and production maturation requirements are integrated into FYNSP planning and monitored during execution.
- NNSA is adding CHE replacement to the Alt 370 to mitigate technical risk to the W88 warhead program.

2.4.1.3 B61-12 LEP

Short Program Description

The B61 is one of the oldest nuclear weapons in the stockpile. On February 27, 2012, the Nuclear Weapons Council authorized Phase 6.3 (Development Engineering) for the B61-12 LEP. This LEP will address multiple components that are nearing end of life and military requirements for reliability, service life, field maintenance, safety, and use control. NNSA, in coordination with the Air Force, studied a number of design options to address the military's requirements, ranging from component replacement alterations to full-scope nuclear and non-nuclear refurbishment. The joint effort also included a separate study to assess the schedule and cost for each option. The selected option includes refurbishment of both nuclear and non-nuclear components to address aging, assure extended service life, and improve the safety, security, and reliability of the bomb. With these upgrades and the addition of new Air Force components, the B61-12 LEP will consolidate and replace the B61-3, -4, -7, and -10 bombs. The consolidation will enable a reduction in the number of gravity bombs, consistent with the Nuclear Posture Review (DOD 2010) objectives. The scope incorporates component reuse where possible and omits high-risk technologies to reduce cost and schedule risks. The first production unit is planned for FY 2020.

Accomplishments

In FY 2014, the B61-12 LEP completed several major accomplishments, including the following:

- Completed more than 20 B61-12 LEP system-level joint, ground, and aircraft integration tests using functional developmental hardware.
- Executed the first vibration fly-around and instrumented measurement vehicle flight to validate flight environments.
- Delivered 10,323 items of hardware, including prototype hardware, to support Integrated Contractor Orders.
- Completed first integration test of B61-12 LEP bomb assembly and tail kit assembly with aircraft platform interfaces.
- Demonstrated that the GTS design meets key DOD requirements and initiated pre-production activities ahead of schedule.

Deliverables, Plans, Schedules, and Milestones

The following are primary deliverables for the B61-12 LEP in FY 2016 through the end of the program:

- First Development System Drop will occur in FY 2015.
- Obtain Phase 6.4 (Production Engineering) approval in FY 2016.
- The Air Force will hold a Design Review and Acceptance Group review in FY 2016 to assess design and qualification against military requirements.
- Conduct first System Qualification drop in FY 2017.
- Obtain Phase 6.5 (First Production Unit) approval in FY 2019.
- Conduct the final Design Review and Acceptance Group reviews in FY 2020.
- Complete the first production unit no later than March 2020.

Trends and Changes from the FY 2015 FYNSP

There are no significant trends or changes to the B61-12 LEP budget profile from the FY 2015 FYNSP profile.

Risks

The risks to execution of the B61-12 LEP production include congressional continuing budget resolutions, budget sequestrations, and Government shutdowns affect execution of production schedules and create funding uncertainties.

Risk Mitigation

The following primary risk mitigation measures are being implemented by the B61-12 LEP:

- NNSA is carefully managing annual work packages and using risk-based contingency to minimize the effects of short-term budget gaps. NNSA will continue to engage with Congress to communicate the need for consistent funding and support for the B61-12.
- NNSA has implemented formal tracking and interface agreements between LEPs and other programs to assure technology and production maturation requirements are integrated into FYNSP planning and monitored during execution.

2.4.1.4 W80-4 LEP

Short Program Description

The W80-4 LEP title reflects the July 2014 Nuclear Weapons Council downselect to the W80 warhead in Phase 6.1 of the cruise missile warhead LEP program. This LEP will consider W80-based reuse, refurbishment, and replacement options for nuclear and non-nuclear components to provide a warhead for the Air Force's cruise missile to replace the current, aging, ALCM. The program will integrate the warhead with the replacement missile platform and address warhead component aging concerns and military requirements for reliability, service life, field maintenance, and surety. LLNL and SNL, respectively, are the nuclear and non-nuclear national security laboratories[3] for this LEP. Key design requirements established for this LEP include using IHE, maximizing use of non-nuclear components developed for other LEPs, exploring options for enhanced surety, and concurrent engineering with the Air Force on the warhead/missile interface. NNSA has requested funding in the FY 2016 President's Budget Request to support the DOD-requested first production unit in FY 2025.

Accomplishments

- Initiated Phase 6.1 concept study activities in accordance with the weapon development cycle in July 2014.
- Completed a Nuclear Weapons Council–approved downselect to the W80 warhead for the W80-4 LEP.

Deliverables, Plans, Schedules, and Milestones

- The Phase 6.1 Report, including draft Military Characteristics and stockpile-to-target sequence, and the request to proceed to Phase 6.2, are scheduled for delivery in June 2015.
- The program is scheduled to enter Phase 6.2 (Feasibility Studies) in FY 2015 and continue into FY 2017. This phase will identify and develop design options and compare design and manufacturability tradeoffs and life-cycle advantages and disadvantages with respect to reuse, refurbishment, and replacement; surety; military requirements for reliability, service life, and field maintenance; and warhead/missile integration.
- There are no Phase 6.2 deliverables in FY 2016. Phase 6.2 will conclude with a written Phase 6.2 report, identifying preferred design options, and an outbrief to the Nuclear Weapons Council Standing and Safety Committee.
- Phase 6.2a is planned to start in FY 2017, including performing a detailed cost study of selected design options, identifying production issues, and developing workload and process development plans to accomplish the LEP production. Phase 6.2a also will include development of technical and programmatic documents in anticipation of developing a program baseline early in Phase 6.3. At the conclusion of Phase 6.2a, the Weapon Design and Cost Report, along with estimated DOD costs, will be presented to the Nuclear Weapons Council, along with a final warhead design downselect and a recommendation for proceeding to Phase 6.3.
- Phase 6.3 is planned to start in FY 2018. Phase 6.3 will develop the Baseline Cost Report and Selected Acquisition Report; complete a detailed design demonstrated to be feasible with

[3] *NNSA's national security laboratories are LLNL, LANL, and SNL). NNSA's nuclear weapons production facilities are the NSC (formerly called the Kansas City Plant), Pantex, SRS, and Y-12. In addition, both LANL and SNL have specific production responsibilities.*

regard to critical safety, performance, and production considerations; produce the final draft version of the Military Characteristics and stockpile-to-target sequence; and produce a draft addendum to the Final Weapon Development Report for review by the Design Review and Acceptance Group.

Trends and changes from FY 2015 FYNSP

A $186 million increase in the budget request in FY 2016 from FY 2015 reflects the change of the first production unit to FY 2025 and execution of Phase 6.2 activities for the duration of FY 2016.

Risks

- Congressional continuing budget resolutions, budget sequestrations, and Government shutdowns affect execution of development schedules and create funding uncertainties.
- Changing the first production unit to FY 2025 introduces low-level schedule risk in technology development.

Risk Mitigation

- NNSA is engaging in a technology readiness assessment for the W80-4 LEP to mitigate or eliminate high-risk technologies and focus technology maturation on options that support the schedule.
- NNSA continues to refine program requirements in conjunction with DOD and is developing information on which to make cost-informed decisions.

2.4.1.5 W78/88-1 LEP (IW-1)

Short Program Description

The first ballistic missile warhead LEP in the 3+2 Strategy is the W78/88-1 (IW-1) warhead. The Nuclear Weapons Council's objective for this LEP is to deploy an interoperable nuclear explosive package for use in both the Mk21A ICBM and the Mk5 SLBM aeroshells, with adaptable non-nuclear components. Hence, this LEP is referred to as the first IW option, the IW-1. IWs, together with the B61-12 and the Air Force cruise missile warhead, will lead to a reduction in both the overall stockpile numbers and the number of warhead types. These activities are consistent with the DOD requirements in the Nuclear Posture Review (DOD 2010).

In June 2012, the Nuclear Weapons Council authorized a Phase 6.2 study for a W78/88-1 IW. In FY 2013, work on the W78/88-1 (IW-1) was accelerated to enable an early focus on the preferred design concept. The U.S. Strategic Command, the Office of the Secretary of Defense, the Air Force, and NNSA supported the early pit downselect decision, which was briefed to the Nuclear Weapons Council. In FY 2014, NNSA completed the W78/88-1 (IW-1) nuclear explosive package downselect process. That downselect decision package was developed by the LLNL/LANL joint-design, dual-certification team and presented to NNSA. The decision was supported by the Nuclear Weapons Council. However, because of budget constraints, the first production unit for the W78/88-1 (IW-1) was shifted to FY 2030, in deference to the priority given to the Air Force cruise missile warhead (now called the W80-4), and the FY 2014 W78/88-1 (IW-1) activities were focused on congressionally directed alternative studies and the remainder of the Phase 6.2/6.2A activities delayed to meet the schedule alignment.

Accomplishments

- In FY 2014, NNSA completed the W87-like pit nuclear explosive package downselect. That decision was supported by the Nuclear Weapons Council.
- NNSA conducted an orderly shutdown of the program while ensuring that all programmatic and technical documentation had been archived and captured for the benefit of future restart of the program.

Deliverables, Plans, Schedules, and Milestones

The W78/88-1 (IW-1) LEP will restart in FY 2020 with a planned first production unit in FY 2030. Initial production following that date will support the Air Force portion of IW-1 due to the age of the W78 relative to that of the W88.

Trends and changes from FY 2015 FYNSP

There are no significant trends or changes to the W78/88-1 (IW-1) budget profile from the FY 2015 FYNSP profile.

2.4.2 Stockpile Systems

The Stockpile Systems program consists of the following four major activities:

- **Weapon Maintenance** includes production of LLCs (*e.g.*, GTSs and NGs), as required in accordance with national requirements documents and directive schedules; day-to-day stockpile maintenance and repair activities; production and delivery of components for each weapon type; refurbishment and replacement of aging components to maintain stockpile life; and rebuilds.
- **Weapon Surveillance** includes new material laboratory tests; new material flight tests; retrofit evaluation system laboratory and flight tests; stockpile laboratory tests; stockpile flight tests; quality evaluations; special testing; and surveillance of weapon systems to support assessment of the safety, security, and effectiveness of the stockpile. Weapons Surveillance also contributes to the Annual Assessment Reports and memorandum to the President.
- **Weapon Assessment and Support** includes activities associated with management of fielded weapon systems. This major effort provides systems and component engineering support and supports the planning, resolution, and documentation of SFIs, including assessment of root causes, extent of conditions, and impact to system effectiveness or safety. It also includes planning, developing, and updating the technical basis for the materials, components, and weapons and performing weapon assessments. In addition, this effort includes activities associated with preparing, writing, and coordinating the Annual Assessment Reports and Weapon Reliability Report and activities to assess and resolve system-specific weapon response issues and to support the Nuclear Explosive Safety and the Nuclear Weapon System Safety Groups, as required.
- **Development Studies and Capability Improvements** include activities associated with improved surveillance, technical basis improvements, technology maturation for insertion or replacement, and system and surety studies.

FY 2017 to FY 2020 Key Milestones

B61 Stockpile Systems

- **Weapon Maintenance.** Achieve first production of the electronic NG qualified for the B61-11 in FY 2019.

W76 Stockpile Systems

- **Development Studies and Capability Improvements.** Complete scheduled activities for surety enhancements.

W78 Stockpile Systems

- **Development Studies and Capability Improvements.** Begin surety enhancement development activities in FY 2020.

W80 Stockpile Systems

- **Weapon Maintenance.** Continue production of LLCs and Alt 369, which includes NG replacement.

W87 Stockpile Systems

- **Weapon Maintenance.** Continue full-scale production of Small Ferroelectric NGs. Complete final reclamation activities for existing GTS in FY 2015. Continue firing set qualification and first production unit activities.
- **Weapon Surveillance.** Conduct Retrofit evaluation system tests for the W87 LLC exchange and firing set rebuilds in FY 2016.

W88 Stockpile Systems

- **Weapon Maintenance.** Achieve first production unit build of new NGs and remanufacture of the GTS. Begin Full-scale production of NGs and GTSs in FY 2019.
- **Development Studies and Capability Improvements.** Continue critical development and integration and start-system-level qualification activities to replace the legacy W88 system NG and GTS. Conduct activities for surety enhancements.

2.4.3 Stockpile Services

The Stockpile Services Program provides the enabling elements essential for research, development, and production capability and capacity within the nuclear security enterprise. Stockpile Services are required by multiple weapon systems and provide the capability basis to conduct system-specific weapons work. These services include:

- providing containers for nuclear component shipments,
- maintaining production and surveillance capabilities (*e.g.*, calibration and repair),
- conducting experimental studies (*e.g.*, effect of adhesive-HE compatibility of thermal ignition, experimental measurement of brush discharge characteristics, and optical lightning detection system),
- performing engineering R&D to support assessments and certifications, and
- operating facilities to support Directed Stockpile Work mission activities.

Stockpile Services Program R&D provides weapon system component development, including technology maturation for NGS, GTSs, and AF&F devices. R&D services also include subcritical experiments to obtain data on plutonium and hydrodynamic experiments to understand implosion behavior.

Management of the physical infrastructure (see Chapter 4) and the workforce (see Chapter 7) are also necessary for Stockpile Services and all related programs.

Improvement and modernization projects include the Product Realization Integrated Digital Enterprise (PRIDE) program to modernize data integration and access information across the nuclear security enterprise.

2.4.3.1 Production Support

Production Support is the backbone for the manufacturing capability of the stockpile and includes those activities that provide the capability and capacity to sustain the nuclear security enterprise's production mission. The production mission is defined as weapon assembly, weapon disassembly, component production, and weapon safety and reliability testing. Production Support funding not only sustains current Directed Stockpile Work capabilities, but enables the modernization of the production capabilities to improve efficiency and to prepare manufacturing operations to meet future requirements. To gain better cost efficiency within the NG enterprise, a newly implemented funding model calls for Production Support funding (with a corresponding work scope transfer) to provide the base capability for development and production of neutron tubes and generators for all weapon systems while the weapon systems maintenance funding pays for production of the NGs to be installed in the individual systems. This funding model will achieve improved mission performance for the nuclear security enterprise. As indicated previously, Production Support requires close coordination with the Component Manufacturing Development activity under the Advanced Manufacturing Development Program, which is charged with development and initial deployment of new manufacturing and production capabilities.

The Production Support mission includes the following:

Engineering Operations. Internal plant-wide activities that establish product process flows and improvements; develop and maintain operating procedures; determine critical design parameter and manufacturing process capabilities; establish process controls, metrics, and quality indices; and develop process safety controls/assessments.

Manufacturing Operations. Activities that manage and provide oversight to manufacturing departments and include all internal non-weapon-type specific manufacturing operations and processes, material controls, supervision, planning and scheduling, inventory control, and internal production-related transportation and safety activities; also includes classified manufacturing operations that cannot be associated with a particular warhead.

Quality, Supervision, and Control. Includes activities dealing with quality control of operating expenses; supervision of general in-line inspection and radiography; procedures development and execution; process control certification for war reserve products; measurement standards and calibration techniques; calibration of equipment, tooling, gauges, and testers; and Quality Assurance (QA)-related equipment/process for certification.

Tool, Gage, and Equipment Services. Activities that include preparation of specifications and designs for non-weapon-type specific tooling (tools, gages, jigs and fixtures) and test equipment and design and development of tester software (including tester control and product assurance). This category also includes work related to verification/qualification of hardware and software, as well as procurement processes and maintenance (corrective and preventative) that directly support production-related equipment/process components.

Purchasing, Shipping, and Materials Management. Planning, engineering, supplier management and logistics activities associated with the materials supply chain.

Electronic Product Flow. Activities that include internal plant-wide purchase, design, development, installation, configuration, testing, training and maintenance of computer systems (hardware and software) directly linked to the performance of site-specific production functions, but that are separate and distinct from general-use administrative/office automated systems. Supported systems are in both unclassified and classified environments that enable manufacturing and quality assurance functions. In these environments, information technology (IT) elements are directly linked to plant-wide production.

2.4.3.2 Research and Development Support

The Research and Development Support Program provides the administrative and organizational infrastructure to support R&D capabilities and activities for multiple weapon systems in the stockpile. Research and Development Support also enables the national security laboratories to support the nuclear weapons production facilities in addressing stockpile stewardship and management issues.

The Research and Development Support Program is responsible for:

- providing support for multiple system flight tests;
- providing development, diagnostics, and qualifications of HE surveillance;
- archiving historical weapons data;
- upgrading computer hardware and software to remain current with evolving technology;
- providing the technical skills and knowledge to conduct the core base of tests and experiments;
- implementing quality control, procedures, methods, instructions, certifications, calibrations, and processes for R&D activities;
- supporting detailees and subject matter expert assignments at NNSA; and
- supporting Joint Integrated Life Cycle Surety activities.

In FY 2014, the Research and Development Support Program facilitated the W80 and B83 flight tests and the development of new explosives for flight test diagnostics and qualifications of HE surveillance.

2.4.3.3 Research and Development Certification and Safety

The Research and Development Certification and Safety Program encompasses weapon component development activities; R&D activities (primary and secondary modeling and assessment, weapons effects and system analysis studies, and nuclear safety R&D activities); engineering and information infrastructure support; production liaison and oversight; and material science support. These activities provide the core competencies and capabilities for R&D efforts attributable to multiple weapon systems.

The Research and Development Certification and Safety Program is responsible for addressing LLC issues and sunset technologies that may jeopardize operations and safety if neglected. These technologies include the following:

- **AF&F.** Support is provided for development of early-stage exploratory technologies, such as microelectronics, power sources and batteries, that are applicable to multiple stockpile systems.
- **Nuclear explosive packages.** The activities in this category support technologies to ensure full nuclear design performance of previously fielded nuclear explosive packages. These include replacement of select components; qualification of new materials, including new formulations of IHE; and advanced diagnostics to identify age-related defects and identify acceptable components for reuse. Multiple science and engineering disciplines are included in this category to ensure overall system performance and component certification.
- **NGs.** These components deliver the neutrons at the initiation of the nuclear chain reaction. These units must be inspected and replaced or refurbished in a timely or periodic manner to address aging and obsolescence issues, as well as compatibility with evolving technology. Tests are also conducted to ensure NG performance meets the space and environmental requirements for multiple stockpile systems.
- **GTSs.** These components serve as boosters to achieve and facilitate the required weapon yield. As LLCs, these technologies are also replaced periodically to address aging and compatibility issues. Moreover, engineering endeavors focus on ensuring their performance meets the space and environmental requirements for multiple stockpile systems.

Other Research and Development Certification and Safety program efforts include the following:

- **Nuclear Safety R&D** ensures weapon safety and security for nuclear-related and HE activities. Studies focus on extreme temperature and environment effects, modeling of CHE and IHE safety qualification tests, damage effects and limitations caused by detonations, and nuclear material safety analyses.
- **Surety Engineering** consolidates multiple science and engineering disciplines and ensures emerging technologies meet requirements. Activities focus on auxiliary detonators, future strong-link development, and enhanced safety for initiation systems. Studies are also designed to ensure material properties and radiative effects are not harmful to the surrounding environment.

Additional Research and Development Certification and Safety program activities include:

- conducting R&D and engineering studies and experiments in support of safe nuclear explosive operations;
- conducting non-warhead-specific R&D studies, assessments, and analyses that support weapon certification and safety processes;
- managing Integrated Surety Architectures (ISA) program endeavors to meet DOE and DOD timelines and deliverables (see Section 2.4.7.2);
- supporting execution of hydrodynamic experiments and dynamic plutonium experiments (*i.e.*, experiments driven by HE); and
- supporting obligations and agreements as directed by NNSA officials.

In FY 2014, the Research and Development Certification and Safety program facilitated realignment of system-specific scope and cost estimates for ISA under Stockpile Services and successfully met B61 commitments to support work on the weapon controller unit and strong links. Additionally, Research and Development Certification and Safety performed weapons effects studies, system certification activities, and computer modeling and simulation activities; conducted primary, secondary, chemistry, and materials systems analyses; and completed annual assessment activities for the Secretary of Energy, with the Secretary of Defense, to certify to the President that the stockpile is safe, secure, and effective.

2.4.3.4 Management, Technology, and Production

Management, Technology, and Production (MTP) activities provide the products, components and/or services for multi-weapon system surveillance (laboratory and flight test data collection and analysis), weapons reliability reporting to the DOD, weapon logistics and accountability, and stockpile planning. MTP funding is used to provide plant and laboratory personnel to help sustain the stockpile that includes activities relating to surveillance, weapons requirements process improvements, engineering authorizations, safety assessments, use control technologies to keep the weapons safe, secure and available to the war fighter upon Presidential release authority, containers, base spares used to maintain weapons in a safe reliable status, studies and assessments with respect to nuclear operation safety, weapon components for use in multiple weapons systems and transportation and handling gear used to safely and securely store weapons and transport weapons between DOD sites and DOE sites for use in multiple weapons systems. MTP funding is pooled across the sites for a coordinated product realization enterprise approach for information systems used to record weapon and component transactional activities, an essential program for weapon stockpile inventory and accountability reporting used to report quantities, values and status to Congress. Additionally, MTP includes weapons sustainment activities that benefit the nuclear security enterprise mission as a whole, as opposed to Production Support activities that focus on supporting internal site-specific production missions.

The MTP mission includes the following:

PRIDE. Operation and maintenance of 44 classified electronic information management systems required for weapons accountability, vendor material purchases, viewing/transfer of design and engineering drawings, and transit for surveillance, LLC exchanges, dismantlement, and weapons refurbishment and manufacturing.

Weapons Training and Military Liaison. Staffing the multi-weapon subject matter experts for Unsatisfactory Reports associated with DOD's field issues for testing and handling gear, technical publications, and coding issues; allows maintenance operations to return weapons back to active status.

Studies and Initiatives. Currently, this effort initiative identifies, prioritizes, and funds critical uranium-related requirements (skilled labor, casting, rolling, forming and machining) to re-establish and sustain Y-12's capability to manufacture cases and CSAs for the stockpile, as well as a material capability required for future LEPs.

General Management Support. Non-programmatic costs for program management and oversight, shared taxes, assignees and support services contracts.

Assessments and Studies (Use Control). Includes in-depth vulnerability assessments of nuclear weapons in the stockpile; identification or development and deployment of common technologies to address vulnerabilities, if found; and special studies to support the decision processes for optimizing LEP designs and for option down-select decisions by senior officials.

Surveillance. Efforts that focus on multi-system, common use, or non-weapon specific activities (data capture, reliability assessments, flight test planning) directly contributing to stockpile evaluation, including activities and new capabilities for surveillance transformation. Lengthened surveillance cycles (due to budget) to collect data for weapon systems could violate weapon reliability, annual assessment stockpile rationale standards, and laboratory/flight test requirements. Lengthening surveillance cycles increases the time that a potential defect could go undetected in the stockpile, and subsequently increases the amount of time the DOD could have a deficient nuclear deterrent.

External Production Missions. Weapon response subject matter experts across all systems and all laboratories. Weapon response manning is critical for Pantex to return to operations in bays and cells (should an unexpected weapon condition or anomaly be observed during LLC exchange replacement). Weapon delivery schedules rely on throughput at the Pantex bays.

Base Spares (Production). Activities associated with production of new non-weapon-specific base spares, containers, LLC forging procurements, detonators, mock HE, and other weapon components.

Base Spares (Maintenance). Activities associated with maintaining existing non-weapon-specific base spares, test handling gear and containers, GTSs, use control equipment, code management switch tubes, and other weapon components.

2.4.4 Warhead Dismantlement and Disposition

Many factors affect dismantlement rates, including shipping logistics, weapon system complexity, and availability of qualified personnel, equipment, and facilities. For FY 2014, Pantex achieved nearly 120 percent of its required weapons dismantlement and Y-12 exceeded its required CSA dismantlement.

Near-term initiatives concerning dismantlement and disposition of retired warheads and bombs include the following:

- Reduce the legacy material inventories at the national security laboratories and nuclear weapons production facilities.
- Reduce legacy part inventories to provide additional staging capacity at Pantex.
- Continue to support the Navy's request for additional W76-0 dismantlement.

Longer-term and ongoing activities include the following:

- Dismantle all nuclear weapons retired prior to 2009 no later than the end of FY 2022.
- Continue to support nonproliferation, LEP, and surveillance needs.
- Dispose of old GTSs to meet safety basis requirements.

2.4.5 Advanced Manufacturing Development

The Advanced Manufacturing Development program develops, demonstrates, and deploys modern technologies to enhance secure manufacturing capabilities and ensure timely support for the production of nuclear weapons and other critical stockpile needs. In accomplishing its mission, this program enables Defense Programs to meet DOD requirements, while also maintaining the capability to provide rapid response to evolving nuclear security requirements.

2.4.5.1 Component Manufacturing Development

The Component Manufacturing Development subprogram invests in technologies used in multiple weapon system applications. The focus is put on the first insertion user to conserve development resources and reduce production uncertainty for LEPs and legacy systems. The subprogram coordinates investments with the Engineering and Science Programs to manage weapon technology and component manufacturing development activities and meet mission requirements on time. Priorities for maturing technologies and manufacturing capabilities are integrated across programs for the planned insertion of components into LEPs, LLCs, alterations, and modifications. The subprogram's primary objective is to leverage the development of multi-system manufacturing capabilities and transition them to the Directed Stockpile Work with reduced risk.

Manufacturing readiness relies on an integrated relationship between production equipment, vendors, personnel, facilities, and other factors that compose a manufacturing system. These activities and projects represent the fundamental capability to support the stockpile and future LEPs, which will fund their own unique set of tools, fixtures, and materials for manufacturing activities. Studies have shown that insertion of immature technologies and immature manufacturing systems increases risk and cost, while significantly decreasing the probability of system or program success. Accordingly, NNSA uses the MRL assessment process to make informed decisions. Of the nine MRLs, ranging from concept (MRL 1) to first production unit (MRL 9), the Component Manufacturing Development subprogram is primarily responsible up to manufacturing process development (MRL 5). The Directed Stockpile Work assumes responsibility at MRL 6 for further development and application to a specific system. This is important because, without the vital work of the Component Manufacturing Development subprogram, the reliability of the nuclear weapons stockpile would be in question.

2.4.5.2 Additive Manufacturing

Additive Manufacturing is a Defense Programs initiative created to vet manufacturing concepts aimed at shortening production schedules and design cycles. This effort is focused on gaining a better understanding of the feasibility of making longer-term investments that will result in reduced cost of design-to-manufacture iterations, fully characterize additive manufacturing processes and capabilities, and produce methodologies that enable qualification and certification for weapons applications. This initiative is a special case of technology maturation that will transition to the relevant programs in support of their specific mission requirements.

2.4.5.3 Process Technology Development

The Process Technology Development subprogram supports development, demonstration, and use of new production technologies to enhance manufacturing capabilities for nuclear weapon materials. Funding will be used to ensure new technologies with the potential to shorten production schedules, reduce risks, enhance personnel safety, or reach optimal maturity levels in time to support mission needs.

At present, this subprogram focuses on uranium processing technology and, specifically, on acquiring major items of equipment for Y-12 by 2025. The purpose of this subprogram is to ensure priority technology investments have a dedicated funding source and can reach optimal levels of maturity without having to compete with other program priorities.

2.4.6 Nuclear Materials Commodities

2.4.6.1 Plutonium Sustainment and Pit Production

The plans for the FY 2016 Plutonium Sustainment Program align with the pit production goals of the Nuclear Weapons Council baseline plan. The Plutonium Sustainment Program balances the requirements for plutonium capabilities, including national policy goals, stockpile requirements, and LEP planning. Execution of this program depends on the infrastructure activities described in Chapter 4.

The Plutonium Sustainment Program for the FY 2016 FYNSP includes the following major activities:

- Continue acquiring and installing pit production equipment to replace old, end-of-service-life machines, as well as additional equipment to increase war reserve production capacity from 10 pits per year in 2024 to 30 pits per year in 2026. NNSA will establish confidence in this production plan through a series of pit production capacity demonstration activities beginning in 2021.
- Continue process development to manufacture a W87-like pit, a candidate for future stockpile needs. Multiple development W87 pits were built in FY 2013.
- Build 4 to 5 developmental pits per year over the FYNSP, after Plutonium Facility (PF-4) operations resume, to facilitate transition to war reserve production through qualification and certification.
- Perform engineering and physics evaluations of the developmental builds for war reserve pit qualification and certification.
- Fund reconstitution of a power supply production capability.

The first war reserve W87 pit is planned in FY 2024, with a ramp-up in production to 30 pits per year by FY 2026. The pit development timeline is shown in **Table 2–4** below.

Table 2–4. Pit development timeline

Type	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*
Pit Production Series	Development Builds			Process Prove-In Builds		Qualification Builds		W87-like WR Builds	W87-like WR Builds
Number of Builds (per year)	4-5			5		5		1	10

WR = war reserve.

Future plans call for demonstrating higher levels of pit production capacity in 2027-2029, as NNSA ramps up to 50 to 80 pits per year by FY 2030.

The Plutonium Sustainment Program also plans to provide the resources to establish a pit reuse capability up to a potential capacity of 90 pits per year, in conjunction with a newly manufactured pit capability by FY 2024. Funding requirements for the Plutonium Sustainment Program will be updated to reflect potential future investments to support reuse.

Pit manufacturing relies on analytical chemistry (AC) and materials characterization (MC) analyses to produce war reserve pits. Without the Chemistry and Metallurgy Research Replacement Nuclear Facility (CMRR-NF) or an alternative, a production capability of 30 pits per year is achievable through several approaches that are not mutually exclusive, including additional shift work, additional use of space in PF-4 at LANL, and use of offsite laboratories that leverage resources outside the Plutonium Sustainment Program. More information regarding the supporting infrastructure is in Chapter 4.

2.4.6.2 Tritium Sustainment and Domestic Uranium Enrichment

Tritium is an integral component of nuclear weapons. An assured supply must be available to meet nuclear security requirements for the stockpile. Tritium, a radioactive material with a half-life of 12.3 years, must be periodically replenished. One of NNSA's missions is to provide freshly-filled tritium reservoirs to replace reservoirs that have reached their end of life.

NNSA's Tritium Readiness subprogram operates a production system to maintain the required inventory of new tritium. Because the current inventory is larger than required, only a small amount is produced today. However, to meet future inventory requirements, the production rate must increase.

Since 2003, tritium has been produced by irradiating lithium-aluminate pellets with neutrons in a commercial nuclear power reactor. The pellets are inserted into specially designed, tritium-producing burnable absorber rods (TPBARs) that are similar in dimension to reactor fuel rods. Irradiation of the rods occurs at the Tennessee Valley Authority Watts Bar Unit 1 reactor.

After irradiation, the TPBARs are removed, consolidated into one or more shipping containers, and transported in secure casks to the Tritium Extraction Facility at SRS for extraction. Gases containing tritium are then piped to the SRS Tritium Loading and Unloading Facility, where the tritium is purified and loaded into limited-life tritium reservoirs. The spent TPBARs are disposed of as low-level radioactive waste.

Future tritium GTSs to be incorporated into LEP weapons may involve larger tritium loads than past weapons in order to require less-frequent exchanges. These proposed future GTSs would also result in better performance margins for the nuclear explosive package and, therefore, higher confidence in the nuclear design without the need for underground nuclear tests. Section 312 of the FY 2015 Omnibus Appropriations Bill directed NNSA to provide Congress with a bottoms-up re-evaluation of active and reserve tritium needs. Final decisions, based on a cost-benefit analysis, to adapt larger tritium loads, are pending.

NNSA's tritium production plan is illustrated in **Figure 2–11**. The major factors in tritium supply planning are defined by the demands created from the exchange of LLCs in existing weapons, the tritium requirements determined by LEPs, and the production efficiency of the TPBARs. Each horizontal bar in Figure 2–11 represents an 18-month irradiation cycle at the Watts Bar Unit 1 reactor.

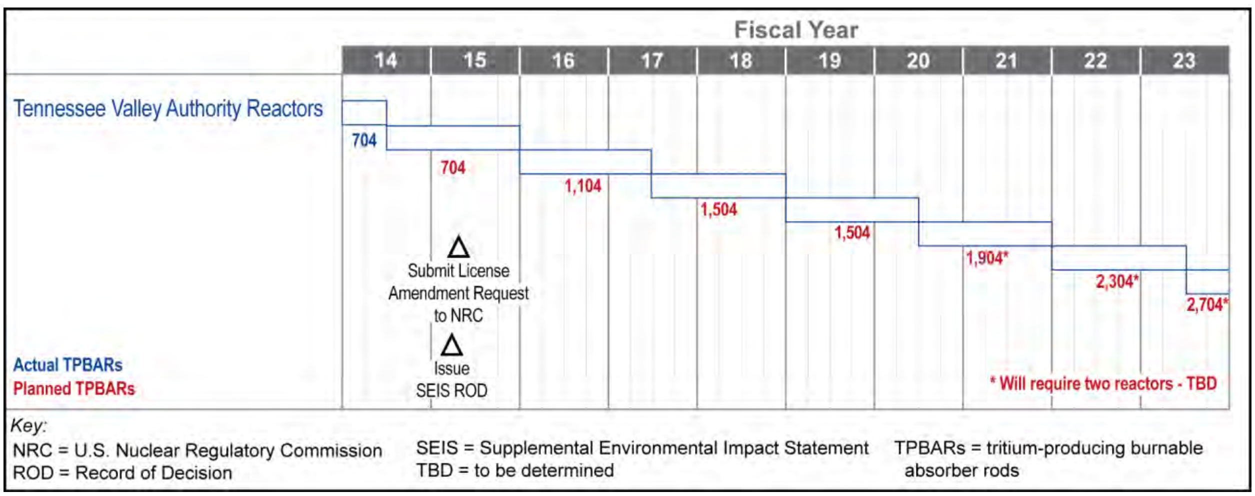

Figure 2–11. Schedule for irradiation of tritium-producing burnable absorber rods to meet post-Nuclear Posture Review (DOD 2010) requirements

Factored into the production assessment requirements is the recovery of tritium through dismantlement of weapons. Tritium reservoirs are removed from all inactive weapons and from those that have been retired and are awaiting dismantlement. The reservoirs are returned to SRS for recovery of the tritium and because this inventory is already considered in the supply planning. A total of 704 TPBARs were loaded in April 2014. Cycle 13 will be completed by September 2015, when the next refueling outage is scheduled.

To meet future requirements, the number of TPBARs must increase to over 2,000 in the FY 2022 time frame. The ramp-up to higher TPBAR numbers has begun. To support this ramp-up, NNSA has updated the environmental impact statement, and a license amendment request was submitted to the Nuclear Regulatory Commission covering the increased TPBAR levels. NNSA out-year budget projections include the higher TPBAR numbers required.

An integral component of tritium production is ensuring the availability of unobligated low-enriched uranium (LEU) for use as reactor fuel by the Tennessee Valley Authority reactors. NNSA uses unobligated uranium for tritium production for national defense purposes. However, there is no domestic supplier of such material following the shutdown of the Paducah Gaseous Diffusion Plant in 2013 and the 2014 bankruptcy of the United States Enrichment Corporation, now known as Centrus Energy Corporation. The Tritium Readiness subprogram has identified sources of unobligated fuel through 2027. DOE’s Domestic Uranium Enrichment effort supports a U.S. interagency evaluation of options to achieve a reliable and economic way to provide unobligated LEU reactor fuel for tritium production. DOE’s Uranium Inventory Working Group is reviewing the complex's uranium inventory composition to identify any available material, as well as the cost associated with obtaining that material, for tritium production. The Uranium Inventory Working Group is exploring the feasibility and cost of preserving the unobligated status of existing enriched uranium, down-blending HEU from the inventory, and processing spent nuclear fuel. DOE is also evaluating other uranium enrichment technology options, including the cost of building out a national security train of AC100 centrifuges (developed by Centrus Energy).

2.4.6.3 Uranium Sustainment

The uranium missions include producing parts for CSAs, providing fuel for the Navy, disposing of excess uranium materials, and conducting R&D programs that require uranium. The enriched uranium mission is performed in several large industrial buildings at Y-12, including Building 9212, which dates back to the Manhattan Project. These buildings were to be replaced with the Uranium Processing Facility; however, cost and schedule growth within the project led NNSA to consider alternative ways of accomplishing the uranium mission.

In January 2014, NNSA chartered Oak Ridge National Laboratory Director Dr. Thomas Mason to form a team, with representation from the national security laboratories, to develop and recommend, by April 15, 2014, an alternative approach to the Uranium Processing Facility Project that would result in delivery of Building 9212 capabilities for not more than $6.5 billion by 2025.

That group, known as the “Red Team,” said that the Uranium Processing Facility must be considered in the context of the broader enriched uranium mission. The team’s approach emphasized maximizing the use of existing facilities, aggressively reducing safety and mission risks, and building new floor space only for capabilities that are inappropriate for transition to existing facilities.

To execute the uranium mission, the Red Team recommended creating an Enriched Uranium Manager, now called the Uranium Program Manager, to oversee the transition and balance resources among investments in safety and mission risk reduction, facility risk reduction, and new construction.

Although those three priorities depend on each other, this section describes safety and mission risk reduction efforts in existing facilities, while facility risk reduction and the new construction are described in Chapter 4.

Goals

The following Uranium Program goals are related to safety and mission risk reduction:

- Transition Y-12 Building 9212 capabilities to other existing facilities so NNSA can cease enriched uranium programmatic operations in Building 9212 by 2025.
- Sustain and increase the reliability of NNSA's uranium capabilities, including casting sustainment, machine tool upgrades, application of new technologies for chip processing, and waste solidification.
- Aggressively reduce the safety risk by expanding and accelerating the Area 5 de-inventory program and focusing on items with offsite dose consequences.

Plan

The first goal, ceasing enriched uranium programmatic operations in Building 9212, depends on five activities. These are designed to stop the flow of material into Building 9212 and increase the flow of material out of Building 9212. The first activity is to stop recovering solutions that have little SNM and prepare for eventual decontamination of the facility by installing a calciner in Building 9212, to be operational by September 2019. The second activity is to replace the metal purification capability by installing uranium electrorefiners in Building 9215, to be operational by November 2020. The third activity is to relocate the machine chip processing capability to Building 9215, where the metal turnings are produced, to be completed by June 2021. The fourth activity is to relocate the 2-megaelectron volt radiography to an existing x-ray vault in 9204-2E, to be completed in June 2017. The final activity is to construct new floor space for casting, special oxide production, and salvage and accountability functions as part of the Uranium Processing Facility project by 2025.

The second goal sustains and increases the reliability of the uranium capabilities that must remain in existing facilities through a series of smaller individual activities. These include replacing obsolete non-capital equipment, increasing equipment maintenance, purchasing critical or long-lead spare parts, and conducting studies to increase the efficiency of process equipment.

The third goal aggressively reduces safety risk by expanding and accelerating the Area 5 de-inventory program to reduce material working inventories to near the just-in-time level beginning with Building 9215 in September 2015 followed by Building 9204-2E in September 2016 and Building 9212 in September 2021. The program relocates material to the Highly Enriched Uranium Material Facility (HEUMF) and prioritizes movements by material forms with the highest consequence in the case of an accident starting in March 2015 and continuing through September 2017. When possible, the program converts the material into a less hazardous form for long-term storage.

As previously stated, this plan relies on infrastructure investments to maintain safe operations in existing facilities, as described in Chapter 4.

Figure 2–12 depicts NNSA's Uranium Program mission interfaces, where all capability and capacity issues, including refining, casting, and storing, are based on the uranium mission requirements and strategy. All infrastructure investments and equipment recapitalization will be able to draw from those mission requirements.

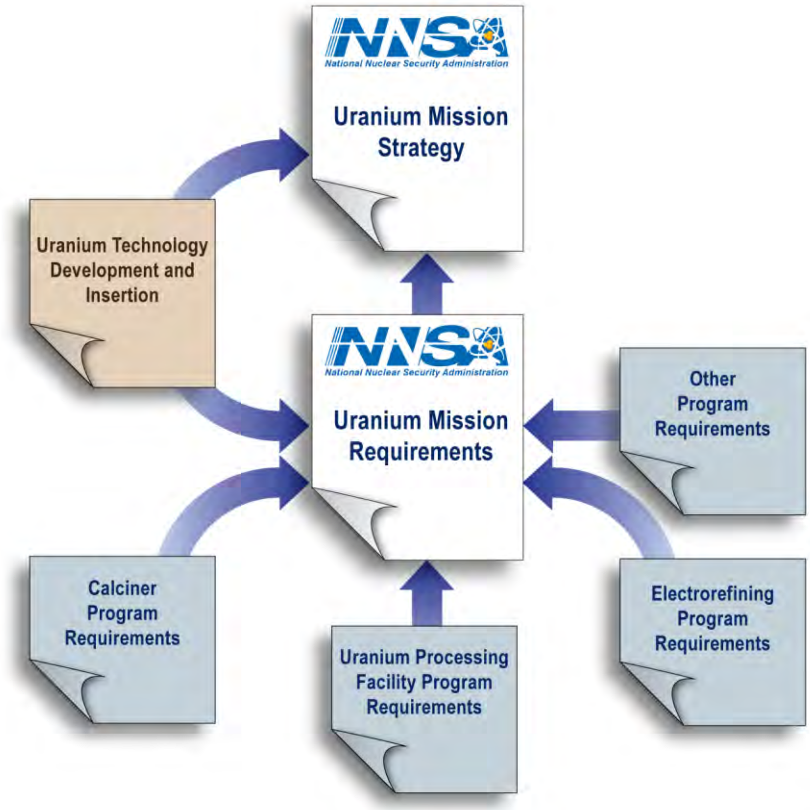

Figure 2–12. NNSA's uranium mission requirements

2.4.7 Cross-Cutting Programs

2.4.7.1 Nuclear Enterprise Assurance

The Nuclear Enterprise Assurance (NEA) Program has been established to identify and mitigate the consequences of the current and dynamic spectrum of threats to the nuclear security enterprise. NEA includes a Weapons Trust Assurance element to ensure a safe, secure, and effective stockpile, as well as Supply Chain Risk Management to ensure malicious hardware or software cannot enter the nuclear security enterprise supply chain. The underlying requirement is to design, develop, and produce all future weapons with enhanced trust features that are resilient to subversion attempts. For all legacy stockpile weapons, mitigation steps will continue to be taken to assure a safe, secure, and effective stockpile.

NNSA is institutionalizing NEA for the B61-12 and W88 Alt 370 by developing Program Protection Plans for hardware and software applied to these weapon systems. These plans identify mission-essential functions and critical components in addition to required activities to prevent or mitigate compromise, which could result in reduced weapon system functionality or impact operability. The Program Protection Plans are incorporated into the Integrated Master Schedules, which are supported by the Integrated Planning Teams, approved by the NNSA Federal Program Manager, and coordinated with the respective Lead Project Officers and Project Officer Groups.

NEA is being incorporated into the Nuclear Explosive and Weapon Security and Use Control program. The four major elements of the approach are:

- apply a principle-based engineering and product realization approach to the weapons supply chain and trustworthiness throughout the weapon's life cycle;
- improve understanding of the evolving advanced persistent threat;
- implement positive measures to improve the supply chain and trustworthiness of the weapons, as appropriate, based on risk and programmatic constraints; and
- establish understanding and improve confidence in the supply chain and trustworthiness of the nuclear weapon system.

Nuclear Enterprise Assurance program principles are important to provide a foundation for action that decreases or eliminates the potential for an adversary to sabotage, maliciously introduce unwanted function, or otherwise subvert the function of a nuclear weapon system without detection.

2.4.7.2 Integrated Surety Architectures

The ISA program will enhance NNSA transportation surety by integrating nuclear weapon shipping configurations with elements of physical security. This risk mitigation approach was endorsed by the 2010 JASON Surety Study and subsequently validated by the 2013 Joint Integrated Lifecycle Surety baseline assessment. ISA, which will kick off in FY 2016, is an extension of the Integrated Surety Solutions for Transportation (ISST) program initiated in FY 2014. ISA includes all NNSA transportation-focused activities planned for ISST and, in addition, will explore the potential extension of ISST concepts and technologies to other nuclear weapon venues. Major ISA product development activities are shown in **Figure 2–13**. The ISA implementation sequence has been revised to ensure that all W88 Alt 370 units returning to the Navy will have ISA capability. This requires development of an ISA W88 Alt 370 shipping configuration (Alt 940) and the Safeguards Transporter (SGT) interface modifications to become lead product development activities. These activities precede the restart, in FY 2017, of full-scale development of the Multi-application Transportation Attachment Device (MTAD), which, together with the SGT modifications, will enable ISA capability for all air-delivered weapons (*i.e.*, the B61-11/12, W80-1, B83-1, and possibly the W80-4). Development of ISA shipping configurations for the remaining ballistic missile warheads will follow, with the W76-1 starting in FY 2019, the W78 in FY 2020, and the W87 in the out-years beyond the FY 2016 FYNSP. The ISA program goal is to have operational capability for all weapons in transportation by the end of FY 2028. Planning (feasibility and cost studies) and residual technology maturation will be supported in FY 2015 by the Directed Stockpile Work R&D Certification and Safety program. In FY 2016 and beyond, the Certification and Safety program will continue to support development of multi-application products (SGT modifications and MTAD), while the Stockpile Systems program will develop ISA products for specific warhead applications like the W88 Alt 940.

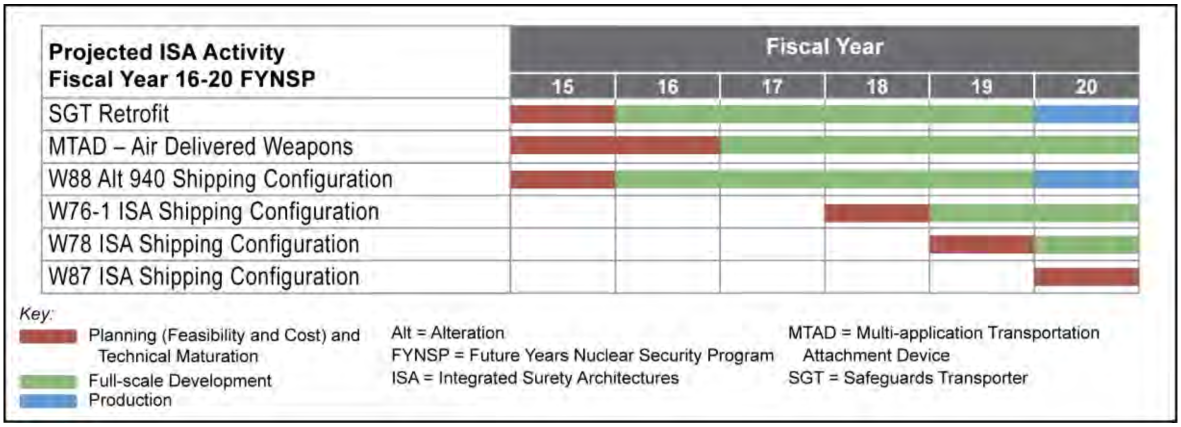

Figure 2–13. Potential schedule for Integrated Surety Architecture solutions implementation for National Nuclear Security Administration transportation

2.5 Summary of Significant Stockpile Management Accomplishments and Plans

2.5.1 Recent Major Stockpile Management Accomplishments

- Completed full recovery of the FY 2013 production shortfall for the W76-1 LEP and exceeded the FY 2014 production baseline, while maintaining scheduled deliveries to the Navy. The program also achieved the halfway point in production in September 2014.
- Exceeded targets for warhead disposition at Pantex and CSA dismantlement at Y-12 by more than 5 percent.
- Completed over 20 B61-12 LEP system-level joint ground and aircraft integration tests using functional development hardware.
- Initiated the first W88 Alt 370 Life of Program purchases, resulting in long-term savings.
- Completed two W88 Alt 370 development flight tests: the Critical Radar Assembly Flight Test and the Follow-on Commanders Evaluation Test 50.
- Completed the W88 CHE Refresh planning, design, material downselect, development hardware fabrication, and testing, as authorized in FY 2014 by the Nuclear Weapons Council-directed baseline change.
- For the W78/88-1 LEP, completed downselect activities, DOD W78 customer requirements review, and orderly close-out of LEP activities until restart in FY 2020.
- Initiated Phase 6.1 concept study activities in accordance with the weapon development cycle for the W80-4 (formerly the cruise missile warhead) LEP.
- Delivered all scheduled limited LLC exchanges for the B61, W76, W78, W80, B83, W87, and W88. The LLCs included GTSs, NGs, and alteration kits delivered to DOD and Pantex to maintain the nuclear weapons stockpile.
- Conducted surveillance programs for all weapon systems using data collection from flight tests, laboratory tests, and component evaluations sufficient to assess stockpile reliability without

nuclear testing. Surveillance culminated in completing all Annual Assessment Reports and Laboratory Director Letters to the President.

- Achieved the first production unit for the small ferroelectric NG for the W87 program and began deliveries to DOD.
- Met the Navy's expectations to return W76-0 warheads early, saving the Navy several million dollars in weapon-staging costs.
- Performed analyses in conjunction with DOD to support key surety decisions for both NNSA and DOD. Added new capabilities to accommodate cyber and insider threats.
- Completed an extraction of 300 TPBARs at the Tritium Extraction Facility in the third quarter of FY 2014.
- Issued the revised W87 Development Pit Build Plan, which detailed the experimental matrix with pit production rates at four to five pits per year through FY 2018.

2.5.2 Stockpile Management Activities, Milestones, and Key Annual Deliverables

To be successful in moving forward, Stockpile Management has a number of goals, milestones, and annual activities that have been discussed throughout this chapter. While the complete integrated body of work is required, the following figures graphically depict those elements that are the culmination of each of the major program elements. **Figure 2–14** shows the Stockpile Management Program's goals, planned milestones, and key annual activities through FY 2040 for its weapons assessment, surveillance, and maintenance activities. **Figure 2–15** shows the milestones set for the LEPs, major weapons component production, and weapons alteration and dismantlement activities.

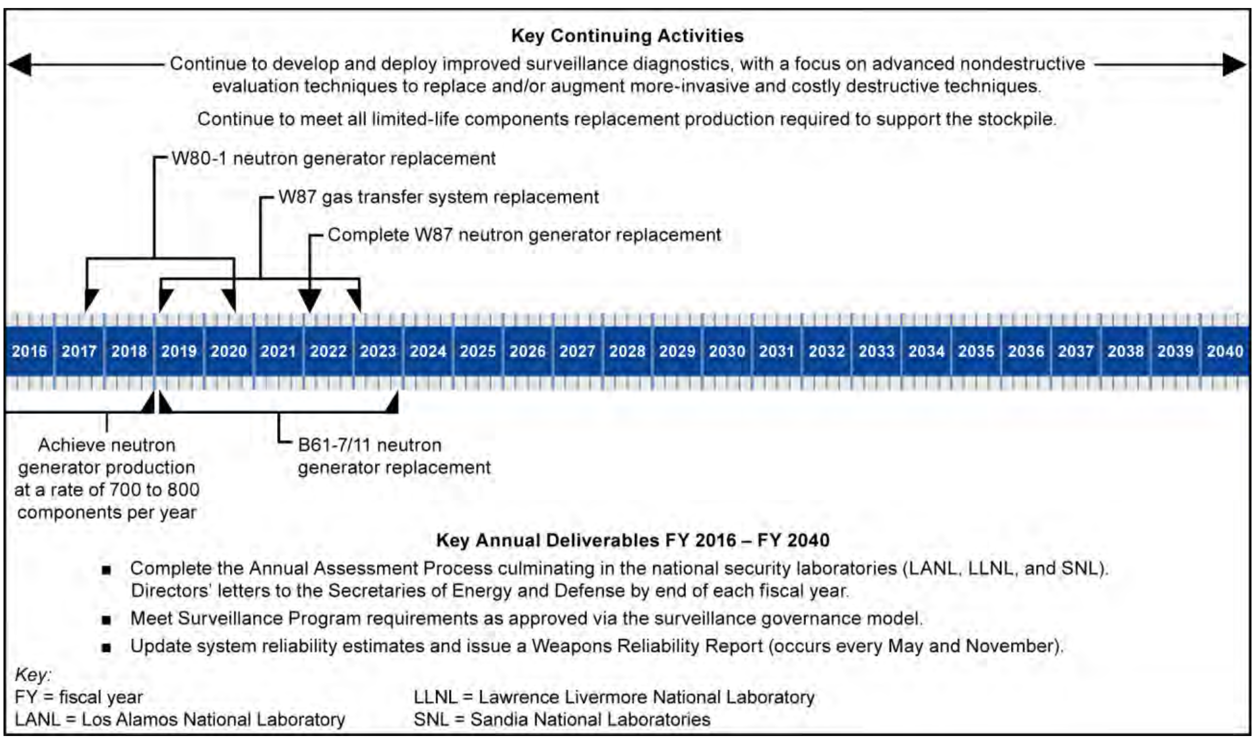

Figure 2–14. Goals, milestones, and key annual activities for weapon assessment, surveillance, and maintenance

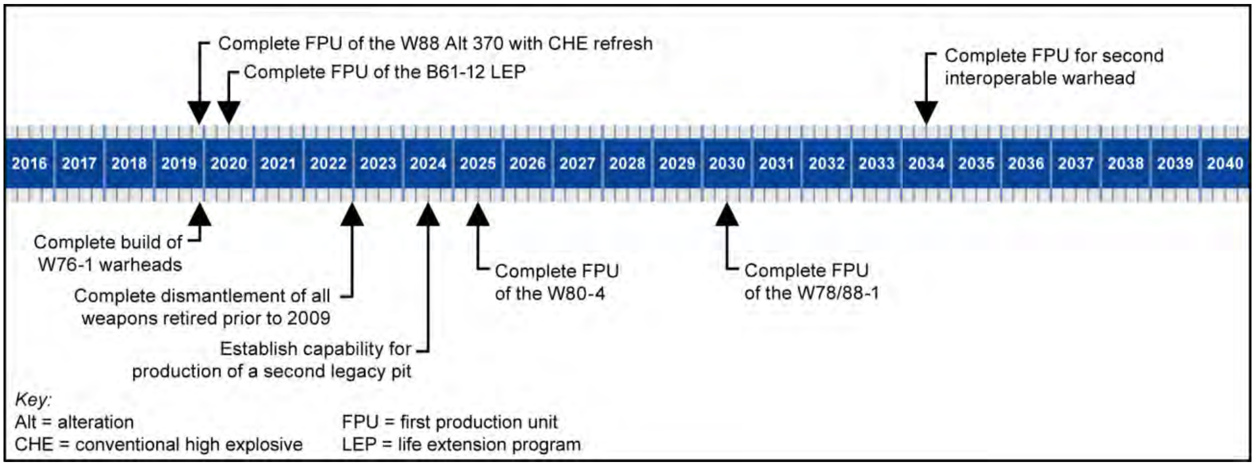

Figure 2–15. Milestones for life extension programs, major weapons component production, and weapons alteration and dismantlement

Chapter 3
Research, Development, Testing, and Evaluation Activities

This chapter discusses the essential RDT&E activities that underpin stockpile stewardship. The chapter has been reorganized significantly from the previous complete version of the SSMP (the full FY 2014 SSMP and the updated FY 2015 version). The introduction below has been revised to provide a more complete description of the purpose and success to date of Science-Based Stockpile Stewardship. This is followed by a description of the high-level planning tools and supporting capabilities. The chapter concludes with a description of the programs that conduct RDT&E activities. Starting with this FY 2016 SSMP, Nuclear Test Readiness (previously Chapter 4 in the FY 2014 and FY 2015 SSMPs) is discussed in this chapter. The status of test readiness has not changed since 2014, so interested readers should review the 2014 SSMP for detailed information.

FY 2014 Research, Development, Testing, and Evaluation Activities Accomplishments

- *Developed and assessed life extension program alternatives based on high explosive, hydrodynamics, and material property experiments and simulations.*
- *Conducted science-based assessment of the W78 lifetime, including three-dimensional (3D) modeling.*
- *Resolved question of primary performance of multiple systems using the Dual-Axis Radiographic Hydrodynamic Test facility and 3D modeling.*
- *Extended neutron generator lifetimes, based on modern assessments, thereby allowing scheduling flexibility for weapon alterations.*
- *Enabled higher confidence in a weapon system based on National Ignition Facility and Los Alamos Neutron Science Center data and 3D assessments.*
- *Enhanced models of plutonium, uranium, and beryllium based on materials data from the Z pulsed power facility, gas guns, diamond anvil cells, and other facilities.*
- *Tested plutonium multi-phase models based on FY 2013 Gemini series data.*
- *Fully supported Cycle 19 Annual Assessment Review Process; provided reports to Project Officer Groups, U.S. Strategic Command Strategic Advisory Group Stockpile Assessment Team, and Secretary of Energy.*

3.1 Introduction

The National Defense Authorization Act of 1994 (P.L. 103-160) established Science-Based Stockpile Stewardship (also known as the Stockpile Stewardship Program) to sustain the nuclear deterrent in the absence of nuclear testing. Today, some 20 years later, Stockpile Stewardship scientists and engineers have established a solid record of success in computing, hydrodynamic testing, subcritical experiments, high-energy-density (HED) physics, and materials and weapon-effects science. These scientific achievements have enabled resolution of many stockpile issues since the end of nuclear testing and provided more detailed knowledge than could have been attained through nuclear testing as practiced in the early 1990s. This success demonstrates that Stockpile Stewardship can provide the scientific capabilities required by the safeguards discussed during the original Comprehensive Nuclear-Test-Ban Treaty debate.

From 1945 through 1992, the United States conducted 1,030 nuclear tests, along with an additional 24 nuclear tests jointly conducted with the United Kingdom. These nuclear tests supported development and deployment of 63 different weapon systems, from the B1 through the W88.

The development of nuclear weapons over many decades led to common practices for determining when nuclear testing was required.[1] In the final years of nuclear testing, the United States was executing nuclear tests in support of several objectives, including completion of W88 development; development of the W89 and W91 (both of which were subsequently canceled); development of IHE-based primary options; and exploration of weapons physics, nuclear safety, and survivability. The key Stockpile Stewardship Program strategy is to establish a sufficient scientific understanding of the nuclear explosive process to replace those capabilities that were enabled by nuclear testing and to support discovery and correction of any deficiencies that might occur during the lifetime of a weapon. This required a much deeper understanding of the nuclear explosive process than was necessary during the era of nuclear testing. Stockpile Stewardship scientists broke down the operation of a weapon into a sequence of individual steps, analyzed the steps through computational models and experiments, and reintegrated the steps through large-scale weapon simulation codes and computational tools. This process necessitated development of new experimental facilities that could replicate the densities, pressures, velocities, temperatures, and timescales present in a nuclear detonation; development of high-fidelity weapon simulation codes; development and acquisition of very large, high-performance computing platforms; and acquisition of detailed experimental data to validate and calibrate the models. New approaches also became necessary to qualify nuclear and non-nuclear components against hostile nuclear attack, which also required new or improved experimental tools and simulation codes.

A key Stockpile Stewardship Program strategy is to understand the various environments (normal, hostile, abnormal) and their potential impacts on weapon performance. These environments impose thermal, mechanical, and radiation loads that engineering models and experiments have to address. Nuclear weapons are subject to aging during the decades between manufacture and retirement. These aging effects must be taken into consideration when assessing the ability of weapons to meet the requirements of the stockpile-to-target sequence.

The Accelerated Strategic Computing Initiative provided the requirements and resources for U.S. computer vendors to develop new generations of massively parallel, high-performance computers (10^9 operations per second, or a gigaflop, in 1992 and 10^{15} operations, or a petaflop, in 2010 [see **Figure 3–1**]). This has enabled significant increases in simulation capabilities; three-dimensional (3D) weapon simulation codes now allow for unprecedented resolution in simulations of the stockpile.

The experimental facilities that were built since 1992 in support of the Stockpile Stewardship Program include the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility at LANL, the National Ignition Facility (NIF) at LLNL, the U1a Complex (U1a) at the Nevada National Security Site, and the Microsystems and Engineering Sciences Applications (MESA) facility at Sandia National Laboratories. These and other capabilities have also improved surveillance and maintenance of the existing stockpile and provided methods and data to close SFIs. The quality and resolution of the data from these new facilities and capabilities were and continue to be unprecedented; these data are used to benchmark new physics models in the weapon simulation codes and supplement the physical data used in conjunction with the codes. Facilities existing prior to 1992, such as the Z pulsed power facility (Z), Los Alamos Neutron Science Center (LANSCE), Saturn, High Explosives Applications Facility (HEAF), Contained Firing Facility

[1] *A notable exception to this reason was that of a stockpile confidence test. Usually, the test was conducted after the weapon system had entered the stockpile.*

(CFF) and the High-Energy Radiation Megavolt Electron Source (HERMES) III, have been maintained and upgraded and continue to make essential contributions.

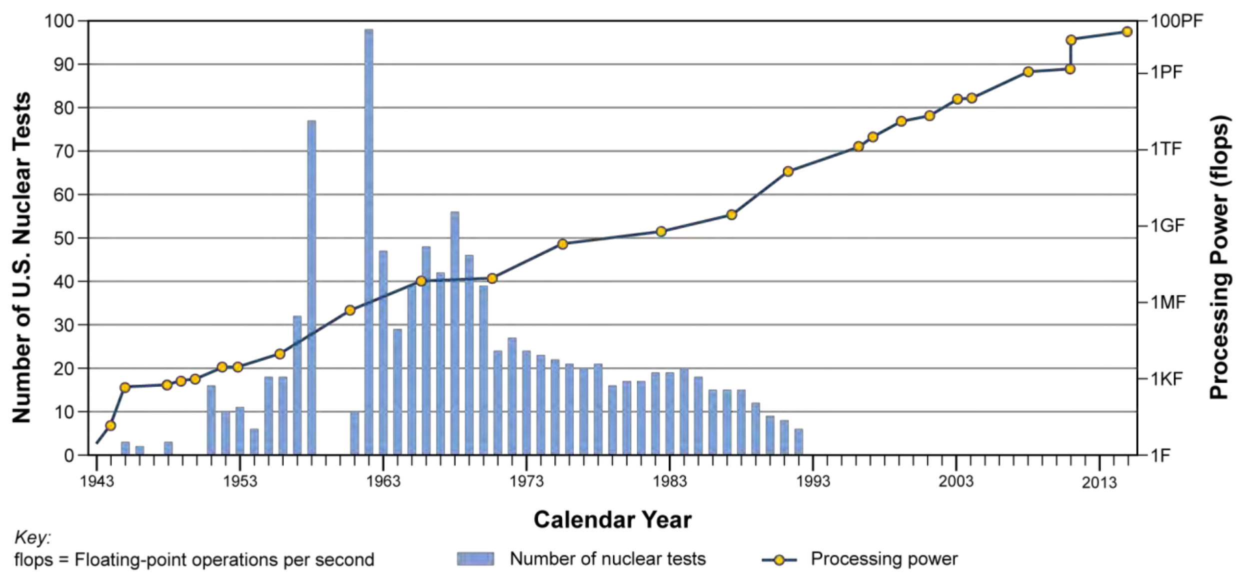

Figure 3–1. Processing power of the largest NNSA computing platform and number of nuclear tests

3.1.1 Recent Stockpile Stewardship Program Accomplishments

From its inception, the Stockpile Stewardship Program has played a major role in the full range of stockpile activities. Recent activities include design, development, and delivery of the B61-11 and W87 LEPs and ongoing W76-1 production and deployment and B61-12 development. Stockpile Stewardship modeling and experimentation capabilities also played a critical role in technology maturation for and design and qualification of the B61-12 and W88 Alt 370 and enabled the nuclear survivability qualification of several components.

In addition, the national security laboratories completed the Annual Assessments of the Stockpile each year and resolved all issues to date. The ability to manufacture pits was re-established at LANL and newly manufactured pits were built, certified, and deployed in replacement W88 warheads. The laboratories determined that certain limited life components could be replaced less frequently. New stewardship tools and capabilities have been applied to broader national security areas, including foreign nuclear weapon assessments, nuclear counterterrorism, advanced conventional munitions, climate modeling, energy security, and advanced nuclear materials detection.

Despite significant advancements in capabilities, a variety of open issues remain. These issues fall broadly into four areas: responding to current stockpile issues, sustaining the stockpile through LEPs, providing unique expertise and capabilities to support broader national security missions, and retaining expert stockpile stewards into the indefinite future.

3.1.2 Responding to Current Stockpile Issues – Component Lifetimes and Aging

A central Stockpile Stewardship challenge is assessing age-related failures sufficiently in advance to allow for correction. This challenge requires aging models for all weapon materials, components, and subsystems. Improved test capabilities, coupled with modeling, have been and are continuing to be developed to provide both functional testing of the full system and component-level performance data to support reliability calculations and aging assessments. For example, establishing confidence in the estimates of primary system lifetimes has been one of the most important stockpile management issues to date. Therefore, the national security laboratories have assessed pit lifetime estimates through experimental, theoretical, and computational studies to predict the performance of primary systems. The laboratories have also used the information to predict the minimum lifetime at which predicted primary performance could fall below the required margin to assure reliable system performance. Lifetimes can be lengthened through measures that increase the margin or reduce the uncertainties in system lifetime estimates.

The national security laboratories released the first system-specific pit lifetime estimates in 2006 using this methodology, and this work continues. To date, the laboratories have found no evidence that would decrease the 2006 lifetime estimates.

Currently, high-explosive-driven subcritical experiments are the only reliable way to obtain the pressures and temperatures that plutonium reaches in a primary implosion. Diagnosing these integrated experiments with sufficient accuracy to contribute to the assessment of performance of future 3+2 Strategy configurations and to elucidate the effects of aging is still a work in progress. This work includes the planned development of advanced radiography and neutron-diagnosed subcritical experiments (NDSE) at U1a.

The Stockpile Stewardship Program allows stewards to develop and deploy improved surveillance diagnostics to better assess the current state of the stockpile as it ages. Declining stockpile numbers are driving the reliance upon nondestructive testing for surveillance. Pantex routinely uses laser gas sampling and x-ray computed tomography. Similar laser gas sampling techniques have been deployed for canned subassembly surveillance at Y-12. Residual gas analysis and x-ray computed tomographic scanning are employed for non-nuclear components to detect evidence of aging or contamination that could adversely impact component functionality.

For Stockpile Stewardship's non-nuclear surveillance program, new evaluation techniques and specific component-level studies are enabling timely decisions to replace or reuse hardware in the stockpile. A recent contribution was identification of the underlying causes of delamination in a component that was creating new failure mechanisms. This delamination was subsequently mitigated *via* changes in production processes. Other recent contributions include development of techniques to nondestructively evaluate detonator characteristics to enable correlation to performance, new techniques to evaluate thermal batteries nondestructively, and new methods to evaluate lightning arrestor connector safety performance. All these efforts strongly leverage materials science and physics-based models.

3.1.3 Stockpile Stewardship Program's Role in Life Extension Programs

Stockpile Stewardship Program capabilities are essential to the success of the LEPs. Examples for the B61-12 and W88 Alt 370 include development of reliable, radiation-hardened compound semiconductor transistors to provide an adequate margin for hostile environment requirements; incorporation of high-fidelity modeling into the design process to reduce the number, duration, and cost of design cycles; and provision of validated modeling and experimentation capabilities to optimize qualification testing, as well as to enable qualification where test capabilities no longer exist (*e.g.,* for hostile environments). These changes can also affect certification of weapon systems by moving the systems away from the as-tested configurations.

Future LEP opportunities include pit reuse and converting systems that use CHE to IHE to improve safety and security, as well as to improve efficiency at the nuclear weapons production facilities. Pit reuse involves the challenge of designing and certifying an IHE implosion system to work properly with a pit that was originally designed and tested within a CHE implosion system. Experimental and computational capabilities developed under the purview of RDT&E will be critical to this effort.

Improved surety (safety, security, and use control), more cost-effective designs and production processes, and decreased waste streams are major challenges in weapons production. Using the Stockpile Stewardship Program's capabilities, NNSA has the opportunity to reduce the life-cycle cost of the weapon, including associated production processes, through an improved understanding of material properties, aging phenomena, and weapon performance.

3.1.4 Supporting Broader National Security Missions

The national security laboratories have long applied their nuclear weapons expertise to challenges other than maintaining the stockpile. These challenges include nuclear nonproliferation efforts, understanding the nuclear capabilities of adversaries, and assessing and countering nuclear threats. Such capabilities are essential to national security missions across the United States Government. Historically, these activities were built on the margin of the core Stockpile Stewardship Program, but the more complex global security situation today demands dedicated new experiments, enhanced theoretical and computational models, and additional reinterpretation of archival nuclear test data.

In addition, Stockpile Stewardship Program capabilities are increasingly being applied to develop advanced conventional (*i.e.*, non-nuclear) systems. In performing this work, national security laboratory experts are able to exercise critical nuclear design and engineering skills and provide broader experience and validation opportunities to Stockpile Stewardship capabilities, turning synergistic technology advancements in those areas into direct benefits for stockpile maintenance and sustainment (*e.g.*, enabling efficient modern radar design for LEPs).

3.1.5 Retaining Expert Stockpile Stewards into the Indefinite Future

Attracting and retaining world-class staff requires performing cutting-edge research that is both challenging and has a compelling mission. The national security laboratories have developed or maintained facilities that provide research opportunities that serve to attract and retain scientists and engineers. Aging and less-than-state-of-the-art capabilities have the opposite effect and adversely impact the quality of research. The core mission, sustaining the Nation's nuclear deterrent by developing the scientific understanding inside the Stockpile Stewardship Program, provides a wide range of research opportunities. These opportunities are supplemented by broader national security mission applications that provide some unique research challenges. In addition, the laboratories offer new staff the opportunity to team with more experienced staff to pursue world-class, cutting-edge research that is frequently unique to a particular laboratory and is funded by Laboratory Directed Research and Development.

3.2 Nuclear Test Readiness

The United States continues to observe the 1992 nuclear test moratorium. NNSA has maintained a readiness to conduct an underground nuclear test if required to ensure the safety and reliability of the stockpile or, if otherwise directed by the President, for policy reasons. DOE and NNSA has maintained a 24- to 36-month nuclear test readiness posture (response time) pursuant to Presidential Decision Directive 15 (1993) during a period when readiness to test was funded as an active program. NNSA's evaluation of test readiness response time has changed over the years, and the fundamental approach taken to achieve test readiness has also changed. The status of nuclear test readiness and associated facilities has not changed significantly since the 2014 SSMP. That information is provided in Chapter 4 of the 2014 SSMP.

In addition to the artifacts of nuclear testing (test site, holes, cranes, *etc.*), NNSA maintains test readiness by exercising capabilities at the national security laboratories and the Nevada National Security Site through the Stockpile Stewardship Program. Maintaining test readiness is a product of a robust, technically challenging Stockpile Stewardship Program, which invests in development of the necessary personnel and infrastructure. This strategy relies on reconstituting the remaining underground testing elements when needed, rather than maintaining obsolete facilities.

Operations such as subcritical experiments exercise the people, physical assets, and infrastructure support services required for an underground nuclear test. These include critical skills and formality of operations, ranging from weapon design; design, preparation, and fielding of advanced diagnostics; modern safety analysis; experiment execution; and recovery and analysis of data. These experiments are challenging multi-disciplinary efforts that enhance the technical competency of the nuclear security enterprise workforce.

3.3 Grand Challenges

As part of its Stockpile Stewardship Program work, including preparing the SSMP itself, the national security laboratories have identified several specific and challenging areas that require additional focus; these have been designated "Grand Challenges." Because of the classified nature of the specific applied problems, these Grand Challenges are described in greater detail in Chapter 3 of the classified Annex to this FY 2016 SSMP.

3.3.1 Certification of the Evolving Stockpile

Aging and stockpile modernization through LEPs inevitably introduce changes to the stockpile. Evolving threat environments may also introduce changes that must be certified within the limitations of the "no integrated nuclear testing" policy. These certification challenges require an evolving set of stewardship capabilities.

3.3.2 Boost

A key challenge for the Stockpile Stewardship Program is the area of boost physics, which is focused on improving the capability to develop an empirical understanding of initial conditions, as well as modeling and simulating boost and thermonuclear burn.

3.3.3 Vulnerability and Hardening

Warheads must be designed to operate even under extremely hostile environments or fratricide effects. In many cases, test capabilities do not exist to certify that stockpile hardware meets requirements, and RDT&E capabilities must be applied in order that design and qualification meet requirements. Addressing design and qualification involves complex multi-scale, multi-physics solutions, starting with detailed understanding of weapon outputs and ending with integrated system responses to the direct and indirect radiation effects. High-performance computational capabilities are required to evaluate the survivability of weapon systems under external radiation exposure from hostile environments or fratricide; such capabilities not only support qualification when test capabilities are not available, but also increase confidence when testing is representative, but not comprehensive. These capabilities are validated using limited nuclear test data, as well as by modern experimental capabilities that provide testing in harsh radiation environments at representative levels. As weapon configurations and requirements change, survivability in these environments must be reassessed and certified.

3.4 Management and Planning

NNSA's tools and approaches to address RDT&E are unchanged from the FY 2015 SSMP. NNSA continues to improve its planning processes by aligning activities with programmatic elements and recent stockpile decisions. The capabilities provided by RDT&E facilitate assessment of the stockpile condition, evaluation of the effects of anomalies on warhead performance, and implementation of solutions. RDT&E also supports broader national security issues by providing the capabilities needed to avoid technological surprise and assure confidence in weapons system performance.

3.4.1 Defense Programs Advisory Committee

To provide independent technical advice on key issues for NNSA, in 2013 the Office of Defense Programs chartered a Federal Advisory Committee Act–compliant advisory committee comprised of selected experts: the Defense Programs Advisory Committee (DPAC). This committee is made up of experienced experts and academics outside of both DOE and NNSA.

DPAC provides advice and recommendations to the Deputy Administrator for Defense Programs regarding stewardship and maintenance of the Nation's nuclear deterrent.

DPAC activities include, but are not limited to, periodic reviews of the diverse, major activities of the Office of Defense Programs through assessments of the Nation's stockpile, the RDT&E infrastructure needed to maintain the stockpile and the overall nuclear deterrent, and the nuclear weapons production facilities and related manufacturing technologies.

DPAC is also used for ongoing analysis of the Defense Programs mission and its foundation in national strategic policy (*e.g.,* the Nuclear Posture Review [DOE 2010], New START, and other relevant treaties); application of Defense Programs capabilities to broader national security problems; analysis of management issues, including facility operations and fiscal matters; and analysis of issues of broader concern to NNSA.

3.4.2 The Predictive Capability Framework

In the last decade, NNSA and the national security laboratories formulated the PCF, a framework to guide and communicate advances in "predictive science." Such advances are necessary to continue to allow certification without testing and to address the Stockpile Stewardship Program's Grand Challenges. The PCF reflects the assessment of where weapon science will be heading in the early to mid 2020s. The three NNSA national security laboratories developed a series of "pegposts" to progress systematically toward the ultimate goal of replacing calibrated simulations with higher fidelity, science-based simulations based on advances in weapon science research. These pegposts are also informed by known, out-year needs for stockpile maintenance and LEPs. Pegposts often become level 1 milestones two to three years before completion. Prior to being formally defined as milestones, pegposts can and are revised, moved, or deleted.

A host of enabling capabilities support advances in weapons science and engineering, including experimental facilities and computational tools. Major advances over the next decade have been identified and are captured in the revised PCF chart. The 13 pegposts are grouped under four lines or "strands" of activity: Primary Physics, Secondary Physics, Weapon Engineering, and Safety and Security, as illustrated in **Figure 3–2**.

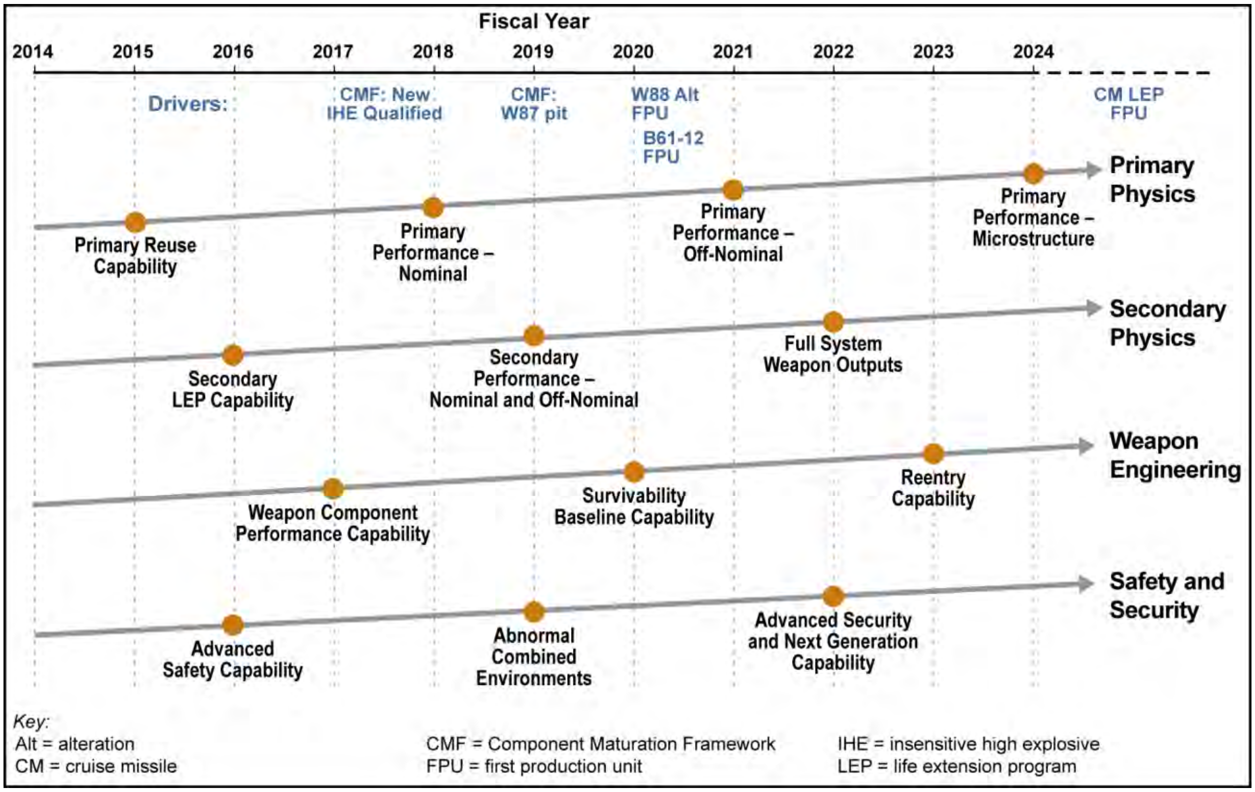

Figure 3–2. Version 2.0 of the Predictive Capability Framework, identifying major efforts required to advance stockpile assessment, sustainment, and certification capabilities

Each pegpost in Figure 3–2 represents a major effort to further integrate the scientific contributions to stockpile assessment or certification. Achieving these pegposts relies on advances in the enabling capabilities. The pegposts are based on computational simulations of increasing complexity that will require improvements in both the capability and capacity of high performance computing. Validation of the simulation models and advances in understanding nuclear weapon performance rely on the data from experimental facilities, such as DARHT, NIF, Z, as well as platforms at the Nevada National Security Site [*e.g.*, U1a].

Figure 3–2 identifies some of the motivating drivers of the PCF along the top of the figure. In addition to these specific drivers, the outcome of the PCF (*i.e.,* improved predictive capability in the form of simulation codes, models, and methods), requires other stockpile management and stewardship components, including the Component Maturation Framework (CMF), alterations, LEPs, and annual assessments.

The pegposts in FY 2015 and FY 2016 deliver the capabilities to assess primary reuse and secondary designs. These assessments will ensure the predictive science is in place to determine the most likely design options for the W80-4 (in the FY 2015 SSMP, this was the cruise missile warhead) and the IW-1, including pit reuse recertification and secondary reuse. The out-year PCF pegposts build on these capabilities by developing common models to quantify uncertainties in predictions, as well as models to assess the impact of variability caused by engineering, aging, or manufacturing. The culmination of all these advances will support the delivery of high-fidelity, full-system weapon outputs.

3.5 Experimental and Computational Capabilities

This section discusses the modeling and experimentation capabilities required for stewardship in three areas: modeling and simulation, HED experiments, and hydrodynamic (and subcritical) experiments. The section concludes with a description of smaller RDT&E activities that are beyond these three areas, but are crucial to long-term sustainment of the nuclear deterrent and support these three broad areas.

The Stockpile Stewardship Program's challenges demand a simulation-based predictive capability built on modeling and simulation efforts and the experimental facilities described in the following sections. Simulation and experiments are closely coupled. In addition to predicting and assessing nuclear weapons behavior and performance, simulations are used to design experiments. These calculations allow for more-cost-effective experiments by ensuring correct deployment of experimental components, particularly diagnostics. Experiments, in turn, are instrumental in advancing understanding of the processes taking place during weapon performance because they provide much of the fundamental material properties data for physically realistic predictions. They also serve as a means of validating the predictive capability of simulations.

3.5.1 Modeling and Simulation

The modeling and simulation capability developed for stockpile stewardship relies on Integrated Design Codes (IDCs), Science Codes, and high performance computing systems, together with the necessary infrastructure consisting of both software and hardware. Designers and analysts use IDCs to simulate component and system performance in normal, abnormal, and hostile environments for nuclear and non-nuclear components. Researchers use Science Codes to investigate specific phenomena in detail, resulting in the material and physical models utilized by IDCs. Calculations using both IDCs and Science Codes are performed on the Stockpile Stewardship Program's computing platforms.

The capability embodied in IDCs is a key integrating element used for weapon physics and engineering assessments of the Nation's stockpile. Much of the experimental data obtained by NNSA since the 1992 nuclear test moratorium, in addition to the legacy underground nuclear test data and the accumulated experience of the Directed Stockpile Work Program, are embodied in IDCs and in the models, algorithms, and related physical databases developed for them. IDCs are a principal tool used across the stockpile for design studies, maintenance analyses, experimental design, qualification, Annual Assessment Reports, LEPs, Alts, SFIs, warhead safety assessments, and weapons dismantlement.

The current predictive capability of IDCs is successfully supporting most of today's stockpile stewardship missions. However, as the life of the stockpile is extended and changes caused by aging, material replacement, advanced and additive manufacturing techniques, alterations, and modernization move the stockpile further from configurations tested in underground nuclear tests, maintaining the stockpile will require IDCs to be more predictive. Predictive capability is limited both by approximations in the physics models and the inability to resolve critical geometric and physics features at very small length scales. The proposed Matter-Radiation Interactions in Extreme (MaRIE) experimental facility (see Section 3.5.5) will interrogate materials in extreme environments and provide data to fill this gap in physical understanding.

Results from high-fidelity experiments, such as those conducted at NNSA's HED, hydrodynamic, and subcritical facilities, are instrumental in improving and validating the quality of the physics models used in the IDCs, as well quantifying the uncertainties in the models and codes. The purpose of the experiments is to recreate the unique environments occurring in the operation of a nuclear weapon as closely as possible.

Science Codes are used to generate physical models and data when it is impractical, impossible, unsafe, or prohibited by treaty to do so experimentally. Examples of such data include material strength and damage models, HE behavior, equations of state, x-ray opacities, and nuclear cross sections.

Exascale computing systems, which represent the next generation of computing systems, will reduce the need for some approximations, allow simulations to run at substantially smaller length scales, and enable more accurate quantification of margins and uncertainties. In addition, understanding the behavior of weapons materials created using advanced techniques such as additive manufacturing will require predictions spanning a large range of scales (from the mesoscale [the scale of the material's internal structure] to the scale of the weapon). Successful predictions will be enabled by an exascale computing capability coupled with an experimental diagnostic capability to measure the dynamic response of materials at the mesoscale in extreme environments. Details of the plan for achieving exascale computing are presented in Appendix C. The mesoscale experimental diagnostic capability provided by the MaRIE experimental facility is discussed in Section 3.5.5.

Exascale computing systems will present significant challenges, many of which are already present in today's quickly evolving computer systems. Two new computational systems that reflect the phases of the evolution toward exascale are Trinity, which will be located at LANL and will be ready for production use in FY 2017, and Sierra, which will be located at LLNL and will be ready for production use in FY 2019. The specifications for these systems are listed in **Table 3–1**.

Table 3–1. Specifications of Most Recent Advanced Computing Technology System Procurements

	Trinity	*Sierra*
Vendor	Cray	IBM
Peak FLOPS	>40 PetaFLOPS	120-150 PetaFLOPS
Number of Cores*	>760,000	TBD**
Number of Nodes	>19,000	TBD**
Power	<10 MegaWatts	10 MegaWatts
Memory	>2 PetaBytes (system total)	512 GigaBytes per node
Disk Space (usable)	>80 PetaBytes	120 PetaBytes
Processor Technologies	Intel® Haswell and Knights Landing	IBM Power® and NVIDIA® Volta Graphics Processing Units
Interconnect Network	Aries Dragonfly	Mellanox® Infiniband® fat tree

TBD = to be determined.
* The term "core" is roughly synonymous to the term "processor" used to describe older systems.
** Details will be publicly released prior to system delivery.

While procurement of some of the world's most capable computing systems is often newsworthy, the costs of these procurements represent only one-eighth of the resources dedicated to the development and maintenance of the Stockpile Stewardship Program's modeling and simulation capability. **Figure 3–3** shows the balance of the budgets for hardware system procurements, operations and software environments, and development of the models and codes.

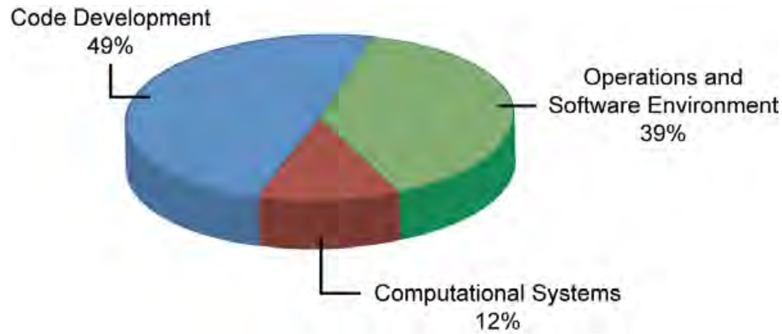

Figure 3–3. Modeling and simulation budget distribution (FY 2016 budget request)

3.5.2 High Energy Density Facilities

The operational sequence of a modern nuclear weapon multiplies the initial chemical energy stored in the HE by many orders of magnitude in achieving full system output. Energy densities become sufficiently high that plasma effects are important. Understanding this HED regime is critical to predicting the performance of nuclear weapons and understanding boost. Specific phenomena of interest include dynamic material behavior in extreme conditions, radiation transport, hydrodynamics, and thermonuclear burn, along with outputs and effects. Achieving the requisite conditions for HED experiments is only possible at facilities specifically designed to reach these conditions: NIF at LLNL, Z at SNL, and the Omega Laser Facility (Omega) at the University of Rochester's Laboratory for Laser Energetics.

The 192-laser-beam NIF was designed to produce the conditions required for thermonuclear ignition. With the completion of the National Ignition Campaign in 2012, (which did not reach ignition) NIF's role is expanding to tackle a broader array of weapons physics issues, such as material properties, radiation flow, thermonuclear burn, and outputs and effects, as well as continuing studies leading to thermonuclear ignition. NIF can reach higher densities, pressures, and temperatures than any other facility in the world. In 2015, NIF will begin experiments to determine the properties of high atomic weight materials, including very small quantities of plutonium, in conditions relevant to nuclear weapons performance. Working in tandem with Omega and the Z, NIF contributes to an array of national capabilities that are needed to probe fundamental weapons physics issues.

Z is a pulsed-power facility capable of delivering 26 million amps of current to small radii (10 centimeters and less), where the resulting electromagnetic forces drive dynamic experiments to investigate weapon physics topics such as the properties of materials, opacity, radiation flow, and thermonuclear burn. Z can access regimes of relevance to weapon operation and effects. Continued upgrades and improvements will realize Z's full pulsed-power potential of 32 million amps. The higher current will increase x-ray outputs for radiation effects experiments, as well as for studies of material equations of state and thermonuclear burn at higher magnetic pressures.

Omega is a 60-beam laser facility that provides a platform to conduct HED experiments that investigate physics issues for both weapons performance and inertial confinement fusion. The main Omega laser is supported by Omega EP [Extended Performance], an additional laser that can operate independently or in tandem with the main Omega laser. Both lasers include an extensive suite of optical, nuclear, and x-ray diagnostics to probe high-energy phenomena. In addition to fielding fundamental experiments, Omega contributes to diagnostic development and serves as a staging platform for energy experiments at NIF.

NIF, Z, and Omega are supported by many smaller-scale facilities, such as the Trident laser at LANL and the Jupiter laser at LLNL. These intermediate energy facilities enable experiments that do not require the highest energy densities and serve an important role in diagnostic development and calibration.

3.5.3 Hydrodynamic and Subcritical Experiments

The Stockpile Stewardship Program assesses the effects of aging and various manufacturing processes on proposed approaches to LEPs, SFIs, and other issues that affect the viability of the stockpile. To fulfill these responsibilities without nuclear testing requires hydrodynamic tests with surrogate materials and subcritical experiments using plutonium. These experiments, combined with theory, modeling, and simulation tools and other focused experiments, underwrite the confidence in the Nation's nuclear deterrent.

The Stockpile Stewardship Program has accomplished significant work on radiographic sources and other advanced diagnostic techniques. The DARHT facility at LANL, the CFF at LLNL, and the Cygnus Dual-Axis Radiographic Facility at the Nevada National Security Site produce high-speed radiographic images that contribute to understanding and simulation of weapon physics.

DARHT is a critical resource for characterizing the hydrodynamic conditions required for primary boost. The first DARHT axis generates a single x-ray pulse, and the second axis provides a multi-pulse capability to characterize the final moments of a primary implosion by producing time-dependent data. Other diagnostics include pin and photon Doppler velocimetry and high-speed cameras. DARHT's capabilities both improve NNSA's understanding of the current stockpile and help investigate issues of primary performance that will enable future primary reuse capabilities.

CFF provides single frame single-axis radiographic hydrodynamic test capabilities in a building that is rated for tests of the largest primaries in the stockpile. Multiple diagnostics are available for a single hydrodynamics test, including pin and photon Doppler velocimetry diagnostics, wide-angle radiography, and optical framing cameras.

In addition to these large-scale facilities, smaller installations provide data to inform NNSA's modeling and simulation capabilities and to study single physics issues of interest.

U1a at the Nevada National Security Site is presently the only facility where focused and integrated subcritical experiments, which mate HE with special nuclear materials, are conducted. Cygnus, located at U1a, provides a dual-axis radiographic source as part of the suite of diagnostics that produces data on the performance of surrogates and plutonium for refining models and understanding the early stage implosion of primaries. However, an integrated facility that can adequately diagnose the final stages of a primary implosion using plutonium does not exist.

To better diagnose this regime, NNSA developed a *Mission Need Statement and Program Requirements for Enhanced Capabilities for Subcritical Experiments* (LLNL-TR-650015) in February 2014. Following approval of CD [Critical Decision]-0 in September 2014, several requirements documents were developed that defined the robust radiographic requirements and other technologies, at various technical readiness levels, that could be evaluated in CD-1 (scheduled for September 2015). In addition, an NDSE capability, timed to fire late in conjunction with a subcritical experiment implosion, is being pursued to improve the ability to answer questions related to integral plutonium behavior. The details of the proposed experiments, facilities, and NDSE are included in Chapter 3 of the classified Annex to this 2016 SSMP.

3.5.4 Laboratory-Scale Science

The large projects and facilities described above crucially depend on a great deal of "small-scale science." This work is conducted by individuals or small teams using laboratory and plant facilities. The following describes some of the more prevalent small scale areas:

- **Nuclear physics.** Nuclear physics includes nuclear cross sections (probabilities of nuclear reactions), the physics of fission and fusion processes, and research into the synthesis of heavy elements. Currently, activity is mostly limited to work that supports reassessment of yield and safety studies.
- **Plasma and atomic physics.** This research area includes development of new radiation sources (such as neutron and x-ray sources for radiation effects studies and radiography), understanding atomic data relevant to modeling nuclear weapons performance and effects, and diagnostics and physical understanding of fusion physics on HED platforms.
- **Chemistry.** Major areas of chemistry and chemical research include analytical chemistry, inorganic chemistry, organic chemistry (including chemistry related to HE), physical chemistry, nuclear chemistry, and radiochemistry.
- **High explosives.** Nuclear weapons use HE to drive the primary to super-criticality. Consequently, the development of explosives, manufacturing, processing, safety, aging, and disposition are all essential core competencies of the nuclear weapons laboratories. It is essential to fully understand HE properties and performance in order to predict primary performance. A more detailed discussion of essential challenges related to explosives development and the challenges of converting to an all-IHE stockpile is provided in the classified Annex to this chapter.
- **Materials.** In the nuclear explosive package of a nuclear weapon, materials are subjected to extreme states of pressure, strain, strain-rate, and temperature. Such extreme states are typically several orders of magnitude greater than those obtained under ambient conditions. Predictive capability requires a detailed understanding of the fundamental physics governing the dynamic behavior of materials from ambient to extreme conditions. During a nuclear explosion, the range of relevant loading of materials may span six orders of magnitude or more. The extreme conditions are difficult to produce in laboratory or non-nuclear explosive systems and, in some physical regimes, must be probed using large facilities such as Z, DARHT, and NIF. For the complete weapon, including its non-nuclear components, the entire range of materials science, from theory and modeling to small-scale experiments to large integrated experiments, is required by the laboratories to understand material response in normal, abnormal, and hostile environments. The dynamic properties of a wide variety of materials (metals, ceramics, polymers, electronic materials, *etc.*) must be understood. This includes modeling and characterization of impacts from processing and fabrication on dynamic properties for materials used for or related to nuclear weapons.
- **Additive manufacturing.** Additive manufacturing, also known as 3D printing (including with metals), is an example of an advanced manufacturing technology that could have broad impact across weapons components and materials. Beginning in FY 2013, laboratory and plant sites began partnering to develop this technology for applications including tooling, stockpile components, and experimental testing hardware. NNSA is accelerating laboratory, plant, industry, and university co-development and scale-up of advanced manufacturing technologies, like additive manufacturing, for nuclear weapons missions. The proposed MaRIE facility

(discussed below) is intended to provide *in situ* measurement of microstructure evolution and materials performance under extremes of temperature, pressure, and shock loading.

- **Engineering science.** The ability to deliver a weapon safely and reliably; arm, fuze, and fire it and to be assured that it will function properly if, and only if, intended requires a broad suite of theoretical, computational, and experimental engineering research capabilities. These capabilities include structural mechanics, shock physics, fluid dynamics, thermal physics, and electromagnetics. The research is often multi-disciplinary and is coupled strongly with materials science and radiation science.
- **Radiation science.** Weapons can be subject to extreme hostile and fratricide environments, as well as to space radiation and intrinsic radiation environments. Research into the interaction of radiation with the weapon and its subsequent response is essential to meeting radiation requirements. This multi-disciplinary research is coupled with engineering and materials science. While many experiments require the environments provided by HED facilities (Z, NIF, Omega), unique capabilities at the Saturn, HERMES III, and Ion Beam Laboratory accelerators, as well as the Annular Core Research Reactor, are key to advancing this science.
- **Microsystems science.** The extreme radiation requirements for weapons can far exceed the capability of commercial microelectronics to survive and function. Microsystems research provides designs and manufacturing processes that enable devices and circuits to meet radiation requirements. System design and qualification requires strong engagement with radiation and engineering science.

3.5.5 Emerging Facilities

The MaRIE facility is currently in the planning stages. As proposed, MaRIE would combine many different types of diagnostic imaging probes (protons, photons, neutrons) for *in situ* characterization of materials under extreme conditions of temperature, pressure, and radiation to provide real-time measurements of states of matter and phase transitions. While each of the individual techniques intended for MaRIE exists at some level in different facilities in the United States and around the world, no facility to date has combined these capabilities in one location. When combined with diagnostic capabilities from across the national security laboratories and the modeling and simulation capabilities developed under the Advanced Simulation and Computing Program (ASC), MaRIE would, for the first time, allow rapid, thorough characterization of microstructure, physical properties, and material in a single facility. These capabilities are essential to achieving the goals of rapidly developing new materials from conception to fabrication, characterization, and application, while avoiding the indirect methodologies of the past and present.

To put this in context, consider some of the promise of advanced manufacturing. New manufacturing methodologies promise faster and possibly less wasteful fabrication of components, ranging from replacements of existing items to production of objects that may be impossible to fabricate with conventional techniques. However, unless the structure and performance of these materials and components can be characterized in an equally rapid manner, the series of characterization experiments could be long, expensive, and potentially cost prohibitive. The capabilities of MaRIE would facilitate such substitutions by allowing direct, *in situ*, real-time measurements of the structure, properties, and performance of both existing and new materials, and the generation of input for simulations would then enable more rapid introduction of new components. Hence, MaRIE could accelerate the adoption of advanced manufacturing, not just in nuclear weapons applications, but in any critical, high-technology applications. Furthermore, MaRIE would attract the scientists and engineers required to maintain a viable scientific community and, thereby, would enable long-term maintenance of the skilled workforce upon which the U.S. nuclear deterrent ultimately rests.

As envisioned, MaRIE will be located at Los Alamos, and include a first of it's kind X-ray free electron laser [XFEL] in tandem with the LANSCE facility. It is currently pre-CD-0 and is awaiting the generation of a mission needs statement.

3.6 Programs

3.6.1 Science Program

Science Program capabilities enable development and qualification of advanced safety concepts, new materials and manufacturing processes, reuse and other options for LEPs, and contributions to weapon lifetime assessments.

Key Science Program products and activities support: (1) stockpile Annual Assessments, (2) certification statements for LEPs and weapon modifications, (3) prompt resolution of stockpile issues (*e.g.,* SFIs, including aging issues), (4) development of certification methodologies for warhead reuse or remanufacturing options for future LEPs, (5) maintenance and exercise of nuclear-weapons-relevant capabilities through experiments and calculations for the Annual Assessments, and (6) development and maturation of technologies for the nuclear explosive package. Science Program products are developed in partnerships with ASC, the Inertial Confinement Fusion Ignition and High Yield (ICF) Program, the Engineering Program, and the Directed Stockpile Work Program.

One Grand Challenge is to understand and provide models for primary boost. The Science Program is making significant advances in understanding this phenomenon from the initial conditions required for boost to its subsequent dynamics and role in producing the primary yield of stockpile weapons. A second Grand Challenge is associated with the complex processes occurring during operation of the secondary. Activities supporting improved models of primary and secondary performance span a range that includes experiments to measure the properties of materials, hydrodynamic experiments, subcritical experiments that probe properties of plutonium in extreme conditions, and HED experiments at ICF facilities that study material in regimes that could otherwise only be examined in nuclear explosions. The benefits of these activities include not only accurate estimates of weapon yield, but detailed weapon outputs used for hostile environment design and qualification.

Implosion hydrodynamics studies advance nuclear primary science through complex, integrated experiments that test, validate, and improve primary models, as well as analyze material performance under relevant physical conditions.

Materials science is relevant to all nuclear weapons components and physics requirements. Relevant materials include plutonium, uranium, other metals, high explosives, polymers, foams, composites, and gases. Research in this area provides equation of state, thermodynamic, and constitutive property data to support development and certification of advanced theories and models for nuclear weapon performance. Materials data are also applied to validate models and simulation codes and are used to identify and develop new material options to support component reuse and LEPs. The experiments are conducted at several laboratory facilities, including PF-4 at LANL's Technical Area (TA)-55, Z, U1a, LANSCE, the Joint Actinide Shock Physics Experimental Research (JASPER) facility at the Nevada National Security Site, other gas and powder gun facilities, HE facilities and firing sites, and small-scale laboratories used for testing and characterization. The Dynamic Compression Sector, which is being developed at the Argonne National Laboratory Advanced Photon Source, boasts unique capabilities for coherent x-ray diagnosis of materials experiments under dynamic conditions. These include laser shock, gas and powder guns, coupled with dynamic imaging and x-ray diffraction, small angle x-ray scattering, and velocimetry to explore equations of state of materials, mechanical response, and reaction chemistry under shock conditions. Additively manufactured materials pose the unique challenge of performance characteristics defined by the manufactured microstructure, which would be interrogated at the proposed MaRIE facility.

Nuclear physics work is accomplished at LANSCE using the Time Projection Chamber, Chi-Nu capabilities, and the Device for Advanced Neutron Capture Experiments (DANCE) to provide nuclear cross section and neutron output spectra that underpin databases used to simulate transport, criticality, boost, and weapon output. The cross section work done at LANSCE recently has contributed to the first recent adjustment in the expected yield of an existing warhead in the current stockpile for several decades.

The Science Program also supports development of advanced experimental technologies. R&D continues on x-ray radiographic sources and the associated accelerators for subcritical experiments at U1a, as well as diagnostics at DARHT and CFF. Pulsed power development efforts include use of the Linear Transformer Driver accelerator technology for materials and hydrodynamic applications; the Precision High-Energy Density Liner Implosion Experiment (PHELIX) technology for proton-radiography-diagnosed hydrodynamics, transport, and boost-related experiments; and Z and its successors for technology development related to neutron sources, radiation physics, materials, and hydrodynamic applications. In addition, improving and developing the pRad proton radiography capability at LANSCE supports primary, secondary, and materials physics experiments.

The Capabilities for Nuclear Intelligence (CNI) initiatives expand predictive capabilities for application outside of the U.S. stockpile design domain, in support of non-stockpile national security priorities. CNI enables Intelligence Community assessments of foreign state programs and designs and provides opportunities to exercise the skills of weapons designers on challenges of national security importance. These initiatives have been ongoing for the past 4 years.

Although there is considerable overlap between the capabilities needed to sustain the U.S. stockpile and those needed to assess foreign weapon activities, CNI addresses the capability gaps resulting from basic differences between U.S. and foreign approaches to nuclear weapon design, production, and qualification. As foreign designs may be far outside the tested and validated U.S. design experience, CNI also provides critical weapon skills, training, and experimental opportunities for designers and engineers that are not provided during LEPs by simultaneously testing the limits of validity for stockpile tools and models. CNI is principally funded in the primary assessment sub-program of the Science program.

The subprograms of the Science Program also contribute to development of the future national security laboratory workforce through the Stewardship Science Academic Alliances. The Stewardship Science Academic Alliances funds university research in unique scientific fields that are relevant to stockpile stewardship but are not funded elsewhere by the Government or private industry. These include materials under dynamic conditions and in extreme environments, hydrodynamics, low-energy nuclear science and radiochemistry, and HED science. This is funded with contributions across all of the subprograms.

The five subprograms of the Science Program are displayed in **Figure 3–4** and are described in more detail in Appendix B. Milestones are provided in Figure 3–8, located at the end of this chapter.

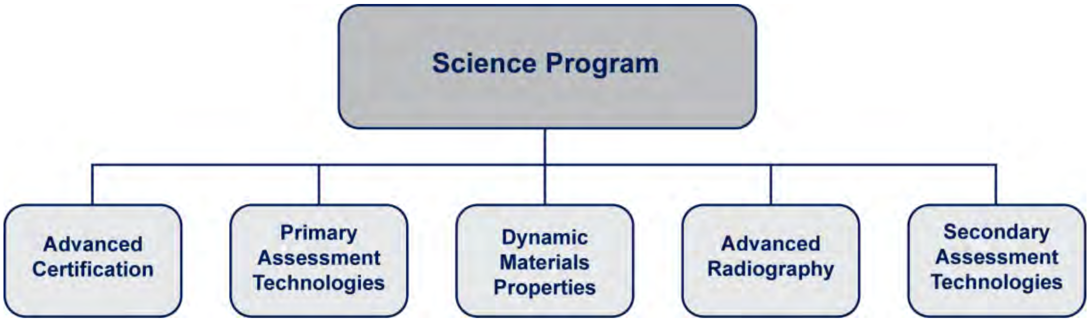

Figure 3–4. Subprograms of the Science Program

3.6.1.1 FY 2014 Accomplishments of the Science Program

- Executed two integrated hydrodynamic experiments in support of pit reuse concepts enabling future stockpile options at DARHT at LANL and CFF at LLNL.
- Conducted a total of five plutonium and five surrogate experiments on JASPER, as well as three plutonium experiments on Z to obtain data to improve the fidelity of plutonium multi-phase equation-of-state models.
- Continued assessment of the potential effects of plutonium aging and their impacts on pit lifetimes and reuse.
- Executed Leda at U1a, a scaled experiment that demonstrated new diagnostic capabilities for future subcritical experiments and exercised the nuclear security enterprise to satisfy the requirement to exercise capabilities to maintain the safety for Category 3 nuclear operations at U1a.
- Achieved approval of the Justification and Mission Need (CD-0) for enhanced diagnostics capabilities at U1a. LANL and LLNL finalized a joint radiographic requirements document for U1a entitled, *Primary Physics Requirements for a Proposed Enhanced Radiographic Capability in U1a* (LA-CP-14-007707). Significant progress was also made toward neutron diagnostics to be fielded at U1a by carrying out conceptual design and transport studies and testing neutron source technologies.
- Performed the first detailed estimates of plutonium cross-section uncertainties at LANSCE using the Time Projection Chamber. The Chi-Nu team also measured the relevant fission neutron spectrum; measurements and analysis of the actinide nuclear reaction data were performed using the DANCE array at LANSCE and the Triangle Universities Nuclear Laboratory.
- Made progress in evaluating additive manufacturing technologies using polymers and metals and in developing certification methodologies to address life-extension options.

3.6.2 Advanced Simulation and Computing Program

ASC provides the high-performance computing codes and systems that underpin stockpile stewardship. ASC IDCs serve as the computational surrogate for nuclear testing to predict weapon environments, effects, performance, and safety. ASC depends heavily on the understanding, experience, and data gained through Directed Stockpile Work and Science Programs. ASC and other programs are integrated through the PCF. In addition, ASC benefits greatly from collaboration with DOE's Office of Science for Advanced Scientific Computing Research.

In coordination with other Government agencies, ASC supports nonproliferation, emergency response, nuclear forensics, and attribution activities. ASC resources have been used to characterize special nuclear materials and devices *via* post-detonation analysis and to assess security-related mitigation strategies.

ASC created a new subprogram in FY 2014 called Advanced Technology Development and Mitigation to help develop advanced computing technologies to support stockpile stewardship and to mitigate the effects of these new technologies on NNSA's IDCs. This strategy recognizes the need for exascale computing capabilities to support out-year requirements for computational assessments, although the stewardship mission will continue to be accomplished with the available computational resources until such systems are available. As requested by Congress, ASC's plan for achieving exascale computing is outlined in Appendix C.[2]

The six ASC subprograms are displayed in **Figure 3–5** and described in more detail in Appendix B. Milestones are provided in Figure 3–9, located at the end of this chapter.

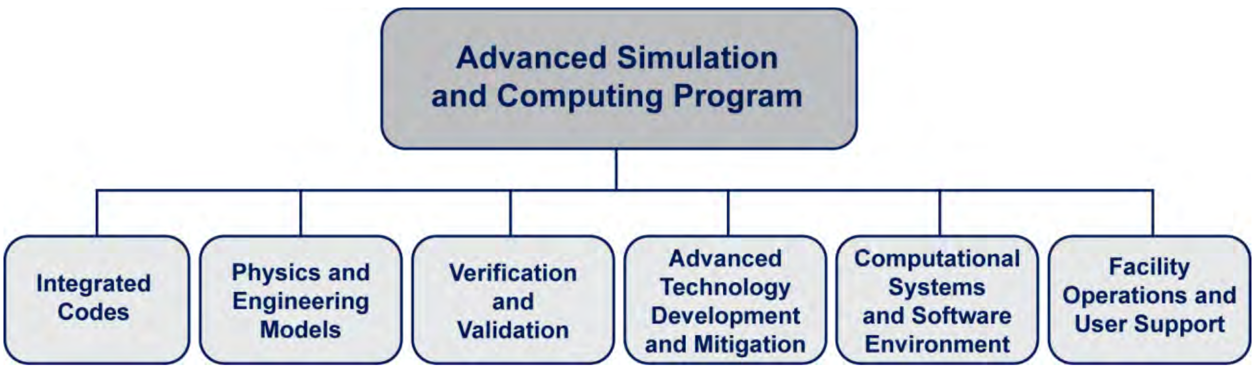

Figure 3–5. Subprograms of the Advanced Simulation and Computing Program

3.6.2.1 FY 2014 Accomplishments of the Advanced Simulation and Computing Program

- Provided B61-12 computational simulation support using ASC capabilities: modeled thermal-mechanical safety scenarios to determine representative conservative accident scenarios; completed simulations of the subsonic captive carry response for the Joint Strike Fighter; provided simulation-based design assessment of the aerodome, impact sensor, and firing control unit.
- Provided W88 Alt 370 computational simulation support using ASC capabilities. In collaboration with the Engineering Program, completed a cavity system-generated electromagnetic pulse validation study of experiments on Z. Implemented an improved x-ray air-transport database that led to more accurate definitions of internal x-ray component requirements. Developed models for turbulent boundary layer, base pressure fluctuations, and atmospheric turbulence, consistent with aerodynamic loadings expected during normal atmospheric reentry of the Mk5/W88.

[2] *The NNSA plan for exascale computing is provided in response to the request in Public Law 113-66, National Defense Authorization Act for Fiscal Year 2014, Sec. 3129 Plan for Developing Exascale Computing and Incorporating Such Computing into the Stockpile Stewardship Program).*

- Supported the W78/88-1 LEP mechanical design, specification of component environments, and subassembly tests.
- Demonstrated a new hydrodynamics method for use with models that are crucial to the FY 2015 LANL/LLNL Energy Balance II milestone.
- Improved hydrodynamics and strength modeling capabilities for more realistic simulations of material break-up.
- Completed 3D Global Security simulations on the Tennessee Valley Authority's Sequoia nuclear plant using over 2 billion computational cells.
- A highly scalable transport modeling capability was released that enables design physicists to complete accurate weapon assessments much faster than previously possible.

Critical Skills and Peer Review

During the process to vet a modern ASC code for annual assessment calculations, LANL's B61 team discovered a discrepancy between the ASC code, the trusted "legacy" code, and a hydrodynamics experiment. Unfortunately, the team did not have staff available with the right experience and skills to address the discrepancy promptly.

Following an internal review, LANL called on LLNL to perform an informal peer review. After a lengthy process involving a careful comparison to LLNL code results, exchanges with experts at SNL, comparison to additional hydrodynamics experiments, and a substantial effort to rebuild critical skills and knowledge, the discrepancy was resolved.

As this example illustrates, a lack of skills can result in errors in the codes and the manner in which they are run. In the absence of nuclear testing the Nation depends critically on the accuracy of its simulation codes and the expertise of its workforce.

3.6.3 Engineering Program

The goal of the Engineering Program is to develop capabilities to assess and improve the safety, security, effectiveness, and performance of the nuclear explosive package and non-nuclear components throughout a weapon's lifetime. The purpose is to ensure confidence in the design of all components and subsystems and increase the ability to predict their response to external stimuli (*i.e.,* large thermal, mechanical, and combined forces and extremely high radiation fields) and aging effects, as well as to develop essential engineering capabilities and infrastructure. The program includes advanced technology development and physics discovery experiments supporting design and qualification, including validation of advanced modeling capabilities. The Engineering Program also provides a sustained basis for certification and assessment throughout the life cycle of each weapon.

FY 2016 objectives include the following:

- Support design and qualification for the B61-12 and W88 Alt 370, as well as future LEPs.
- Provide a formal process to mature improved safety and security technologies using the *Technical Basis for Stockpile Transformation Planning*.
- Provide fundamental, sustained R&D on the engineering basis for stockpile assessment and certification.
- Assess and improve fielded nuclear and non-nuclear components.
- Increase the ability to predict the response of weapon components and subsystems to aging and to normal, abnormal, and hostile environments.
- Advance components and materials testing to minimize or avoid destructive testing while ensuring high-level reliability and certification.

The four subprograms of the Engineering Program are displayed in **Figure 3–6** and are described in more detail in Appendix B. Milestones are provided in Figure 3–10, located at the end of this chapter.

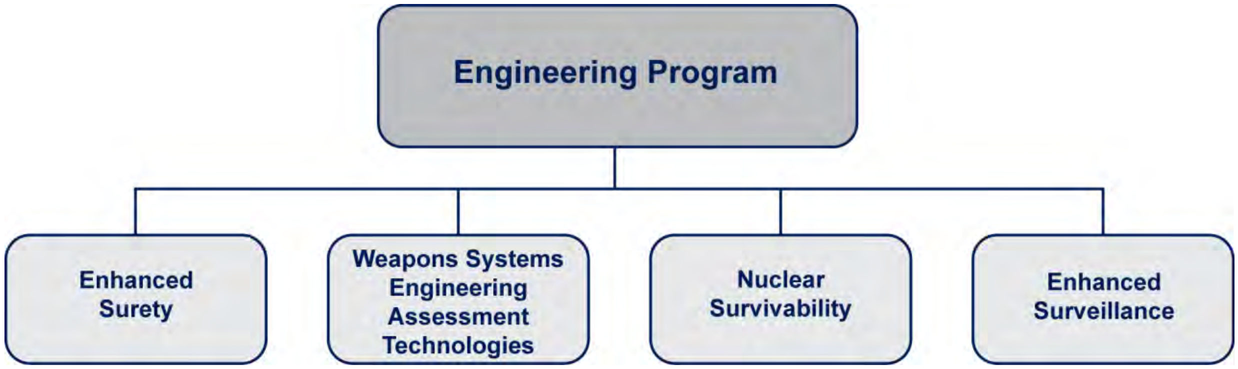

Figure 3–6. Subprograms of the Engineering Program

3.6.3.1 FY 2014 Accomplishments of the Engineering Program

- Provided validation data set for a coupled thermal-mechanical thermal battery model that will be used for the B61-12, the W88 Alt 370, and future battery design and testing efforts.
- Acquired one data set on the thermal-structural response of laser welds that will be used to validate simulations for B61-12 qualification.
- Fielded the first ever radiation experiments for cavity system-generated electromagnetic pulse effects at NIF in collaboration with the United Kingdom's Atomic Weapons Establishment during two experimental series.
- Validated a model prediction at SNL for a heterojunction bipolar transistor, which is relevant to upcoming weapon system alterations and will be compared against data gathered at the Annular Core Research Reactor.
- Developed Spectrally Encoded Imaging, a new diagnostic technique used to interrogate HE during testing.
- Developed an improved firing set disassembly process for surveillance, thereby reducing the cycle time and greatly reducing the impact on the quality of the recovered components.
- Completed B61-3/4/10 System Tester Qualification Engineering Release.
- Generated a validation data set for PBX 9502 explosive in a weapon configuration that was subjected to several thermal cycles.
- Performed a radiation transport calculation of a hostile neutron attack using an engineering analysis baseline model of a warhead that had assembly and reentry preloads applied.
- Additively manufactured experimental fixturing and select components were used in hydrodynamic testing, demonstrating the current capabilities of additive manufacturing to accelerate testing and support product innovation. In addition, some components were developed that would have been extremely difficult to produce conventionally.

3.6.4 Inertial Confinement Fusion Ignition and High Yield Program

The ICF Program provides scientific understanding and experimental capabilities in HED physics to validate the simulation codes and models used to maintain a safe, secure, and effective nuclear weapons stockpile without underground testing. More than 99 percent of the energy from a nuclear weapon is generated in the HED state (pressures greater than 1 megabar). ICF operates and conducts experiments in facilities that create these HED conditions. This experimental basis, combined with archived legacy data from the underground test program, gives confidence in the codes and models used to support annual assessments and certifications, plan LEPs, and resolve SFIs. ICF facilities (such as NIF, Z, and Omega) provide the only platforms on which the simulation codes that couple transport processes with hydrodynamics models can be experimentally validated.

ICF supports stockpile stewardship through two principal experimental directions. First, it conducts non-ignition HED physics research, develops diagnostics, and provides experimental expertise. Ongoing experiments explore issues in materials science, radiation transport, and hydrodynamics to provide a fundamental scientific knowledge relevant to nuclear weapons and to test the codes and models that underpin stockpile confidence. Second, the ignition HED physics effort is dedicated to developing thermonuclear burn and, ultimately, to demonstrating ignition in the laboratory. The demonstration and application of ignition, when and if ignition is demonstrated, and thermonuclear burn will validate models in the most extreme conditions generated in a nuclear explosion that cannot be reproduced in the laboratory in any other way; that demonstration remains a major goal for NNSA and DOE.

Early ignition experiments showed differences between code predictions and data, revealing physics unknowns and technical complexities that will require time to study and resolve. Advances in diagnostics and experimental techniques have provided improved insight into where models are diverging from experiments, and more recent experiments have demonstrated advances toward the physics regime that are of great interest to the weapons program. Implosions designed to be more hydrodynamically stable, with a lower convergence ratio (the ratio of the initial radius of the capsule to the final radius), have resulted in performance that is closer to code simulations and close to the onset of alpha heating (significant heating of the capsule gas by alpha particles emitted by fusion reactions). Future progress in this area will require better understanding and control of hydrodynamic instabilities and implosion symmetry. It is important to continue pursuing this Grand Challenge to maintain scientific leadership and credibility, while recruiting scientists and engineers who will participate in stockpile stewardship. Much of this research is open and shared; hence, ICF research provides an avenue to establish the quality of relevant science through the broader scientific community, thereby directly supporting deterrence.

The six ICF subprograms are displayed in **Figure 3–7** and are described in more detail in Appendix B. Milestones are provided in Figure 3–11, located at the end of this chapter**.**

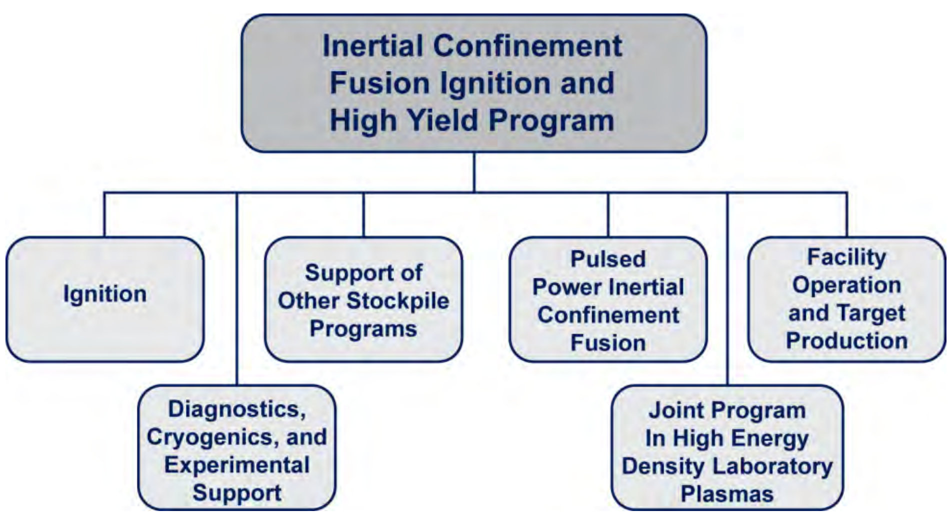

Figure 3–7. Subprograms of the Inertial Confinement Fusion Ignition and High Yield Program

3.6.4.1 FY 2014 Accomplishments of the Inertial Confinement Fusion Ignition and High Yield Program

- Developed a ten-year strategic vision for the HED sciences, consistent with the DOE Strategic Plan.
- Conducted a comprehensive review that addressed the experimental program at NIF and the alignment of that effort with the ten-year vision.
- Made progress toward achieving ignition in the laboratory:
  - Demonstrated a new, more-stable, indirect-drive-ignition design in which performance at NIF is improved (with neutron yields approaching 10^{16} and significant heating from alpha particles).
  - Conducted the first indirect-drive experiments at NIF with alternate ablators (beryllium and high density carbon).
  - Achieved highest neutron yields to date in ignition-relevant, direct-drive, cryogenic target implosions at Omega.
  - Conducted the first integrated magnetized liner inertial fusion experiments using Z, with both magnetization and laser-plasma preheating.
  - Showed symmetry control in polar, direct-drive experiments at NIF that provide understanding of the relevant laser-plasma interaction conditions.
- Completed a community-led, 120-day study on improving operational efficiencies at NIF.
- Demonstrated improvement in shot rate and efficiency at NIF during FY 2014; implemented many of the recommendations from the 120-day study.
- Performed many non-ignition HED experiments at NIF, Omega, and Z, including equation of state and strength (also including plutonium at Z).
- Prepared a five-year National Diagnostics Strategy that unifies the approach to diagnostic investment at Omega, Z, and NIF.
- Established an ICF/HED Review Panel to conduct a major ICF program review in FY 2015.

3.6.5 Other Programs

The unique normal, abnormal, and hostile environment requirements for warheads significantly constrain the technologies that can be applied to provide critical weapon system functions. Even where commercial products may perform similar functions, materials and design specifics cannot be easily modified to meet system requirements. Advanced technology development is aimed at ensuring warhead reliability in all required environments, while also enhancing safety and security. Advanced technology development efforts span fundamental research in the materials, radiation, microsystems, and engineering sciences toward application of established engineering design capabilities. Such advanced technology development may take years to achieve a technology readiness level that is suitable for final system-specific technology maturation during the full-scale engineering development for an LEP.

In addition to the Science, ASC, Engineering, and ICF Programs, portions of other programs also provide RDT&E capabilities for the advanced technology development activities described in this chapter. These include capabilities in RTBF Program Readiness, which developed the compound semiconductor transistor technology that will be inserted into the B61-12 and W88 Alt 370. RTBF Program Readiness also develops and nurtures critical skills, including R&D skills.

3.7 Milestones, Objectives, and Future Planning

Milestones for the Science, ASC, Engineering, and ICF Programs are provided in **Figures 3–8** through **3–11**. Many milestones presented in earlier versions of the SSMP have been revised or eliminated so that the programs can be better aligned with the most recent version of the PCF. The current program milestone figures include, in fact, milestones that are identical to the PCF pegposts and are indicated by the prefix "PCF."

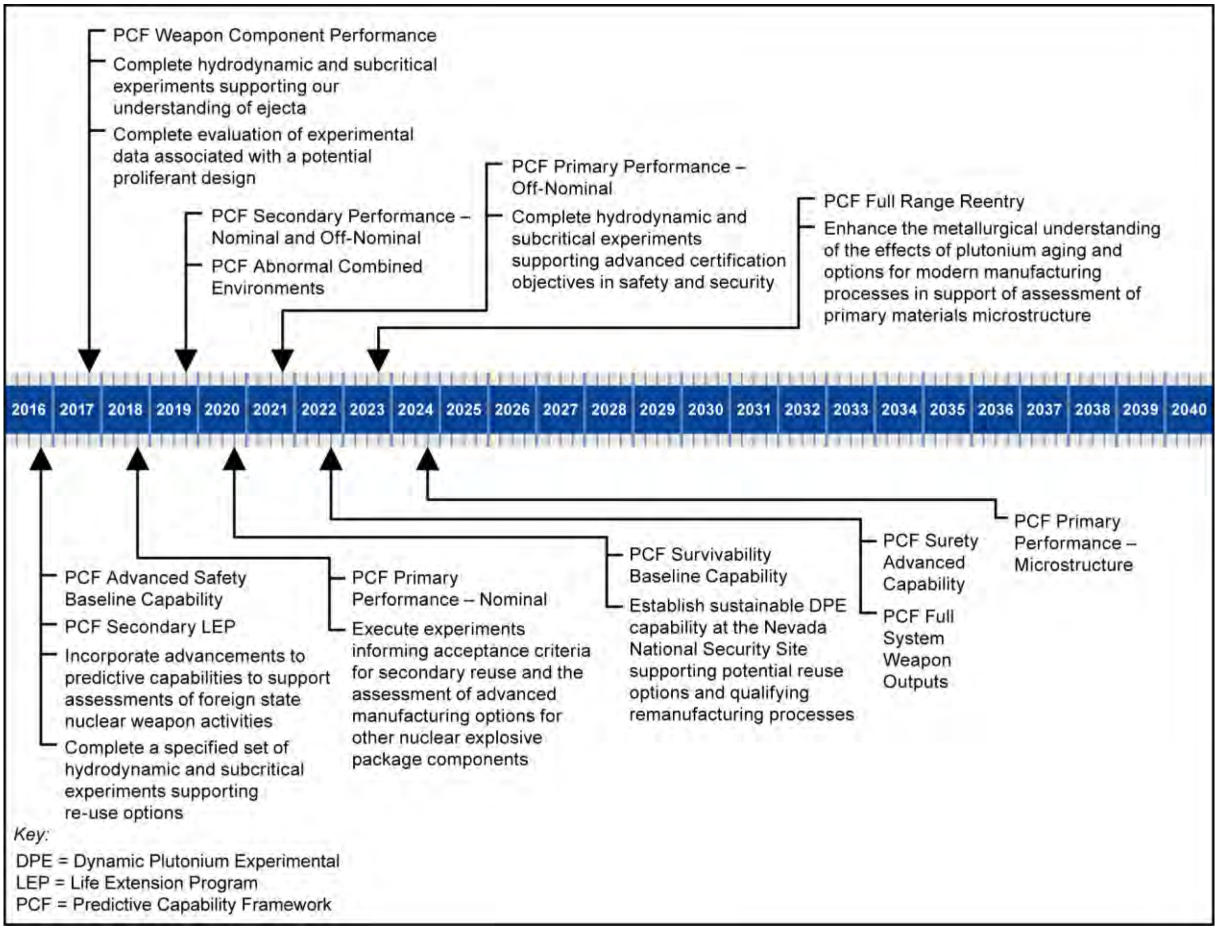

Figure 3–8. Experimental and analysis milestones and objectives led by the Science Program

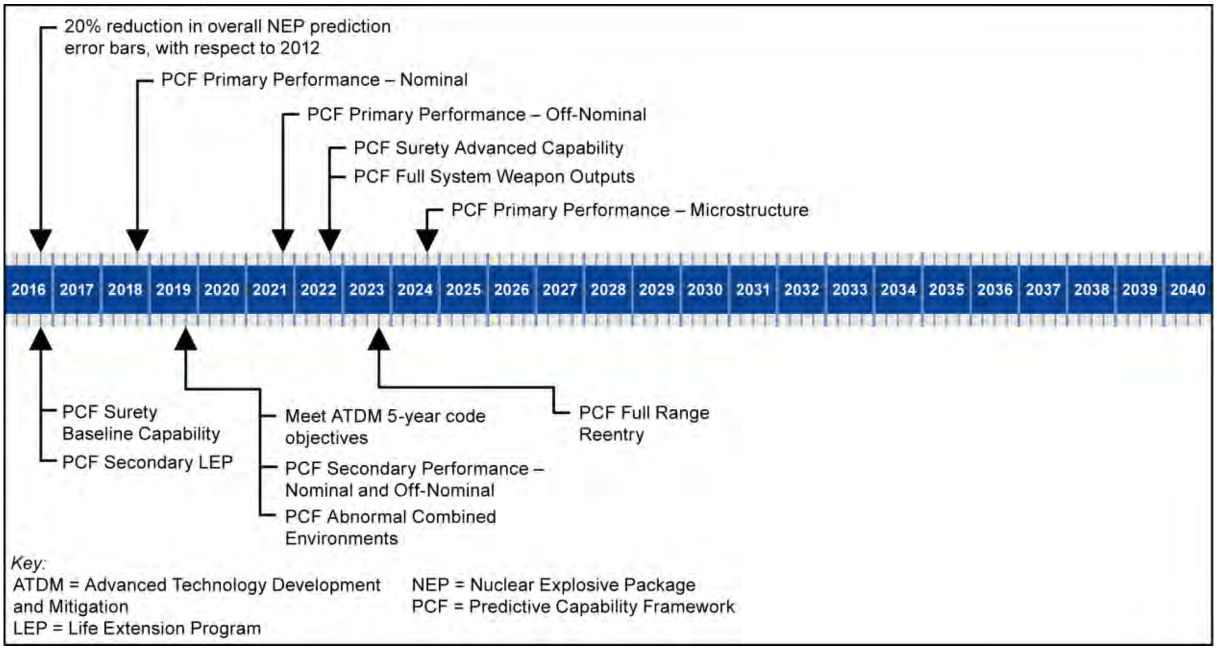

Figure 3–9. Computational milestones and objectives led by the Advanced Simulation and Computing Program

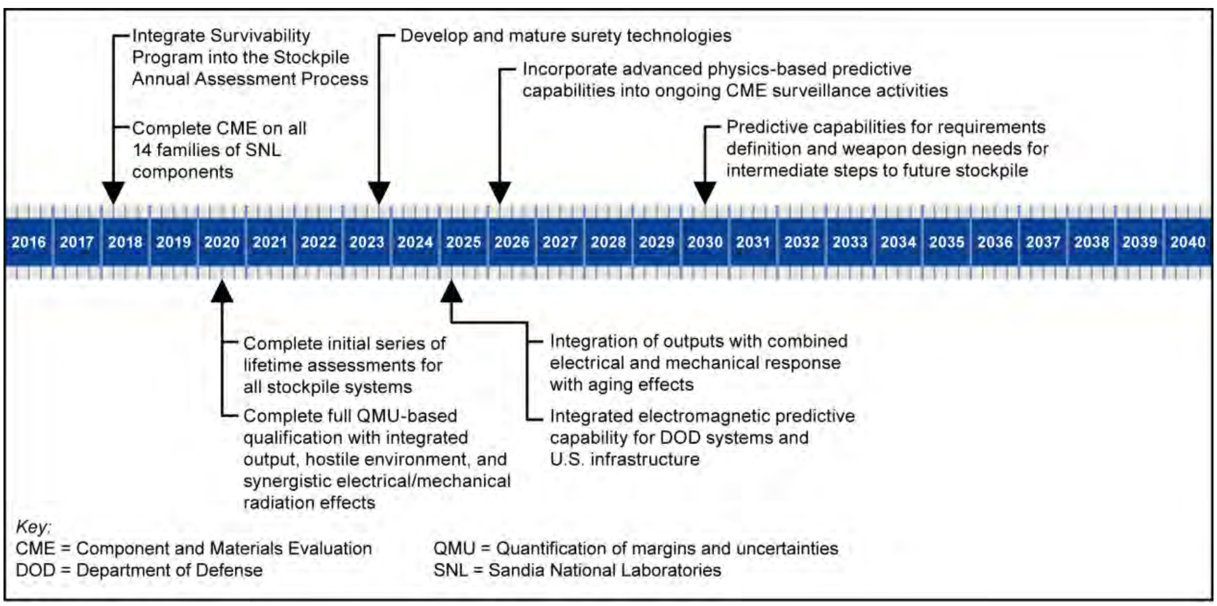

Figure 3–10. Engineering and technological milestones and objectives led by the Engineering Program

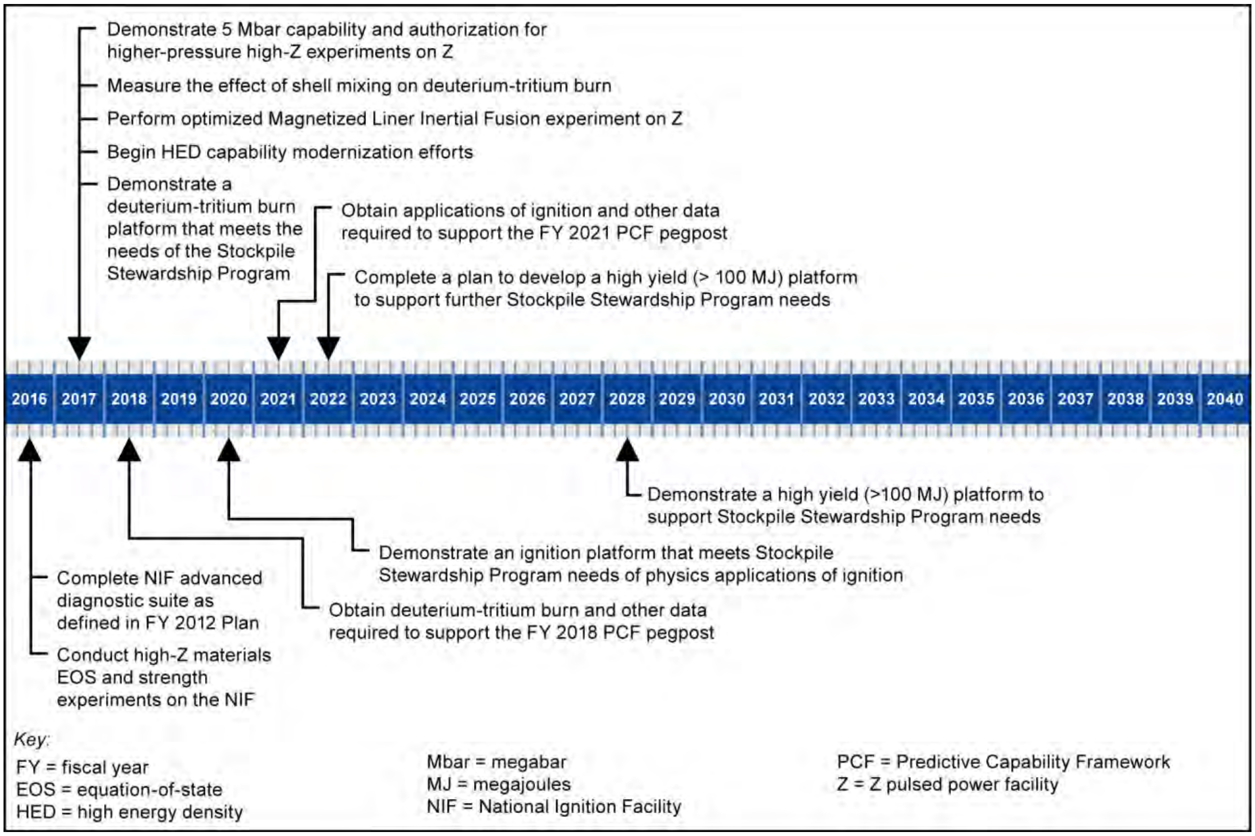

Figure 3–11. Milestones and objectives based on experiments on NNSA's high energy density facilities and led by the Inertial Confinement Fusion Ignition and High Yield Program

Chapter 4
Revitalize Physical Infrastructure

The stockpile management programs described in Chapter 2 require specialized, unique facilities and equipment to extend the life of the Nation's weapons, dismantle retired weapons, perform surveillance, and replace LLCs. Among these are metallurgy and chemistry laboratories, nuclear reactors, and special rooms called bays and cells, where nuclear explosives can be assembled and dismantled. Also required are various types of equipment, such as pressing machines and lathes, melting furnaces, and silicon chip manufacturing equipment. The process of sustaining the nuclear weapons stockpile requires many different hazardous materials that must be specially stored and kept secure, and produces hazardous waste streams that must be processed in specialized facilities to protect the environment and the public. NNSA's RDT&E programs, described in Chapter 3, require specialized, unique experimental and diagnostic equipment, such as high-powered lasers, particle accelerators, advanced radiography equipment, many of the world's fastest computers, and the facilities to house them. The national security laboratories, nuclear weapons production facilities, and the Nevada National Security Site also require reliable general purpose infrastructure to house their one-of-a-kind programmatic facilities and equipment, as well as utilities, roads, fire-suppression systems, and other safety systems. Without this physical infrastructure, the NNSA mandate to maintain a safe, secure, and effective nuclear stockpile would not be possible.

Sustaining and recapitalizing NNSA's infrastructure is a complex, difficult, and expensive task, complicated by the fact that a majority of these assets are well beyond their designed service lives. More than half of NNSA's buildings are over 40 years old, and 29 percent date to the Manhattan Project era. As a specific example, **Figure 4–1** shows the age of construction of the buildings at Y-12.[1]

This chapter describes NNSA's recent achievements, the challenges it faces in managing infrastructure issues, and the plans put in place to overcome these challenges in a portfolio that is so vital to NNSA's mission.

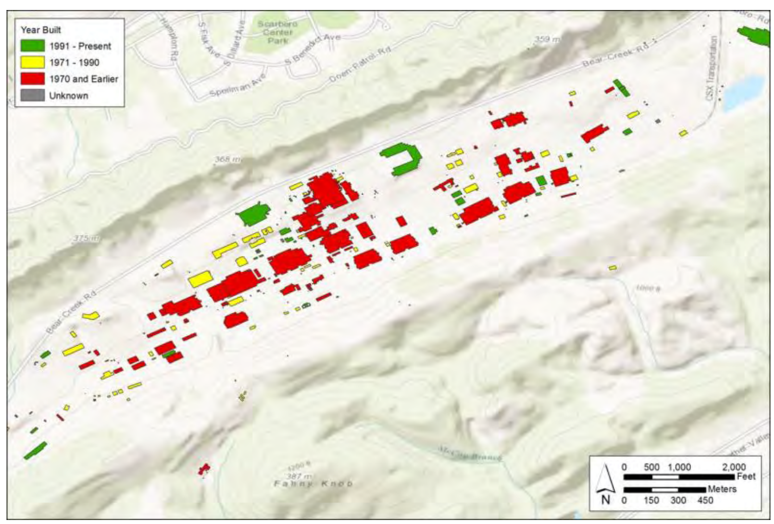

Figure 4–1. Data on the age of Y-12 buildings from the G2 Program Management System

[1] *Appendix D, "Workforce and Site-Specific Information," contains detailed information about the NNSA sites.*

4.1 Introduction

NNSA's physical infrastructure is funded and managed in two categories.

- **General Purpose Infrastructure** includes all of the facilities, infrastructure (such as roads and fire suppression systems), site utilities, and equipment that are not specifically program focused, but support mission execution. Also included in this category are building envelopes (*e.g.*, roofs, walls) that house the programmatic infrastructure, as well as surveillance and maintenance of excess general purpose and programmatic infrastructure.
- **Programmatic Infrastructure** includes the equipment, core capabilities, and processes housed and enabled by the general purpose infrastructure. Programmatic infrastructure allows NNSA to carry out research, testing, production, sustainment, and disposition related to the entire range of its national security commitments.

These infrastructure categories have both similarities and some important differences, leading to distinctive approaches and processes in both short- and long-term management of their assets. Both categories of infrastructure must be maintained safely throughout their life cycles until their eventual disposition. The following sections describe the specific strategies NNSA has implemented to provide and sustain the facilities and equipment necessary for performing the NNSA mission.

FY 2014 Physical Infrastructure Accomplishments

- *Relocated non-nuclear component manufacturing from the Bannister Federal Complex to a new, leased National Security Campus in Kansas City.*
- *Completed the Nuclear Facility Risk Reduction Project at Y-12 to address short-term infrastructure risks.*
- *Completed HE Pressing Facility construction at Pantex $30 million under budget.*
- *Improved infrastructure condition assessment, maintenance, and planning:*
  - *Initiated Laboratory Operating Board Process for Facility Condition Assessment.*
  - *Adopted Mission Dependency Index to provide a more accurate indicator of how each asset supports the mission.*
  - *Deployed G2 Program Management System.*
  - *Selected BUILDER as new NNSA facility assessment system.*

To date, NNSA infrastructure has successfully enabled execution of the mission. Several new mission-critical facilities have been completed; facility availability and utility reliability have remained high; interim investments are in progress; and more investments are planned to manage risk in the short term. NNSA has laid the groundwork for more integrated, nuclear security enterprise-wide planning. For the general purpose infrastructure, NNSA has initiated vastly improved management tools that allow improved assessment, better visibility of infrastructure condition, and facilitate improved management and decision making. On the programmatic side, NNSA has assigned managers to key mission-critical commodities. The commodity managers are developing strategies for ensuring continued production and processing for uranium, tritium, and plutonium activities. This may include replacing or repurposing existing facilities and replacing or relocating process equipment. In addition, plans are in place to replace aging facilities and equipment for capabilities that do not have specified commodity managers, but are just as necessary to the future stockpile, such as lithium and HE production and processing.

However, significant recapitalization is required to revitalize the infrastructure during the 25-year planning period. A significant portion of NNSA's infrastructure has aged well beyond its useful design life and requires revitalization or disposition. The aging infrastructure issue has been reported in

Government Accountability Office documents and in independent reviews chartered by the Secretary of Energy in 2005 and 2008 and by Congress in 2014.[2]

The latest review, by the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, recognized the magnitude of these challenges, as reflected by the following statement in their report:

> *"Throughout the enterprise, the panel heard evidence of failing infrastructure, lack of sufficient funding, and practices that will inevitably increase future costs."*

The complexity of these challenges was also noted by the panel:

> *The complexity of ongoing modernization requirements, coupled with addressing safety, security, and environmental issues in an increasingly austere budget environment, requires holistic and integrated decision-making mechanisms to meet operational requirements and find cost-saving solutions across the enterprise.*

Without sustained investment, risks to mission execution and worker, public, and environmental safety will increase as infrastructure elements that underpin critical mission areas continue to age and approach failure.

4.2 General Purpose Infrastructure

4.2.1 Current State

Management of the physical infrastructure assets for any technical enterprise is a complex task. Good stewardship depends on balanced allocation of resources in four areas:

- providing new assets,
- operating and maintaining existing assets,
- periodically renewing and reinvesting in existing assets, and
- disposing of assets at the end of their useful life.

4.2.1.1 NNSA as a Unique, Diverse, and Complex Enterprise

The operations at each NNSA-owned site comprise a vast array of facilities, utilities, infrastructure, and equipment, many of which are highly specialized, to support mission deliverables. The DOE Facilities and Infrastructure Management System (FIMS) reports more than 6,300 assets, representing more than 38 million gross square feet, that are owned by NNSA. The buildings alone are equivalent to six Pentagons. In addition, thousands of items of programmatic equipment support R&D, design, production, experimentation, and testing in support of operations and deliverables. NNSA owns over 2,000 square miles of land, 2,500 miles of paved roads, and all the other utility systems that normally serve such an enterprise. In effect, each site is like a city with a major industrial park designed to perform one or more of the NNSA primary missions.

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[2] *Secretary of Energy Advisory Board Report (aka Galvin Report) 2005; Supplemental Programmatic Environmental Impact Statement (SPEIS), December 19, 2008; A New Foundation for the Nuclear Enterprise: Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, November 2014.*

In FY 2014, NNSA allocated more than $1.1 billion to manage the general purpose and programmatic infrastructure, which represented 13 percent of the Weapons Activities account budget. Of that amount, $590 million was used to maintain facilities, while an additional $225 million was used to purchase utilities (electricity and natural gas) and operate central steam plants. The remaining dollars were used to replace or recapitalize the most critical infrastructure through the recapitalization prioritization process. Maintenance and operations are, for the most part, fixed annual costs of supporting the mission and are difficult to reduce without substantial investment in new facilities or reduction in the number of facilities.

Even with several challenges during FY 2014, such as leaks in fire suppression systems and spalling of concrete ceilings, no NNSA mission delivery schedules were delayed by failures in the general purpose infrastructure. This is remarkable because of the aged and deteriorated nature of some of the equipment and facilities and is a tribute to the hard work and teaming of the field offices and the staff of the M&O partners. However, the general purpose infrastructure is not sustainable forever and will require significant reinvestment and replacement to ensure continued mission success.

4.2.1.2 Management of Aging Facilities and Controlling Growth of Deferred Maintenance

Periodic reinvestment and renewal is essential to maintain the vitality of the infrastructure and control maintenance costs. The expected service life for facilities varies by type of building; however, with adequate sustainment during their lifetimes, buildings that house scientific laboratories are generally expected to have service lives of 50 years, and administrative buildings are expected to last 75 years. As mentioned, more than half of NNSA's buildings are over 40 years old, and 29 percent date to the Manhattan Project era. In addition, many of these facilities have not had adequate sustainment over their lifetimes. This has potentially shortened the useful life span of some facilities and increased maintenance costs and recapitalization needs. The age of NNSA's facilities presents a unique challenge to continuing to maintain safe operations to meet mission demands.

Moreover, in recent years, the limited availability of capital and maintenance funding has contributed to a steady growth in deferred maintenance,[3] which totaled $3.7 billion at the end of FY 2014 for NNSA. In response to Secretarial direction, NNSA's FY 2016 budget provides funding necessary to ensure no increase in deferred maintenance (DM) relative to the FY 2015 year-end DM level. In addition, Congress has directed NNSA to develop and submit a ten-year strategic plan that would reduce the deferred maintenance backlog below FY 2014 baseline levels and dispose of unneeded facilities.

4.2.1.3 Increased Resources for Disposal of Aging Assets to Increase Operating Efficiency

Failure to dispose of assets that can no longer support the mission imposes a penalty in unnecessary maintenance and operating costs. For example, NNSA assets currently awaiting disposal (which constitute 12 percent of all NNSA assets) consumed $48.7 million in FY 2014 for environmental monitoring and utilities mandated to meet life safety codes. These facilities do not contribute to NNSA mission deliveries, but continue to require substantial funds.

[3] *Deferred maintenance is defined in the DOE Facilities and Infrastructure Management System (FIMSWeb) Users Guide as maintenance that was not performed when it should have been or was scheduled to be and which, therefore, is put off or delayed for a future period.*

4.2.2 Accomplishments

In spite of funding challenges for general purpose infrastructure needs, NNSA supported execution of the national security mission. One notable accomplishment is the recent relocation of non-nuclear manufacturing operations from the Bannister Federal Complex site in Kansas City to the new NSC eight miles to the south, as part of the Kansas City Responsive Infrastructure Manufacturing Sourcing (KCRIMS) project. The project included developing and implementing more efficient business process and sourcing strategies in addition to the relocation. The new leased facility is reconfigurable to accommodate anticipated stockpile support scenarios and is Gold-certified under the U.S. Green Council's Leadership in Energy and Environmental Design (LEED) Certification System. The footprint was reduced from 3.1 million square feet to 1.5 million square feet, and operational costs were reduced by $100 million annually. The 18-month relocation, one of the largest industrial moves in North America, was completed in July 2014, under budget and ahead of schedule. Nearly 3,000 truckloads were required to move the 5.2 million cubic feet of equipment, materials, and product inventory. By using a carefully planned pre-build and rolling shutdown strategy, all mission delivery commitments were met during the relocation, with no loss or compromise of classified information. Plans are in place to transfer the old facility to a private developer in FY 2016, thus eliminating more than $266 million[4] in deferred maintenance.

Overall facility availability and utility reliability remained at very high levels, ably supporting stockpile and other mission activities. In addition, several new general purpose infrastructure capital projects were implemented, which will collectively help reduce deferred maintenance, improve efficiency of operations, and reduce short-term risks to the NNSA mission. These included the following:

- Sandia Silicon Fabrication Refurbishment, consisting of ten recapitalization projects ($25 million)
- LANL continued restoration of the LANSCE radio frequency power system ($11 million)
- Los Alamos Weapons Neutron Research Substation Modification ($3.1 million)
- Nevada Device Assembly Facility Fire Suppression Lead-In Line increased scope to respond to catastrophic failures ($7.6 million)
- Roof replacements and repairs at LLNL and LANL ($4 million)

More significantly, several initiatives were launched to address some of the future challenges related to the general purpose infrastructure. These actions, described in Section 4.2.4, are aimed at increasing capital reinvestment, controlling deferred maintenance, and efficiently managing risks to the mission.

4.2.3 Challenges

NNSA faces complex and difficult challenges in managing its general purpose infrastructure. Four of these are summarized below.

Increasing age of facilities. In recent years, NNSA has given priority within available funding to facilities that directly support mission work. However, many NNSA assets require significant recapitalization investments to extend their service lives, be repurposed, or be dispositioned and removed by demolition. This last category includes the 12 percent that were excess to mission needs in FY 2014. As the average age of facilities increases, the risk of failures impacting mission deliverables increases.

[4] *FIMS data as of January 27, 2015.*

Available funding for capital renewal has been limited and is not likely to increase in future year budgets.

High deferred maintenance levels. Increased deferred maintenance levels provide insights into the current and future condition of NNSA assets. NNSA's deferred maintenance costs totaled $3.7 billion at the end of FY 2014 and are growing at $150 million to $250 million per year. In the FY 2015 Presidents Budget, NNSA funded maintenance so that the backlog will not grow. Although some of this deferred maintenance is for facilities that are soon to be determined as excess, and includes the Bannister Federal Complex at Kansas City, the amount of deferred maintenance on enduring facilities presents a challenge. The current level of deferred maintenance indicates that improved investment strategies and more funding are needed, either for maintenance or for recapitalization and replacement of assets. Identification of increased funding for capital reinvestment has proved difficult in recent years, and NNSA anticipates similar challenges in future budgets. This scenario presents a challenge to addressing the growth of deferred maintenance in line with Secretary of Energy and congressional guidance.[5]

Optimization of investments and enterprise-wide planning. Condition assessment, maintenance planning, and many other processes guide decisions for general purpose infrastructure. These decisions are made on a site-by-site basis by field office personnel and the M&O partners. Limited planning is performed at an integrated, enterprise-wide level. Furthermore, the enterprise currently lacks the latest tools and processes to implement such planning and decision making.

4.2.4 Strategies – The Way Forward

NNSA's strategies for meeting the challenges of sustaining its general purpose infrastructure in a resource-constrained environment are described below.

4.2.4.1 Optimize infrastructure investment decision making to prioritize resources

NNSA is taking an Enterprise Risk Management approach to infrastructure decision making. This approach looks at risks to the infrastructure across the eight NNSA sites and seeks to prioritize needs at a nuclear security enterprise level to address risks optimally. The approach follows the example of the National Aeronautics and Space Administration and many profit-oriented entities. An Enterprise Risk Management approach has been developed in 2015 to inform the FY 2017 budget formulation process.

The Secretary of Energy formed the National Laboratory Operations Board (LOB) in 2013 to engage all of the DOE national laboratories and DOE programs in a joint effort to identify opportunities to improve effectiveness and efficiency. One of the highest priorities identified by the LOB was the need to revitalize general purpose infrastructure.

In November 2013, the Department, through the LOB, established an integrated plan to conduct a site-wide assessment of general purpose infrastructure across all 17 DOE laboratories, as well as the NNSA nuclear weapons production facilities, for the first time using common standards and an enterprise-wide approach. The assessments provided a detailed, uniform analysis of facilities and other infrastructure, as well as information for decisions on future investment. As part of the assessments, consistent definitions of functionality and utilization of the facilities were captured, enabling managers to understand where excess space exists and broadening the possibility of sharing space across DOE. The immediate focus of the LOB assessments was on general purpose infrastructure, however, during FY 2015 NNSA is expanding the assessments to include all infrastructure.

[5] *Appendix D, "Workforce and Site-Specific Information," contains additional information on the age of facilities and amount of deferred maintenance at each site.*

The LOB assessments included qualitative ratings of asset condition as adequate, substandard, or inadequate. The LOB assessments provide a more holistic view of DOE infrastructure than the traditional metric of Deferred Maintenance (DM)/Replacement Value (RPV), by going beyond physical condition and considering the suitability of each facility for its current mission. **Figures 4–2** and **4–3** present NNSA's general purpose infrastructure by the two rating systems, with the traditional Excellent – Good (DM/RPV ≤0.05) corresponding to LOB Adequate; traditional Adequate to Fair (0.05 ≤ DM/RPV ≤0.25) corresponding to LOB Substandard; and traditional Poor to Fail (DM/RPV ≥0.25) corresponding to LOB Inadequate. The broader considerations underlying the LOB ratings give greater definition to the sufficiency of facilities for mission, thereby supporting more informed investment decisions. The percentages in Figures 4–2 and 4–3 are based on total RPV, not the number of general purpose facilities. The findings of the LOB assessment are included for each site in Appendix D, "Workforce and Site-Specific Information."

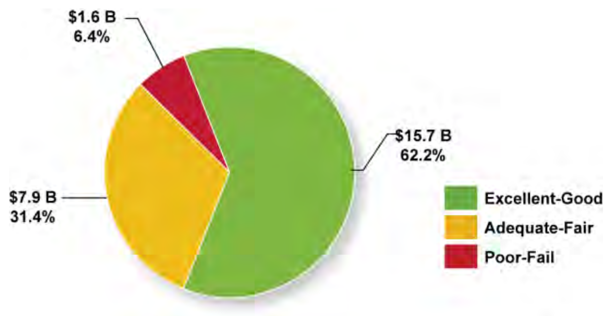

Figure 4–2. NNSA Asset Condition Ratings using DOE Order 430.1B assessment by replacement value of facilities

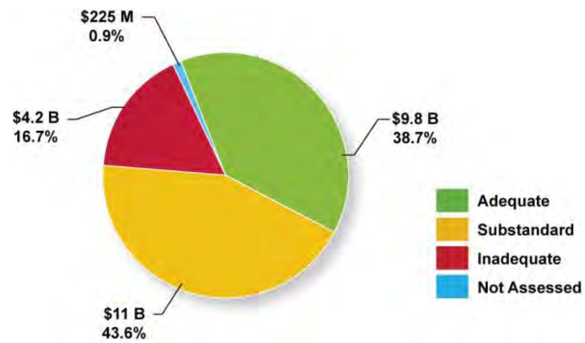

Figure 4–3. NNSA Asset Condition Ratings using LOB assessment by replacement value of facilities

The introduction of the Mission Dependency Index (MDI) metric provides a more holistic and accurate indicator of how each facility supports the mission than the current three-tier Mission Dependency concept. NNSA's MDI extends the concepts of DOD's operationally-based MDI to science, engineering, and manufacturing efforts and will inform the prioritization of proposed infrastructure recapitalization projects. In 2014, NNSA developed and piloted the MDI process and started implementing that process at the national security laboratories, the nuclear weapons production facilities, and the Nevada National Security Site. MDI determinations are on track to produce a complete set of data to inform FY 2017 budget decisions.

Following DOD, NNSA is implementing the BUILDER Sustainment Management System, a system that is being adopted by other Government agencies. BUILDER will inform the FY 2017 budget formulation process.

Asset Condition Definitions

Adequate: Fully capable of performing its current mission with only minor deficiencies that can be corrected within normal operating budgets.

Substandard: Deficiencies limit performance of the mission and refurbishment is required to return the asset to adequate condition.

Inadequate: Major deficiencies that significantly impair performance of the mission; major refurbishment is required.

4.2.4.2 Improve program management tools to provide accurate data for decision making

A new program management plan documents the Enterprise Risk Management approach described above and outlines a path forward for implementation. The new plan standardizes terminology; increases consistency in cost reporting among national security laboratories, the nuclear weapons production facilities, and the Nevada National Security Site; and improves the visibility of execution of work using direct and indirect funds. In FY 2014, NNSA developed the plan and initiated its implementation. Data collected under this plan will be recorded in the G2 software program and will be used as the primary source of information for FY 2017 programming decisions about the general purpose infrastructure.

The award-winning[6] G2 software program, developed by NNSA's Office of Defense Nuclear Nonproliferation's Global Threat Reduction Initiative, is being modified for use in managing the general purpose infrastructure. The G2 software program standardizes and automates processes for scope, cost, and schedule management. It also empowers NNSA's M&O partners to better manage projects, while giving NNSA decision-makers a common, transparent picture of project performance to further enhance data-informed decision making. In FY 2014, NNSA completed much of the programming to enable the software to support multiple activities. Software modifications to align with infrastructure requirements for data collection are complete, prepared to track FY 2015 budget execution, and on track to support FY 2017 budget decisions. G2's flexibility will allow NNSA to better understand its spending and execution, while avoiding an additional data collection burden on NNSA's M&O partners.

The budget structure flexibilities established by Congress in the FY 2014 and FY 2015 authorization and appropriations bills provided new enterprise-wide control points for maintenance and recapitalization that will enable NNSA to target funding at the highest level of NNSA need, while maintaining some flexibility to respond to unanticipated failures of aging infrastructure.

4.2.4.3 Accelerate recapitalization efforts to halt the growth of deferred maintenance, revitalize core capabilities, and reduce operating costs

NNSA is managing recapitalization work as projects, increasing requirements for adequate planning prior to project approval and execution, creating smaller, one- to two-year projects, and closely tracking financial and schedule performance. In FY 2014, NNSA developed and implemented the standardized criteria in G2. This capability is fully operational and will be used to monitor execution of FY 2015 work.

Consistent with the strategy implemented in FY 2014, NNSA is planning increased recapitalization spending in FY 2016, with commensurate reductions in other budget categories. This dovetails with the Department's work (though the LOB) to assess the condition of its general purpose infrastructure and to prioritize infrastructure funding through a cross-cutting budget initiative. This effort is establishing a sustainable trajectory for the Department's infrastructure by ensuring no increase in the backlog of deferred maintenance. Sustainability will be integrated into recapitalization decisions through a Return on Investment methodology to evaluate energy savings and other efficiencies. The goal is to lower the cost of operating the nuclear security enterprise. The Return on Investment methodology is mature and ready to inform FY 2017 budget decisions.

[6] In January 2011, NNSA's development of the G2 Program Management System earned NNSA the Program Management Institute's Distinguished Project Award, the first time this award was given to a Federal agency.

4.2.4.4 Invest in the repurposing, reuse, deactivation, and disposition of facilities no longer needed for mission execution

NNSA is developing investment strategies for repurposing, reusing, and disposing of facilities no longer required for mission execution. In addition, Secretary Moniz has re-emphasized the requirements to meet Government-wide initiatives, such as Freeze the Footprint, and to develop a DOE-level infrastructure plan under the auspices of the Secretary's Laboratory Operations Board. NNSA, within the recapitalization program, is disposing of one facility each year and taking other measures to reduce the risk inherent in unused contaminated facilities. Several NNSA M&O partners are using indirect funds to sustain a minimal level of disposition.

4.2.4.5 Increase purchasing power by employing equipment procurement models that optimize use of funds across NNSA

NNSA is increasing its purchasing power through expanding strategic procurements for building systems and equipment that are common throughout the NNSA enterprise. NNSA is using lessons learned from the successful Roof Asset Management Program to explore other opportunities for strategic, enterprise-level procurement of widely used infrastructure components. In FY 2014, NNSA initiated collection of data and development of criteria to support development of a strategic procurement for other common, enterprise-wide systems.

4.2.4.6 Leverage alternative funding mechanisms to meet NNSA infrastructure needs

NNSA is working to explore potential alternative funding mechanisms that could help finance infrastructure modernization needs while also meeting statutory and policy requirements.

4.3 Programmatic Infrastructure

4.3.1 Current State

Many of the programmatic facilities and much of the equipment have been in service beyond their designed and technical life spans in support of production, experiments, and testing schedules. Many specialized programmatic processes and equipment items are over 35 years old. Therefore, previous decisions to repair, rather than recapitalize, have pushed much of the equipment to the point that maintenance staffs are reliant on third party sources and used parts to keep the systems operational. Dedicated efforts by the M&O partners and field office personnel have kept the availability rate high and minimized the loss of production, but that pace is not sustainable in the long term. Recapitalization and process technology improvements through capabilities-based investments, line item construction funding, capital equipment funding, and some site-specific investments developed within the nuclear security enterprise are allowing NNSA to move from a position of technical obsolescence to near parity with industry for specific vital capabilities. The Pantex Bays and Cells Upgrade project, the Sandia Silicon Fabrication Replacement project, the Nuclear Facility Risk Reduction project at Y-12, and the TA-55 Reinvestment Project at LANL are examples of recapitalization of programmatic infrastructure for essential weapons mission capabilities.

However, funding is insufficient to address technical obsolescence in all capabilities. While investment levels have historically been adequate to address past mission workloads, the increased workload of the current LEP schedule, along with increased testing requirements, is taxing aging programmatic equipment to the point of unplanned equipment failures and capability gaps. The Capabilities Based Investment program, commodity management strategies, and sustainment budgets are being used in concert to address the highest risks in all areas.

4.3.2 Challenges

Two of the challenges of the programmatic infrastructure are summarized below.

Budget fluctuations have affected NNSA's ability to plan capital reinvestment. NNSA's infrastructure, including the programmatically vital equipment, must be sustained and periodically replaced through recapitalization. This is done most efficiently when there is a predictable funding stream that allows weapons program managers to schedule and recapitalize equipment in coordination with mission deliverable schedules. Continuing resolutions have been particularly hard on infrastructure planning because they typically constrain the startup of new investment projects. This results in increased costs due to inflation, replanning, lost windows of opportunity, and potential impacts to mission delivery schedules.

Failure to tailor safety and security approaches has increased costs and complicated management of programmatic infrastructure. Current approaches to safety and security sometimes result in high levels of rigor as a means of avoiding risk. This issue was cited in the congressionally appointed Governance Panel report[7] as an obstacle to effective management of infrastructure. NNSA and DOE safety directives provide the flexibility to grade requirements to achieve the level of protection appropriate to the actual hazard in a facility and a safety benefit that is consistent with the cost. One valuable resource for effectively assessing risk is the Nuclear Security Threat Capabilities Assessment, which DOE and DOD worked together to update in 2011. The document describes, primarily, terrorist threats to U.S. nuclear sites based on historical precedents and plausible scenarios. In many cases, application of a graded approach allows selection of appropriate commercial safety standards to meet DOE requirements. However, this flexibility is not always applied appropriately, resulting in higher costs and reduced productivity. To improve mission effectiveness and reduce cost, NNSA and oversight personnel must be empowered to balance risk against costs when approving an approach that ensures compliance with fundamental safety requirements.

4.3.3 Recapitalization of Programmatic Infrastructure

Programmatic infrastructure includes the equipment, core capabilities, and processes that allow NNSA to carry out research, testing, production, sustainment, and disposition of the entire range of its national security commitments. This section discusses the strategies and plans in place to overcome the challenges faced by key commodities, activities, and capabilities.

4.3.3.1 Strategy for Key Commodities

NNSA has appointed Federal Program Managers for uranium, plutonium, and tritium commodities, with the responsibility to develop and implement management strategies. Ensuring continued mission success is the primary focus of the commodity strategies, and modernizing the supporting programmatic infrastructure is one of the highest priorities.

[7] *Action item 5 from the final report of A New Foundation for the Nuclear Enterprise: Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, November 2014: "It is imperative that existing rulemaking practices and execution oversight be overhauled so that risk is better assessed and balanced with the needs of mission execution."*

Uranium[8]

- Uranium activities include production of parts for CSAs, providing fuel for the Navy, disposing of excess uranium materials, and conducting research and development programs on uranium. Accomplishment of these activities requires the ability to process, store, and recover uranium and manufacture precision uranium components.
- Enriched uranium activities are performed in several large industrial buildings at Y-12; one of which, Building 9212, is over 60 years old. The Uranium Processing Facility is a line item construction project that will ensure the long-term viability, safety, and security of NNSA's enriched uranium capability by replacing most of the capabilities in Building 9212. In 2014, cost and schedule growth within the project led the NNSA Administrator to charter an independent review team ("Red Team") led by Dr. Thomas Mason, Director of Oak Ridge National Laboratory, to develop an alternate approach for completing the project.
- The Red Team report[9] provided several recommendations to deliver Building 9212 capabilities no later than 2025 at a cost not to exceed $6.5 billion. A key recommendation was to utilize the existing uranium infrastructure to a greater extent and construct the minimum floor space necessary for those operations that are not appropriate to be relocated to other facilities.
- Therefore, the NNSA strategy now includes vital process relocations into other existing Y-12 facilities and completion of the Uranium Processing Facility project as a series of smaller buildings. Each of the Uranium Processing Facility buildings will be certified for specific nuclear safety, seismic, and security requirements. Processing capabilities will be located in the appropriate facilities, based on the commensurate risk. This revised strategy consists of the following four key efforts:
  - Cease enriched uranium programmatic operations in Building 9212 by 2025. This requires a set of operational Uranium Processing Facility buildings and relocation of key processes from Building 9212 into existing facilities.
  - Sustain and modernize NNSA's uranium manufacturing capabilities. Key technologies will be employed to further modernize and enhance uranium operations, including electro-refining, calciner, chip processing, and 2 mega electron volt radiography.
  - Reduce material-at-risk inventories from Y-12's enriched uranium processing facilities. Excess uranium inventory throughout the enriched uranium facilities is being repackaged for either disposition or storage into the modern Highly Enriched Uranium Materials Facility (HEUMF).
  - Invest in new and enduring facilities. In addition to constructing new Uranium Processing Facility buildings, additional facility investments in other existing buildings will be made to electrical systems; heating, ventilation, and air conditioning; and equipment controllers to recapitalize and extend their useful lives.

[8] *Uranium Strategy, signed September 2014.*

[9] *Final Report of the Committee to Recommend Alternatives to the Uranium Processing Facility Plan in Meeting the Nation's Enriched Uranium Strategy.*

Plutonium

- The plutonium strategy encompasses the investments needed to meet pit production demands and maintain continuity in AC and MC capabilities. The strategy reflects goals developed over the past several years in coordination with DOD and other stakeholders. Specifically, the plutonium strategy is being executed with a focus on the following:
  - NNSA and DOD remain committed to producing 50 to 80 pits per year by 2030.
  - NNSA plans to produce ten War Reserve pits in 2024, 20 in 2025, and 30 in 2026.
  - NNSA plans to accelerate demonstration of capabilities as soon as the investment strategy allows.
- To meet the plutonium infrastructure needs of the nuclear security enterprise, NNSA adopted a three-step plutonium strategy in January 2014. The first two steps maintain continuity in AC and MC capabilities by optimizing the existing infrastructure. The third step addresses the need to extend the lifetime of PF-4 and provides additional space to support pit production requirements.
- Consistent with direction from the House Energy and Water Development subcommittee, the first two steps of the strategy will be executed as two new subprojects within the CMRR line item. Both subprojects support the goal of ceasing programmatic operations in the CMR Building in FY 2019.
  - The Radiological Laboratory Utility Office Building (RLUOB) Equipment Installation Phase 2 (REI-2) subproject maximizes use of RLUOB by reconfiguring some of the existing laboratory space and equipping empty laboratories with AC and MC capabilities. As a result of changes to NNSA regulations, RLUOB will operate at an increased radiological limit, 38.6 grams of plutonium-239 equivalent, which will enable installation of additional AC and MC equipment.
  - The PF-4 Equipment Installation subproject involves relocation and consolidation of existing PF-4 processes to create open space, decontamination and decommissioning of old glove boxes and equipment in PF-4, and installation of new glove boxes and AC and MC equipment in the created open space.
- The third step extends the lifetime of PF-4 and provides additional production space to reach pit production targets by acquiring modular additions to PF-4. This effort is in preconceptual design and plans are to submit CD-0 documentation in the third quarter of FY 2015. NNSA also reaffirmed a commitment to construct at least two modular structures that will achieve full operating capability not later than 2027.
- In addition to the projects outlined above, the plutonium strategy also involves the following.
  - Continued investment in production equipment through the Plutonium Sustainment Program which will support the production target of 30 pits per year by 2026.
  - In support of improved plutonium processing, LANL is modernizing its plutonium waste processing and treatment capabilities through key line item construction projects, including the Transuranic Waste Facility and Radioactive Liquid Waste Treatment Facility. These facilities will allow sustainable throughput for the pit production cycle.

Tritium

- The newly named Tritium Program Manager is in the process of consolidating programmatic plans from across the tritium enterprise to produce a master tritium strategy that will balance and prioritize the following tritium actions to reduce overall risk in meeting the tritium mission.
  - To move production and R&D processes out of aged and inefficient infrastructure (*i.e.*, the H Area Old Manufacturing facility) and into more modern enduring facilities, NNSA is implementing the Tritium Responsive Infrastructure Modernization (TRIM) construction program at SRS, which consists of one line item project, the Tritium Production Capability, and a suite of capital equipment and general plant recapitalization projects. The TRIM program will eliminate approximately half the deferred maintenance at the site by eliminating the need to maintain two legacy facilities.
  - Three other projects that are currently scheduled outside the FYNSP (*i.e.*, the H Area New Manufacturing (HANM) facility Oxygen Monitor Replacement, HANM Chiller EPA [Environmental Protection Agency] Compliance, and HANM Risk Reduction projects) will extend the life of and reduce operating risk in the enduring HANM loading and unloading facility.
- Although current stocks of domestically produced, LEU fuel exist for the Tennessee Valley Authority's reactors, they will not last the entire 25-year planning period. The Domestic Uranium Enrichment Manager position was created to evaluate alternatives for ensuring the continued supply of this vital part of the tritium production process.

4.3.3.2 Strategies for Other Capabilities

Lithium

The facility where lithium is processed and stored at Y-12 is well beyond its design life. Maintenance and operations in such facilities is expensive and presents risk to the mission. A 300-pound slab of concrete broke off of the ceiling and onto the floor in a production area in FY 2014, demonstrating how aging facility risks are eventually realized. A line item construction project is scheduled to begin in FY 2017 to replace the lithium processing facility. The project will provide a modern, right-sized building to meet mission needs. Advances in lithium manufacturing techniques, combined with use of reserve lithium feedstock materials, will ensure that lithium component production continues uninterrupted during transition to the new Lithium Production Capability facility.

High Explosives

- Construction of the HE Pressing Facility at Pantex was completed in FY 2014, $30 million under budget. The project included design, equipment installation, and construction to support HE pressing, as well as rough contour machining, storage, and radiography. The 45,000-square-foot state-of-the-art facility consolidates HE operations currently performed in 18 outdated buildings totaling 49,000 square feet, with an average age of 56 years. The HE Pressing Facility will significantly improve the reliability of HE operations at Pantex and increase the throughput capacity when fully certified for operation in FY 2016.

- To maintain a safe, secure, and effective stockpile, NNSA must continue to invest in HE R&D and manufacturing capabilities. These functions are located at many unique facilities at several sites. A key element in the management of HE capabilities is the plan to transition the stockpile to IHE in future LEPs. During FY 2015 and FY 2016, NNSA will work with its M&O partners to evaluate whether the present mix of infrastructure and capabilities are right-sized for stockpile requirements across the nuclear security enterprise and to develop a strategy to manage investments in IHE and CHE capabilities.

Weapons Assembly and Disassembly

The weapons assembly and disassembly infrastructure is aging in parallel with the rest of the nuclear security enterprise. Recapitalization of safety systems at Pantex is in progress to ensure uninterrupted assembly and disassembly of weapons to meet maintenance, surveillance, and disposition requirements. NNSA is also planning long-term replacement of Y-12 assembly and disassembly infrastructure as part of its modernization of uranium capabilities.

Nonnuclear Components

- Electronics
  - Electronic component support of the stockpile faces a materials supply issue. The fast-paced advances in the commercial semiconductor industry, driven by the needs of commercial electronics, have created an obsolescence problem with the technologies and products available for radiation-hardened semiconductors. As a result, spares and feedstock are often no longer available. The Sandia Silicon Fabrication Revitalization plan addresses this supply issue by transitioning the production line from the obsolete six-inch wafers to more-readily available eight-inch wafers. This upgrade will provide a stable programmatic infrastructure base through the mid-term while NNSA explores alternatives for continued production of radiation-hardened electronics.
- GTSs
  - NNSA's recapitalization plans at SRS (described for tritium above) support ongoing manufacturing of the tritium-filled GTSs for the existing nuclear stockpile and LEPs, as well as for research.
- NGs
  - The facilities that house the manufacturing activities for NGs are currently adequate. However, it is essential to sustain and modernize the existing production equipment, as well as to modify the production lines in these facilities to perform two to three phased LEPs concurrently.

Design, Certification, Dynamic testing, Experiments, and Surveillance

- NNSA is pursuing programmatic infrastructure upgrades to support an effective stockpile without underground testing. Improvements to diagnostic equipment are occurring across the nuclear security enterprise. For example, the Enhanced Capabilities for Subcritical Experiments project will provide advanced radiography, diagnostics, and explosive testing capabilities to keep pace with demands for current and future LEPs.

- In addition, NNSA is determining the mission need to achieve certification of new materials and new processes, such as additive manufacturing, to address materials challenges in the nuclear stockpile. A capability gap exists for determining time-dependent properties of materials at the "mesoscale" (the dimensional range that lies between atomic scales and the scales of typical engineering design tolerances) that is critical to expanding the understanding of materials behavior in nuclear weapons. The MaRIE project is proposed to address this mesoscale knowledge gap. Establishment of the MaRIE project performance baseline and commencement of construction is planned for the 2020s. This facility would further reduce the possibility of needing to return to testing by increasing the scientific understanding of materials contained in nuclear weapons.

Secure Transportation Asset

The STA Program provides safe, secure transport of nuclear weapons, weapons components, and SNM for the nuclear security enterprise. To accomplish its mission, STA maintains a wide variety of facilities across the United States; its primary headquarters is located in Albuquerque, New Mexico. For physical infrastructure, the focus is on allocation of funds for construction projects, life cycle replacements, repairs, reducing deferred maintenance backlog, and growth in a cost-effective manner. See Chapter 5 for specifics on solutions to STA infrastructure challenges.

Defense Nuclear Security

- DNS is committed to sustaining and modernizing the security infrastructure at all NNSA national security laboratories, nuclear weapons production facilities, and sites in support of the overall NNSA mission. The highest priority for DNS is to address the security infrastructure of both the Y-12 and Pantex sites. Regarding the potential impacts of other NNSA projects, DNS is partnering with the national security laboratories, nuclear weapons production facilities, and sites to develop an approach that will maintain the effectiveness of high-security systems while undertaking more efficient resource utilization. For a more detailed discussion of the DNS mission, see Chapter 6.
- The following are DNS's more-significant, recently completed projects:
  - The LANL Nuclear Materials Safeguards and Security Upgrade Project Phase II was completed in mid FY 2014.
  - The Y-12 Security Improvements Project was completed in mid FY 2014.
- The following construction efforts are being evaluated for the planning period:
  - The Nevada National Security Site Device Assembly Facility Argus Replacement project is proposed for FY 2016 funding.
  - Site security and Perimeter Intrusion Detection and Assessment System upgrades at Y-12 and Pantex (Zone 4 and Zone 12) are being evaluated and prioritized for inclusion in the next FYNSP period.

4.3.4 Non-Weapons Activities Program Dependencies

In addition to the above key activities, several other NNSA programs rely on infrastructure funded by Weapons Activities (*e.g.,* nonproliferation, counterterrorism, counterproliferation and emergency management). These programs will be described in detail in a forthcoming NNSA strategy to prevent, counter, and respond to global nuclear and radiological dangers.

Nonproliferation

- The Office of Defense Nuclear Nonproliferation's Office of Material Management and Minimization relies heavily on the infrastructure maintained by other DOE and NNSA offices. That office remains concerned about the impacts of the aging infrastructure on the implementation of key nonproliferation programs. For example:
  - The program that is converting U.S. high-performance HEU research reactors to LEU fuel relies on Y-12 uranium facilities to produce the LEU fuels. A critical part of the program's efforts is research into a new fuel type using LEU-molybdenum (LEU-Mo) alloy. That program has identified the aging casting furnaces at Y-12 as a program risk and a potential single point of failure in the development of future fuel types. However, the replacement casting facilities planned for the Uranium Processing Facility are being designed to accommodate current and future fuel types in a modern facility, thereby reducing the long-term risk to this program. The conversion subprogram also relies heavily on the Sigma facility at LANL for development of alternative LEU-Mo fuel fabrication processes.
  - The Material Disposition subprogram relies heavily on the PF-4 facility at LANL to disassemble nuclear weapon pits and convert the resulting plutonium metal into an oxide form using the Advanced Recovery and Integrated Extraction System (ARIES).
- The Office of Defense Nuclear Nonproliferation's Office of Nonproliferation and Arms Control (NPAC) also relies heavily on the infrastructure maintained by other DOE and NNSA offices. For example:
  - NPAC relies on the availability of Category I, II, and III SNM standards and sealed sources for detector and system development, as well as for training of foreign partner personnel in the fundamentals of safeguards and material measurement. While the health of facility and SNM infrastructure remains sufficient at this time, downsizing over the last decade has required programs to use less Category I and II materials and more Category III and IV materials for detector development and training. As NNSA recapitalizes facilities that are critical to the NPAC mission, Defense Nuclear Nonproliferation offices will work with the appropriate program managers and through the Construction Working Group to ensure NPAC requirements are considered.

Counterterrorism and Counterproliferation

Counterterrorism and Counterproliferation rely heavily on infrastructure shared with stockpile production, certification, and diagnostic activities. Many of the critical shared capabilities are under consideration for modernization and/or recapitalization by the Weapons Activities programs described here (*e.g.*, analytical chemistry and HE testing). Analytical chemistry is being recapitalized as part of the plutonium strategy, and explosive testing capabilities are under review as part of the HE strategy. Counterterrorism and counterproliferation leaders will coordinate closely with other stakeholders through such forums as the Construction Working Group to ensure their requirements factor into construction and recapitalization discussions.

Emergency Operations

The Office of Emergency Operations leverages infrastructure that is predominantly maintained by other NNSA and DOE offices and interagency partners. A suite of mission-specific equipment requires continual modernization and recapitalization as technologies and methodologies advance. Infrastructure necessary for Emergency Operations core capabilities (Emergency Management, Emergency Response, and Nuclear Forensics) needs mid- to long-term modernization as mission capabilities grow to match partner requirements across the U.S. Government. For example:

- The emergency operations centers (EOC) at Y-12, LLNL, and SNL are funded for replacement within the FYNSP as part of recapitalization of onsite emergency management capabilities.
- Emergency Response must recapitalize much of its aging and obsolete response equipment. This long-term problem is currently being addressed as resources permit. Key areas requiring recapitalization are radiation search, diagnostic, consequence management, and communications equipment, as well as software modernization. In addition, fixed- and rotary-wing aircraft used for consequence management response are currently nearing the end of their life cycle.[10]
- Infrastructure and equipment supporting nuclear forensics is largely healthy and is anticipated to remain so. Required analytical capabilities at LANL are being recapitalized as part of the plutonium strategy. Field environmental testing at the Nevada National Security Site, however, is of concern with the deterioration of the CP-1 facility. Replacement is being discussed as part of a new mission support facility for this and other activities at the Nevada National Security Site.

4.4 Integrated Project List for Capital Construction and Planned Recapitalization

To meet NNSA's known mission needs for the 25-year period from FY 2016 to FY 2040, the national security laboratories, nuclear weapons production facilities, and the Nevada National Security Site have identified mission gaps associated with aged and inefficient assets. All mission gaps are evaluated by infrastructure experts, ranked by program sponsors, and consolidated into an NNSA nuclear security enterprise-wide chronological project list of approved and proposed projects. The result is the approved Integrated Project List of capital construction proposals in the FYNSP and post-FYNSP periods, as presented in **Figure 4–4**. Near-term projects that have been approved are of higher priority and are usually in more advanced stages of development, in accordance with DOE Order 413.3B. Cost ranges for these projects show the total project cost, which captures costs associated with the project from mission need definition to start of operations or project completion.

[10] *Final Report of the Office of Aviation Management Aviation Program Audit of the Nevada Site Office Aerial Measurement System, February 11, 2014.*

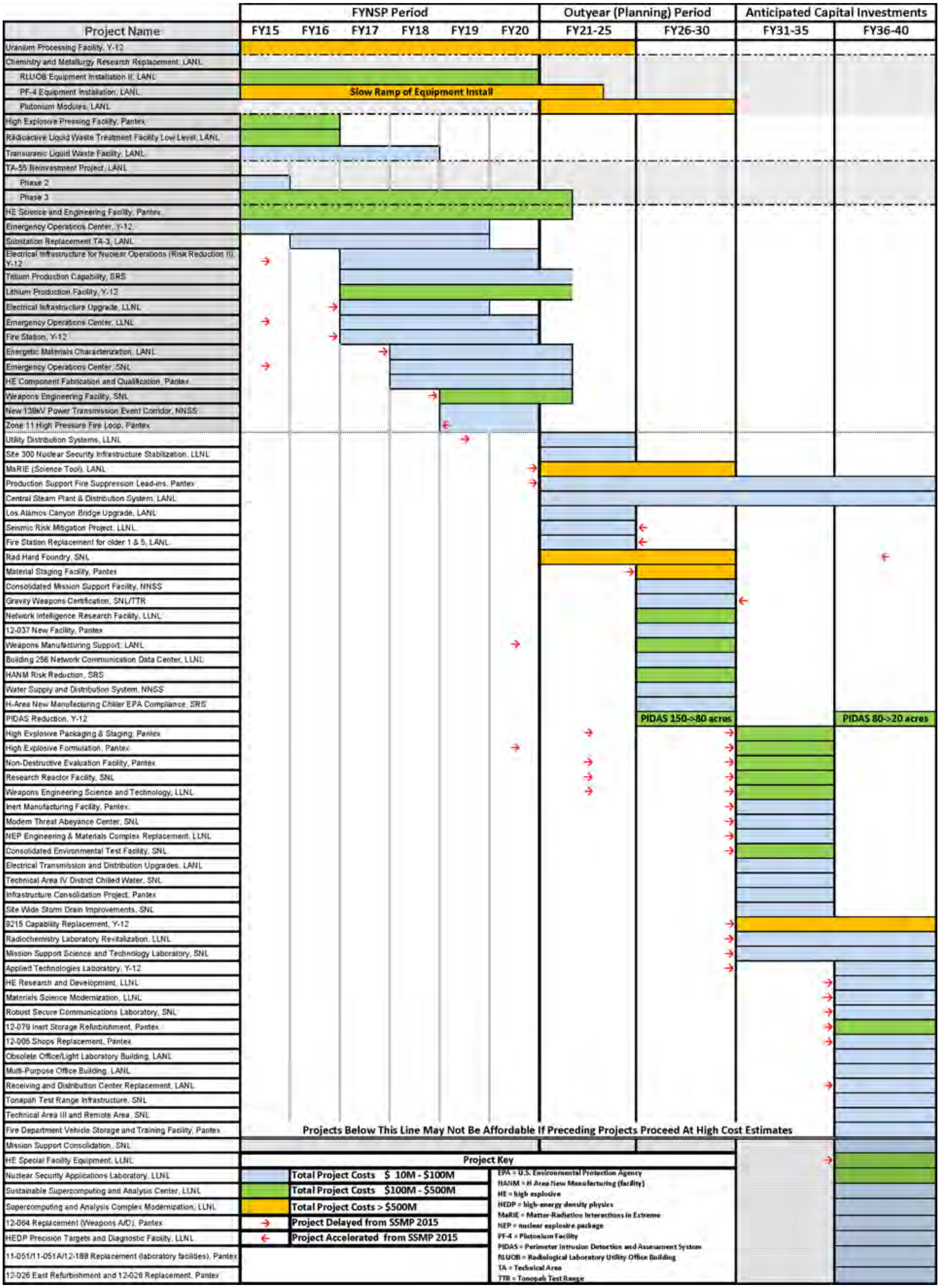

Figure 4–4. NNSA Integrated Project List for capital construction

The proposed post-FYNSP projects are preconceptual and have not been fully scoped. They are shown here in chronological order, grouped into five-year segments with a rough order of magnitude cost and schedule indicated. This information is provided to indicate the state of NNSA planning with regard to future infrastructure recapitalization, but should not be considered as validated costs or as an official schedule for proposed projects. These projects will be re-evaluated each budget year, and priorities will shift based on mission need and funding availability.

Smaller recapitalization projects and expense-funded projects (*e.g.,* minor construction, and capital equipment, including major items of equipment) go through the same prioritization process as the larger capital construction projects. **Figure 4–5** summarizes the minor construction, major items of equipment, capital equipment, and expense-funded projects planned for FY 2016.

Table 4–1 summarizes the required capability, current state of supporting infrastructure, and strategy for achieving the requirements for the mission functions described above. The table links the projects from the Integrated Project List with their functions and the strategies for overcoming current limitations.

4.5 Disposition of Excess Facilities

Management of both general purpose and programmatic infrastructure requires balancing the application of resources throughout the life cycle of the asset. When facilities are no longer needed and are at the end of their useful lives they are identified as excess, but they still require resources to maintain them safely until they can be dispositioned. Some 12 percent of NNSA's facilities have been identified as excess and over the next five years NNSA's total disposition requirement will exceed 7 million gross square feet. (The Bannister Road Federal Complex in Kansas City accounts for 2.9 million gross square feet.) The highest-risk facilities are those that are nuclear-process-contaminated and must be dispositioned by the Office of Environmental Management. NNSA reported this information and the challenges it faces in balancing funding priorities between operating facilities and excess facilities to Congress in its FY 2014 annual report on facility disposition.[11] As stated in that report, NNSA will not be able to make significant progress in dispositioning the highest-risk contaminated facilities, and the backlog of noncontaminated excess facilities is also projected to increase. However, NNSA is making an effort to manage the risks posed by these facilities; in FY 2014, NNSA dedicated $5 million toward disposition and is dedicating another $5 million in FY 2015.

[11] *Fiscal Year 2014 National Nuclear Security Administration Facilities Disposition Report, September 2014.*

Infrastructure Category	Site	Summary of planned investment in FY 2016 (non-line items) (*e.g.*, minor construction, capital equipment [including major items of equipment], and expensed projects)
Programmatic Infrastructure	NSC	– Developmental laboratory modernization – Special application machining modernization
	LLNL	– IHE qualification capabilities recapitalization – LEP and warhead assessment investments
	LANL	– Environmental testing and DARHT capability upgrades – Replacement of TA-55 wet vacuum material handling system
	NNSS	– DAF and U1a Subcritical Experiments support investments – Stockpile stewardship mission infrastructure
	PX	– Life-cycle replacement of production and analytic tools and equipment – Special nuclear material work stations
	SNL	Sandia Silicon Fabrication Revitalization
	SRS	Gas transfer systems unloading station modification and test station laser replacement
	Y-12	– Parts cleaning for direct lithium material manufacturing – Analytic and manufacturing equipment upgrades
General Purpose Infrastructure	NSC	– Prepare for Bannister Road facility disposition – Facility modifications and capital equipment to support weapons production
	LLNL	– Replace mission-critical HVAC systems in several buildings – HE Synthesis Pilot Plant Renovation
	LANL	– Facility modernization, seismic upgrades, safety upgrades, and control system modifications in several mission-critical facilities – Prepare for CMR closure
	NNSS	Electrical, fire protection, and structural upgrades, several mission-critical facilities
	PX	– Several utility and safety system upgrades in mission-critical facilities – Gas laboratory replacement – Facility modifications for B61
	SNL	Refurbishments and upgrades for several mission-critical facilities
	SRS	– Relocation of mission-critical functions – Replace obsolete oxygen monitors
	Y12	Utility and facility repair, replacement, upgrade in several mission-critical facilities and functions

CMR = Chemistry and Metallurgy Research
DAF = Device Assembly Facility
DARHT = Dual-Axis Radiographic Hydrodynamic Test
HE = high explosive
HVAC = heating, ventilation, and air conditioning
IHE = insensitive high explosive
LEP = life extension program
LANL = Los Alamos National Laboratory
LLNL = Lawrence Livermore National Laboratory
NNSS = Nevada National Security Site
NSC = National Security Campus
PX = Pantex Plant
SNL = Sandia National Laboratories
SRS = Savannah River Site
TA = technical area
Y-12 = Y-12 National Security Complex

Figure 4–5. Planned recapitalization projects

Table 4–1. Infrastructure management strategy to sustain National Nuclear Security Administration functions and mission capabilities [a]

Existing infrastructure is estimated to be sufficient for post-Nuclear Posture Review (DOD 2010) mission capabilities.

Existing infrastructure may not be sufficient or is inefficient or unreliable for post-Nuclear Posture Review (DOD 2010) mission capabilities.

Existing infrastructure is not sufficient for post-Nuclear Posture Review (DOD 2010) mission capabilities.

Function	Mission Capability	Required End State	Infrastructure Limitations during Near Term	Plans to Overcome Limitations	Planned Future Associated Projects
Plutonium	RDT&E	Robust design and science capabilities to support and perform LEP schedule and execute the Stockpile Stewardship Mission	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Recapitalize programmatic equipment to prevent technical obsolescence and monitor current facility conditions Build modules to increase capacity	PEI, LANL REI 2, LANL Weapons Engineering and Technology, LLNL Proposed PF-4 Modular Extensions, LANL
	Pit Production	30 ppy demonstration by FY 2021 30 ppy capability by FY 2026 50 to 80 ppy demonstration by 2027 to 2029 50 to 80 ppy capability by FY 2030	Capability does not support >30 ppy	Plutonium Strategy: Plutonium Sustainment investments, install AC & MC capabilities in RLUOB and PF-4, construct two to three modules to extend life of PF-4 and increase capacity	PEI, LANL REI 2, LANL Proposed PF-4 Modular Extensions, LANL
	Storage of Components	Safely and securely protect inventories of nuclear weapons and weapons components	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Evaluate options to modernize facilities and PIDAS, consolidate storage, and sustain existing facilities	Material Staging Facility, PX
	Radioactive Waste Disposition	N/A, Office of Environmental Management has assumed management of this function from the NNSA			TA-50-1, Replacement – RLWTF TW PED and Construction Facility
Uranium	RDT&E	Robust design and science capabilities to support and perform LEP schedule and execute the Stockpile Stewardship Mission	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Recapitalize programmatic equipment to prevent technical obsolescence and monitor facility conditions	Applied Technology Laboratory, Y12 Weapons Engineering and Technology, LLNL
	Production	Sustained manufacture of CSA and associated component assemblies to meet NNSA delivery schedule	Performing hazardous chemical operations in aged, inefficient facilities that do not meet modern safety or seismic standards. Infrastructure has been subjected to high corrosive processes that present risk to programmatic mission.	- Uranium Strategy: Cease programmatic operations in 9212 by FY 2025 through Line Item construction and extending the service life of other Uranium facilities - Recapitalized Programmatic Infrastructure	Uranium Processing Facility, Y-12 9215 Capability Replacement, Y-12 Lithium Production Facility, Y12
	Storage of Components	Safely, securely protect inventories of special nuclear materials and CSA components	Executing mission in HEUMF	Sustain HEUMF	
	Radioactive Waste Disposition	N/A, Office of Environmental Management has assumed management of this function from the NNSA			

Function	Mission Capability	Required End State	Infrastructure Limitations during Near Term	Plans to Overcome Limitations	Planned Future Associated Projects
Tritium	RDT&E	Robust design and science capabilities to support and perform LEP schedule and execute the Stockpile Stewardship Mission	Currently limited to laboratory-scale experiments on individual processes; need capability to conduct full-scale experiments on integrated processes to have confidence that developmental technologies will work when deployed.	Construct Hydrogen Processing Demonstration System by FY 2019	Minor construction project
	Production	Robust capability to continually supply tritium in quantities that meet or exceed demand	Tritium-supply capability insufficient to meet expected demand throughout 25-year planning horizon	- Establish plans to balance tritium supply and demand - Modify Tritium Extraction Facility to enable full operations by FY 2018	Minor construction project
		Robust capability to continually manufacture tritium-filled GTS components	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Sustain facilities and recapitalize programmatic equipment as needed	TRIM Program HANM Risk Reduction HANM Chiller EPA Compliance
	Storage	Safe storage of reservoirs and other tritium vessels	Meeting mission; however, facilities and programmatic equipment are beyond designed service life; currently operating under compensatory measures to meet Safety Basis requirements.	Relocate storage to more robust SRS Tritium Extraction Facility by FY 2018	Minor construction project
High Explosives	RDT&E	Robust design and science capabilities to support and perform LEP schedule and execute the Stockpile Stewardship mission	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Modernize facilities and recapitalize programmatic equipment to prevent technical obsolescence	Energetic Materials Characterization, LANL; HE Science, Technology & Engineering, PX; HE Research and Development Facility, LLNL; Site 300 Nuclear Security Infrastructure Stabilization, LLNL
	Production	Produce, press, and machine the energetic materials to support LEP schedule and the Stockpile Stewardship Mission	New HE Pressing Facility supports needs of current and future LEPs	Sustain existing facility and modernized as needed	HE Science, Technology & Engineering, PX; Energetic Materials Characterization, LANL; 11-051/11-051A/12-188 Replacement (laboratory facilities), PX
	Storage	Safely store IHE, CHE, inert and energetic materials	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Modernize facilities and recapitalize programmatic equipment to prevent technical obsolescence	High Explosive Packaging and Staging, PX; 12-079 Inert Storage Refurbishment, PX;
	Disposition	Dispose of waste energetic materials in an environmentally safe manner	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Sustain existing firing sites and disposal methods	

Function	*Mission Capability*	*Required End State*	*Infrastructure Limitations during Near Term*	*Plans to Overcome Limitations*	*Planned Future Associated Projects*
Weapons Assembly and Disassembly (A/D)	**Assembly bays and cells, weapons surveillance, NDE, and disassembly**	**Perform NNSA A/D schedule**	**Meeting mission in aged faculties with maintained, but obsolete production equipment**	**Recapitalize bays and cells (2016 to 2022) ultimately replace aged facilities**	**12-064 Replacement (Weapons A/D), PX; 12-026 East Refurbishment and 12-026 Replacement, PX; Cell Upgrade, PX**
Security	**Protection of SNM**	**LANL TA-55 PIDAS**	**New PIDAS completed**	**Sustain new PIDAS**	
		LLNL Super Block PIDAS	**Beyond designed service life; however no longer needed due to security category change**	**Downgrade security posture to match security category**	
		NNSS DAF PIDAS	**Meeting mission; however, equipment is beyond designed service life**	**NNSS PIDAS and SNM Staging at DAF will exceed their design life during planning period**	**NNSS DAF PIDAS Argus installation during the FYNSP period**
		Y-12 PIDAS	**Meeting mission; however, equipment is beyond designed service life**	**Refresh the existing PIDAS as the Uranium manufacturing facilities are remodeled. The previously anticipated PIDAS reduction may not be realized due to changes in Uranium Mission footprint.**	**Rescope and execute the Y-12 PIDAS refresh in coordination with Uranium Mission**
		Pantex Zone 4 and Zone 12 PIDAS	**Meeting mission; however, equipment is beyond designed service life**	**Consolidate the PIDAS at PX when the proposed staging facility is constructed and eliminate unneeded PIDAS at Zone 4**	**Recapitalize existing equipment, consolidate PIDAS after completion of the Staging Line Item**
Certification, Testing, Surveillance, and Experimentation	**Life Extension Design Support**	**Robust design and science capabilities to support and perform LEP schedule and execute the Stockpile Stewardship Mission**	**Meeting mission; however, facilities and programmatic equipment are beyond designed service life**	**Modernize facilities and recapitalize programmatic equipment to prevent technical obsolescence**	**Research Reactor Facility, SNL Weapons Engineering Facility, SNL Consolidated Environmental Test Facility, SNL Energetic Materials Characterization, LANL NEP Engineering and Materials Complex Modernization, LLNL Warhead Engineering, Science and Technology Facility, LLNL Site 300 Nuclear Security Infrastructure Stabilization, LLNL Radiochemistry Laboratory Revitalization, LLNL HE Research and Development Facility, LLNL Mission Support Science and Technology Laboratory, SNL Gravity Weapons Certification, SNL MaRIE, LANL**

Function	Mission Capability	Required End State	Infrastructure Limitations during Near Term	Plans to Overcome Limitations	Planned Future Associated Projects
Certification, Testing, Surveillance, and Experimentation (cont'd)	Nuclear Explosive Package – Certification, Surveillance and Assessment	Test, surveil, assess, and certify the physics package elements of the stockpile	Sustain existing capabilities and periodically update the experimental and test equipment	Modernize facilities and recapitalize programmatic equipment to prevent technical obsolescence	Research Reactor Facility, SNL Weapons Engineering Facility, SNL Consolidated Environmental Test Facility, SNL PF-4 Equipment Installation, LANL NEP Engineering and Materials Complex Modernization, LLNL Site 300 Nuclear Security Infrastructure Stabilization, LLNL Radiochemistry Laboratory Revitalization, LLNL Warhead Engineering, Science and Technology Facility, LLNL Mission Support Science and Technology Laboratory, SNL Gravity Weapons Certification, SNL Non-Destructive Evaluation Facility, PX Energetic Materials Characterization, LANL MaRIE, LANL
	Nonnuclear Components – Certification, Surveillance and Assessment	Test, surveil, assess and certify non-nuclear components in the stockpile	Sustain existing capabilities and periodically update the experimental and test equipment	Modernize facilities and recapitalize programmatic equipment to prevent technical obsolescence	Research Reactor Facility, SNL Consolidated Environmental Test Facility, SNL TCR Phase II, SNL
	HE – Test and Certification	Test energetic components and certify weapons components for delivery schedule to the enduring stockpile	Meeting mission; however, facilities and programmatic equipment are beyond designed service life	Modernize facilities and recapitalize programmatic equipment to prevent technical obsolescence	HE Science, Technology & Engineering, PX Energetic Materials Characterization, LANL HE Research and Development Facility, LLNL
	Stockpile Certification and Surveillance – Testing and Experimentation	Test, surveil, assess and certify complete nuclear weapons in the stockpile	Inadequate radiographic infrastructure, including diagnostic equipment for subcritical experiments and hydrographic experiments	Recapitalize hydrotest facilities and gravity bomb data collection equipment	Research Reactor Facility, SNL Weapons Engineering Facility, SNL Consolidated Environmental Test Facility, SNL NEP Engineering and Materials Complex Modernization, LLNL Site 300 Nuclear Security Infrastructure Stabilization, LLNL Weapons Engineering, Science and Technology, LLNL Radiochemistry Laboratory Revitalization, LLNL Mission Support Science and Technology Laboratory, SNL Gravity Weapons Certification, SNL
	ICF	Test, surveil, assess and certify non-nuclear components in the stockpile. Conduct material tests in support of the NNSA weapons missions.	Meeting mission	Recapitalize programmatic equipment to prevent technical obsolescence and monitor facility conditions	HEDP Precision Targets and Diagnostic Facility, LLNL
	Computational science	Develop computer models and codes simulating weapons characteristics to support Stockpile Stewardship Plan	Sustain the current petaflop capability and begin planning for exaflop capabilities	Continue to advance the simulation and computational expertise of the NNSA to support the weapons and other NNSA missions	Sustainable Supercomputing and Analysis Center, LLNL Supercomputing and Analysis Complex Modernization, LLNL

Function	Mission Capability	Required End State	Infrastructure Limitations during Near Term	Plans to Overcome Limitations	Planned Future Associated Projects
Non-Nuclear Components	Electronic Component – Production	Produce radiation hardened silicon disks for satellites and national security applications	Limited supply of six-inch wafer stock exists; MESA must transition to eight-inch products or cease trusted foundry operations	SSIFR recapitalization to eight-inch technology in 2019	Rad Hard Foundry, SNL
	Engineering Components – Production	Produce components for 2 to 3 LEPs and enduring stockpile according to the production schedule	Operations ongoing in National Security Campus	Sustain operations and equipment at National Security Campus through the lease period (2030)	Weapons Engineering Facility, SNL
	Lithium Component – Production	Produce lithium and specialty metal foundry operations in support of NNSA Mission delivery schedules	Performing mission in aged, inefficient facilities with obsolete production equipment	Operate until the existing facility and equipment are replaced	Lithium Production Facility, Y12
	Gas Transfer System – RDT&E	GTS function testing capable of supporting surveillance of the stockpile, developmental systems for LEPs, experimental systems, and production samples	Insufficient GTS function testing forces design lab trade-offs	Construct new function tester by FY 2018	Minor construction project
	Neutron Generator – Production	Produce neutron generators to meet NNSA production deliverables to the stockpile	Facilities are less than 30 years old; equipment is periodically recapitalized	Continue to sustain facilities and recapitalize equipment as necessary	
Enabling Infrastructure	Over 6,300 real property assets, including utilities, distribution systems and roads	Safe, energy efficient, environmentally compliant operations of NNSA assets	- Enabling infrastructure has exceeded its design life and is unreliable as the result of corrective maintenance and repair rather than recapitalization - Deferred maintenance backlog increasing	Recapitalize specific facilities and infrastructure and minimize maintenance to lowered priority assets	Example General Purpose and Programmatic Infrastructure Recapitalization are captured in Figure 4–5

AC = Analytical Chemistry
DAF = Device Assembly Facility
EPA = Environmental Protection Agency
GTS = Gas Transfer System
HE = high explosives
HEUMF = Highly Enriched Uranium Materials Facility
LANL = Los Alamos National Laboratory
LEP = life extension program
LLNL = Lawrence Livermore National Laboratory
MC = Materials Characterization
MESA = Microsystems and Engineering Sciences Applications
NNSS = Nevada National Security Site
PEI = PF-4 Equipment Installation
PF-4 = Plutonium Facility
ppy = pits per year
PIDAS = Perimeter Intrusion Detection and Assessment System
PX = Pantex
RDT&E = Research, Development, Testing, and Evaluation
REI-2 = RLUOB Equipment Installation Phase 2
RLUOB = Radiological Laboratory Utility Office Building
SNL = Sandia National Laboratories
SNM = special nuclear materials
SRS = Savannah River Site
TRIM = Tritium Responsive Infrastructure Modification
Y-12 = Y-12 National Security Complex

Chapter 5
Secure Transportation Asset

The Secure Transportation Asset (STA) Program provides safe, secure transport of the Nation's nuclear weapons, weapons components, and SNM. The program modernizes mission assets and infrastructure, strengthens mission support systems, and improves its workforce capability and performance.

> ***FY 2014 Secure Transportation Asset Accomplishments***
>
> - *Completed 100 percent of shipments (i.e., 115) without compromise, loss of components, or release of radioactive material.*
> - *Enhanced reliability and availability of mission support communications.*
> - *Improved integration with national intelligence assets.*

The pillars of the STA security concept are specialized vehicles, secure trailers, highly trained agents, and robust communication systems. STA will continue to modernize its assets and enhance the capability of its workforce. STA will extend the life of the SGT, conduct an analysis of alternatives for the development, testing, and production of the SGT follow-on trailer (which will be called the Mobile Guardian Transporter [MGT]), complete phased deployment of the Advanced Radio Enterprise System (ARES), and continue replacement of vehicles and tractors and restoration of Federal agent strength levels. In addition, STA will ensure all support systems remain efficiently integrated.

5.1 Secure Transportation Asset Program

Nuclear weapon LEPs, limited life component exchanges, surveillance, dismantlement, nonproliferation initiatives, and experimental programs rely on transport of the weapons, components, and SNM on schedule and in a safe, secure manner. STA supports the DOE goal to reduce the danger and environmental risk of domestic transport of nuclear cargo and consolidate storage of nuclear material. **Table 5–1** indicates that STA provides secure transport for DOE, DOD, and other Government agencies. Because of the control and coordination required and the potential security consequences of material loss or compromise, STA is Government-owned and -operated, and is subject to the reporting requirements of the Government Performance and Results Act.

Table 5–1. DOE and NNSA programs, offices, and other agencies supported by the Secure Transportation Asset Program

DOE and NNSA Program, Office, or Agency	*Type of Shipment or Service*
NNSA Directed Stockpile Work Program	Weapons, joint test assemblies, canned subassemblies, tritium gas transfer systems, tritium gas generators, uranium solids
NNSA Nuclear Counterterrorism and Incident Response Program	Emergency airlift, Office of Secure Transportation personnel and equipment
NNSA Office of Defense Nuclear Nonproliferation	HEU metals and oxides, plutonium metals and oxides, mixed oxides
NNSA Office of Naval Reactors	Reactor fuel replacements, HEU
NNSA Office of Nonproliferation and International Security	Training events with nuclear transport elements of foreign nations
DOE Emergency Management	Alternate NNSA Emergency Operations Center
DOE Environmental Management	Hazardous surplus strategic material, site de-inventory movements
DOE Office of Nuclear Energy	HEU metals
DOE Office of Science	HEU
DOE Secretary, Deputy Secretary	Executive protection, stateside and overseas, as required
National Aeronautics and Space Administration	Radioisotope thermoelectric generators

HEU = highly enriched uranium

5.1.1 Core Components of the Secure Transportation Asset Program

5.1.1.1 Federal Agent Force

Federal agents undergo rigorous selection and intensive training to master a unique set of skills to defend a shipment from the full spectrum of threat scenarios. They must respond to unpredictable situations, including non-hostile emergencies, without endangering the public or the cargo.

5.1.1.2 Specialized Vehicle Fleet

STA maintains a variety of escort vehicles and armored tractors for convoy operations. A methodical engineering process ensures safety, security, quality control, and configuration management of the vehicles. A vehicle remains in operation according to a "reliability life cycle" based on its maintenance history and the life expectancy of its mechanical systems, rather than on its age or mileage. The maintenance is three to four times that of a commercial vehicle: STA inspects, tests, and services a vehicle and its communication system before each convoy mission.

STA procures commercial vehicles and components, which are then modified and reconfigured for a Federal agent team. Equipment compartments and communications systems are installed to support the safety and security of the convoy.

5.1.1.3 Specialized Trailers

Specialized trailers are STA's most critical capital asset. Their design, engineering, testing, production, and use span decades. The design and construction addresses public safety, unique cargo configurations, and protection systems. The SGT, a second-generation trailer used for transporting nuclear warheads and weapons-grade material, was originally designed for a ten-year life cycle. STA reviewed and extended the life cycle to 20 years; the first production units will reach end of service life in 2018. The next-generation trailer is the MGT. STA has initiated an analysis of alternatives study for development, testing, and production of the MGT. STA will use a modern transportation-industry design approach and provide a platform to assure the safety and security of cargo. STA will implement a risk reduction initiative to extend the life of some of the SGT fleet to maintain the current capacity until the MGT has been produced and is operational.

5.1.1.4 Transportation Command and Control System

This component provides multiple communication channels, capabilities for redundant and automated tracking, and robust data storage and processing. The essential elements are the primary and alternate Transportation Emergency Control Center, high-frequency relay stations, satellite services, and an overlapping integrated series of secure communication networks. The primary Transportation Emergency Control Center operates 24 hours a day to control and monitor the convoys. The critical nature of these communication channels mandates that a redundant alternative be available. STA is establishing a new Alternate Operations Facility to serve as a backup location to ensure continuous communications during convoy missions and emergency situations.

5.1.1.5 Geographically Situated Facilities

The STA facilities are geographically dispersed among several sites in Tennessee, New Mexico, Texas, Arkansas, Idaho, Maryland, and Missouri. These sites support communications, training, logistics, mission operations, and management oversight. Three Federal agent commands with vehicle maintenance facilities are in Albuquerque, New Mexico; Amarillo, Texas; and Oak Ridge, Tennessee. Fort Chaffee, Arkansas, has centralized training facilities, a Federal agent academy, and vehicle maintenance facilities.

5.1.2 Major Organizational Efforts of Secure Transportation Asset

5.1.2.1 Liaison and Domain Awareness

STA maintains a liaison program with agencies and organizations that may be in contact with a convoy or have to respond to an emergency. This interface extends across the 48 continental states, but particularly focuses on primary and secondary routes of the convoys. The scope of the liaison function includes Federal, state, tribal, and local agencies and involves interactions with law enforcement officers, firefighters, emergency and hazardous materials responders, dispatchers, and military personnel. STA also provides emergency response information to law enforcement associations, governors' associations (specifically on hazardous material transport), and governors' representatives.

STA has developed an Active Security Doctrine that is operationally focused, intelligence driven, and emphasizes realistic threat scenarios and specific environments on the convoy routes. That doctrine provides options to adjust protection levels commensurate with real-time conditions and the technology to enhance domain awareness along transportation corridors. STA relies on extensive coordination and established data-sharing relationships with the DOE Office of Intelligence and Counterintelligence, the United States Northern Command, the Department of Homeland Security, and the Federal Bureau of Investigation. Implementation of doctrine, intelligence, reconnaissance, and liaison efforts enable STA to evaluate its mission options and mitigate risks.

5.1.2.2 Training

Federal agents receive training in full-scale emergency and tactical operations scenarios, tactical driving techniques, and a variety of weapons and explosives. Each agent command has facilities and staff to refresh primary skills and accomplish most qualification training. At Fort Chaffee, Arkansas, a training command with permanent facilities and billets supports special weapons, tactical scenarios, general agent training, and the Agent Candidate Training Academy. A special vehicle fleet is maintained to support training realism.

5.1.2.3 Safety and Security

Force-on-force validation exercises are the primary means to test all convoy systems, ensure implementation of the Active Security Doctrine, and determine system effectiveness for the STA Site Security plan. The safety and security staff design these exercises; the training and logistical staff then execute the exercises and integrate them with the emergency command and control elements to provide the most realistic convoy scenarios possible. Two primary documents serve as STA's "licenses to operate": the Site Security Plan and the Documented Safety Analysis. These documents outline the compliance with security and safety orders and regulations related to nuclear operations within DOE and NNSA.

5.1.2.4 Aviation Service

The fleet of Government-owned aircraft provides for the efficient and flexible airlift of LLCs, nuclear incident response elements, Federal agents, joint test assemblies, training assemblies, and personnel and equipment associated with national emergencies and disasters. Because of the distances traveled, the quantities and types of materials moved, and the timeliness of the stockpile mission requirements, STA's aviation assets provide the most efficient, safe, and effective mode for transporting LLC shipments and supporting assemblies. STA also maintains an aircraft on 24-hour/seven-day alert that is ready to respond within four hours to nuclear incidents, as well as to support evacuation and relocation of key personnel to maintain the continuity of Government operations. Because the special requirement associated with transporting Federal agents with full equipment and firearms makes commercial travel difficult or in some cases impossible, STA aircraft provide efficient and effective movement of Federal agents in support of operations and training requirements.

The recent purchase of two Boeing 737 aircraft and the transition from contractor pilots to Federal pilots have added a noteworthy dimension to the safety and security of aviation operations. These two major changes have required significant effort to implement, but also have provided an opportunity to take a fresh look at how the aviation fleet is used and how the effectiveness and efficiency of the aviation operations can be enhanced. When both 737 aircraft are fully upgraded, the DC-9 aircraft will be removed from the fleet.

5.1.3 Secure Transportation Asset Goals

The overall goal is to be sized efficiently to support the projected workload with sufficient flexibility to adjust to unforeseen requirements and changes in the security posture, while maintaining a workforce and vehicle fleet capable of responding to the full security continuum.

Annual goals:

- Modernize mission assets and infrastructure.
- Strengthen mission support systems.
- Drive an integrated and effective organization.
- Continuously improve workforce capability and performance.

Long-term goals:

- Complete production and fielding of the Replacement Armored Tractor by FY 2019.
- Upgrade and replace aging vehicles on a continuous basis.
- Implement SGT risk-reduction activities until the new MGTs come on line.

- Complete MGT final design and initiate activities for a first production unit.
- Develop security strategies based on intelligence assessments and risk mitigation and management.
- Rehabilitate and maintain facilities and infrastructure.

STA is focused on replacing end-of-life communications systems for its vehicle fleet, replacing armored tractors, and preparing for the retirement and replacement of the Safeguards Transporter trailers.

To meet changing customer needs within budget constraints and account for emerging threats, STA has developed an integrated, long-term plan to maintain, refurbish, modernize, and replace its critical transportation assets. The life cycles of these assets require substantial investment and deliberate effort spanning decades.

5.1.4 Secure Transportation Asset Strategy

5.1.4.1 Program Planning and Management

STA will maintain the capacity to support the workload associated with dismantlement and maintenance of the stockpile and the initiative to consolidate storage of nuclear material. STA will continue implementing operationally focused and intelligence-driven processes that concentrate on detection, deterrence, and disruption of potential threats while sustaining capabilities to defend, recapture, and recover nuclear weapons, SNM, and weapons components.

5.1.4.2 Strategic Management

STA will provide safe and secure transport of weapons, components, and SNM in support of national security. External factors with the strongest impact on achieving that primary strategic goal are:

- the effects of de-inventory and SNM consolidation on the life span of the vehicle fleet and capacity requirements,
- stabilized fleet replacement schedules,
- an uncertain threat environment, and
- the ability to train agents in realistic over-the-road environments.

5.1.4.3 Major Out-Year Priorities and Assumptions

STA has identified the following four key strategies to guide the Office of Secure Transportation over the next five to ten years. These strategies are aligned with and support the key goals identified in the *DOE Strategic Plan* (DOE 2014).

- **Modernize Mission Assets and Infrastructure.** STA must maintain the transportation assets to support its mission in the face of changing customer needs, budgets, and threats. Modernizing and sustaining these assets requires an integrated, long-term strategy and a substantial investment. The STA strategy includes eliminating outdated assets, refurbishing existing transportation assets to extend their useful life, and procuring new assets.
- **Improve Workforce Capability and Performance.** Although STA's assets and infrastructure are essential for successful mission implementation, the workforce is STA's most valuable resource. That workforce must be continuously replenished, developed, and maintained. This includes everyone in the organization, from Federal agents to senior management. Initial and continued training and development will ensure the staff is competent and proficient. STA will recruit and

retain experienced and innovative personnel and support the development of personnel skills for future leaders.

- **Strengthen Mission Support Systems.** The STA workforce needs proven state-of-the-art technology to support the mission, including reliable, redundant systems to plan, track, and communicate with convoys. STA is upgrading and enhancing the Transportation Command Control System and mobile integrated systems to provide a timely, common operating picture and real-time situational awareness of weather, traffic, and potential threats to security and safety, especially in emergency situations. STA is enhancing data and workflow application systems to support predictive maintenance, minimize vehicles breakdowns, provide management tools, and maximize resource efficiency. STA will deliver technology solutions developed through its own ideas and the experiences of other agencies and industrial partners.
- **Drive an Integrated and Effective Organization.** STA will monitor, evaluate, and improve its operation to ensure its secure transport mission is achievable in a changing environment. This includes activities directly related to that mission, such as safeguards and security requirements and business processes. STA will strive to eliminate redundancies, improve performance and efficiency, and streamline operations. Key milestones, objectives, and future plans are displayed in **Figure 5–1** of Section 5.1.7.

5.1.5 Secure Transportation Asset Challenges

STA has structured its resources to address near- and long-term stockpile needs. The challenges are listed below.

- **Beginning Replacement of the Trailer Fleet.** In 2015, STA will complete an analysis of alternatives to finalize the design for the MGT. STA will continue parallel development of subsystems that are common to all candidate designs. STA will maintain the current capacity by keeping some SGTs on the road beyond the certified 20-year life cycle. It will also scope the SGT risk reduction efforts in 2015 and begin actions to ensure the availability of critical components.
- **Stable and Balanced Vehicle Production.** In the past, vehicle replacements were based on bulk purchases and accelerated production. During the transition to stable steady-state procurement and production, STA must replace vehicles at the end of their life cycle without a surge in production; other vehicles must undergo extensive refurbishment to establish steady production.
- **Sunset Technology.** Resources reaching the end of their service life must be evaluated and replacement activities carefully managed so that, within a limited budget, STA can achieve the greatest benefit through life-cycle management, steady-state vehicle procurements, and maintenance initiatives.
- **Forecasting and Meeting Future Workload.** Future workload planning depends on NNSA and DOE shipping forecasts, consolidation of requests, synchronization of site activities, duration of various weapon activities, and handling and delivery requirements for specific cargo.
- **Retention of Federal Agents.** STA must safeguard career progression, job enrichment, and quality of life to retain agents for 20 to 25 years. The separation from family, long travel hours, and acute stress of the mission pose unique difficulties for retention. STA must continue to adhere to a predictable schedule that balances training and mission weeks so agents can plan personal time to improve their quality of life.

- **Facilities.** Funds must be allocated for construction projects, life-cycle replacements, repairs, and reduction of the deferred maintenance backlog to ensure management in a cost-effective manner. STA has begun planning for the Albuquerque Complex move and transition of existing facilities, which will present funding and logistical challenges. Industry best practices will be implemented to maintain facilities in a safe and operable condition and meet all security requirements. STA's Facility Board prioritizes and matches mission needs to existing funding.

5.1.6 FY 2014 Accomplishments

- Completed 115 shipments without compromise or loss of nuclear weapons or components or release of radioactive material.
- Validated that the Site Security Plan meets the requirements of the Graded Security Protection Policy.
- Completed two operational training events. One live fire event at Ft. Knox, Kentucky and a convoy event at Ft. Riley, Kansas.
- Accepted delivery of 55 of the 89 Escort Vehicle Light Chassis to complete production in early FY 2016.
- Accepted delivery of 5 of the 42 Replacement Armored Tractors, with the goal of finishing production by FY 2019.
- Retrofitted two of five Federal agent units' mission support vehicles with ARES. The last unit is scheduled for completion in FY 2016.
- Completed MGT look-ahead studies and estimates and the concept development tasks.
- Completed the FY 2014 Ten-Year Site Plan for STA facilities and the Five-Year Site Plan for Fort Chaffee, Arkansas.
- Moved Training Command Logistic operations to the refurbished Logistics Support Site facility.

5.1.7 Milestones, Objectives, and Future Plans

The milestones outlined below will move STA towards defined goals. The key strategies remain unchanged; however, STA faces a challenging budget environment, and the risk of funding cuts requires evaluation and analysis of the operational environment to ensure the greatest value to the taxpayer in providing safe and secure transport of the Nation's weapons and SNM.

To stabilize operating budgets and move to steady-state production, STA has adjusted its out-year production plans for all escort vehicles and armored tractors and re-evaluated its plans to maintain a high-frequency communication system. Design and production of the MGT will be challenging during the FYNSP.

5.1.7.1 Milestones update

Trailer Fleet

- Complete analysis of alternatives for the MGT to examine the costs of various options; then finalize the conceptual design and prepare to procure and produce the third-generation trailer.
- Complete the SGT Risk Reduction Initiative Program study to extend some of the SGT fleet to maintain capacity.

Vehicle Fleet

- Complete the ARES installations and retrofits in the vehicle fleet.
- Complete production of the new trailer communication system.
- Complete Escort Vehicle Light Chassis production.

Facilities and Aviation

- Complete 737 aircraft avionics upgrade, ballast installation, and fuel tank suppression.
- Achieve operational capability at the Alternate Operations Facility.
- Complete Albuquerque Complex transition.

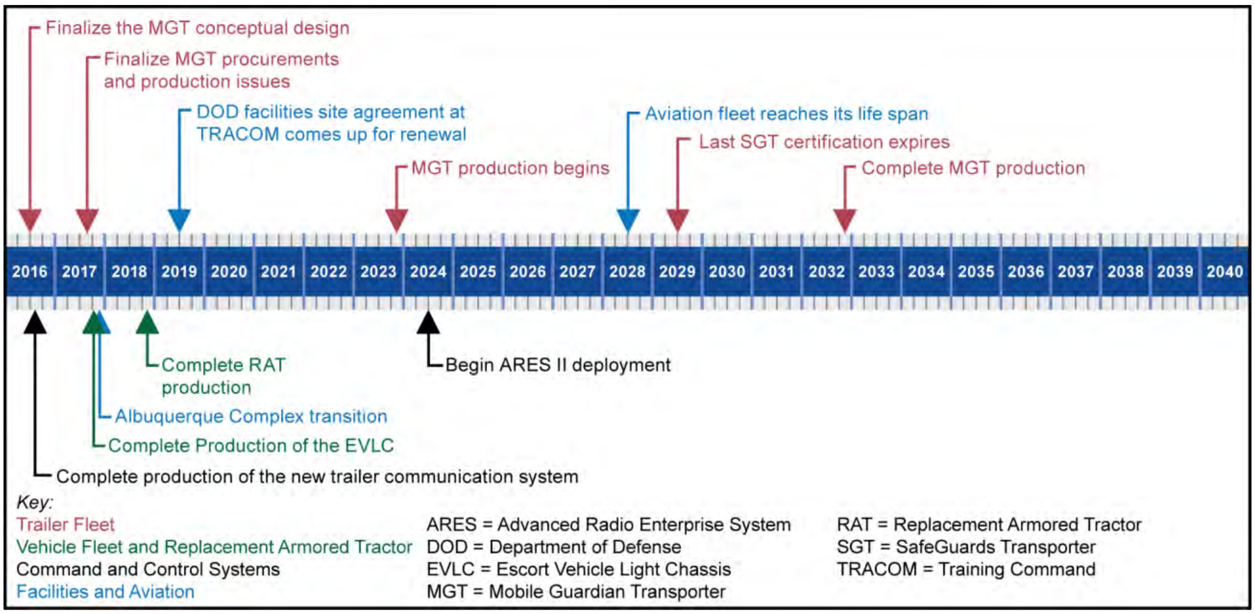

Figure 5–1. Secure Transportation Asset Program milestones and objectives timeline

Chapter 6
Security

Two NNSA programs ensure the security of the Nation's nuclear materials, infrastructure, workforce and sensitive information. These are the Defense Nuclear Security (DNS) and the Information Technology and Cybersecurity Programs. DNS ensures protection, control, and accountability of nuclear materials, as well as the physical security of NNSA's sites and the personnel security of its workforce. Information Technology and Cybersecurity ensures protection of classified and sensitive information about the Nation's nuclear weapons stockpile, as well as sensitive information about the men and women who are the stewards of that stockpile. The Nuclear Counterterrorism and Incident Response Program plays a leadership role in defending the Nation from the threat of nuclear terrorism. This program ensures capabilities are in place to respond to any emergency at an NNSA site and to a nuclear or radiological incident or emergency anywhere in the United States and abroad. It also develops capabilities to address terrorist incidents involving nuclear threat devices. These two programs are described in a separate NNSA document focused on preventing, countering, and responding to global nuclear threats.

6.1 Defense Nuclear Security Program

DNS protects NNSA assets by implementing security measures to thwart theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may affect national security, program continuity, and employee security. In February 2014, the Acting NNSA Administrator announced reorganization of DNS. The new structure is consistent with the Secretary of Energy's goal to improve the security focus across the nuclear security enterprise by creating clear lines of responsibility and accountability for effective, agile decision-making and emergency response. The Chief of Defense Nuclear Security provides implementation guidance and budget and assesses the effectiveness of the physical, information, and personnel security at NNSA's national security laboratories, nuclear weapons production facilities, and the Nevada National Security Site.

FY 2014 Security Accomplishments

- *Completed the Nuclear Materials Safeguards and Security Upgrades (Phase II) Project at LANL.*
- *Completed the Security Improvements Project at Y-12 within cost and schedule.*
- *Implemented Protective Force Enterprise Mission Essential Task List and Handgun Standardization initiatives.*

The Chief of Defense Nuclear Security is also NNSA's Chief Security Officer. As such, the Chief of Defense Nuclear Security/Chief Security Officer reports to the NNSA Administrator and has direct access to the Secretary of Energy. The Chief Security Officer recommends DOE security policy changes as a member of the new DOE Security Committee. When necessary and appropriate, the Chief Security Officer also provides an interface with the new DOE Office of Enterprise Assessment. With that, the primary mission of NNSA's DNS and the Chief Security Officer is to develop and implement sound security programs to protect nuclear weapons, SNM, personnel, classified information, cybersecurity, and NNSA facilities, as well as to control and account for SNM across the NNSA nuclear security enterprise.

6.1.1 Offices of the Defense Nuclear Security Program

DNS is a line management organization. Described below are its five offices.

6.1.1.1 Office of Resource Management and Mission Support

The Office of Resource Management and Mission Support manages the budget and provides business operations support (*e.g.*, human resources, contracts, logistics, and facilities) for DNS. It serves as the focal point for developing and issuing strategic requirements, planning, and communication related to safeguards and security at NNSA.

6.1.1.2 Office of Security Operations and Programmatic Planning

The Office of Security Operations and Programmatic Planning establishes operational direction for the NNSA security program, evaluates execution of operational security requirements, and ensures line management evaluation programs are rigorous and provide confidence that contractor security programs are operating effectively. The major security program topical areas include program planning and management, physical security systems, protective forces, information security, personnel security, material control and accountability, technical surveillance countermeasures, operations security, and incidents of security concern.

6.1.1.3 Office of Classification, Special Programs, and Headquarters Security

The Office of Classification, Special Programs, and Headquarters Security is the primary DNS point of contact with internal and external organizations and agencies with respect to classification and special access matters. The office manages the nuclear security enterprise-wide Classification and Controlled Information Program, provides security oversight of the DOE Special Access Program, and oversees management of the NNSA Classified Matter Protection and Control Program for NNSA Headquarters.

6.1.1.4 Office of Nuclear Materials Integration

In January 2015, NNSA completed a merger and realignment of several offices. As a result, the Office of Nuclear Materials Integration merged under the newly formed Office of Safety, Infrastructure and Operations and is no longer a subordinate office of Defense Nuclear Security.

6.1.1.5 Office of Personnel and Facility Clearances

The Office of Personnel and Facility Clearance administers the personnel security access authorization program for NNSA sites, as well as the Facility Clearance Program for NNSA sites and NNSA Headquarters. Facility Clearance (including Foreign Ownership, Control, or Influence) ensures vetting and registration to manage classified matter for companies.

6.1.2 Defense Nuclear Security Goals

DNS's overall goal is to provide programs to protect the nuclear materials, physical infrastructure, and workforce that are vital to executing long-range plans for the stockpile. Short-term DNS goals include the following:

- Stabilize the DNS workforce and redefine roles, responsibilities, and authorities in terms of the new structure.
- Manage the DNS budget to provide sufficient resources in a constrained fiscal environment.
- Partner with DOE offices and field elements to define and build a robust security culture.

- Implement a life-cycle management plan to ensure the NNSA security program is sustainable.
- Execute classification and controlled information programs to protect the Nation's weapons information.
- Implement and oversee enhanced security for NNSA Special Access Programs across the nuclear security enterprise.
- Complete NNSA initiatives pertinent to Foreign Ownership, Control, or Influence and the Facility Clearance Program, and implement capabilities for customer-interface web service.
- Implement changes to DOE Order 472.2, *Personnel Security*, to ensure accurate, timely, and equitable determination of eligibility for access to classified information across the nuclear security enterprise.

6.1.3 Defense Nuclear Security Strategy

DNS will create a healthy, collaborative security culture based on mutual trust and respect; strive for consistency in process implementation while allowing for purposeful differences; and enhance the long-term viability of NNSA's Security Team. Accomplishing this strategy while fostering an environment of healthy skepticism will include providing input to the DOE Security Committee, implementing programmatic standardization across the nuclear security enterprise, developing career-path training for security professionals that support NNSA needs, and continuing to develop Federal capabilities.

6.1.4 Defense Nuclear Security Challenges

DNS objectives to meet the challenges of nuclear security in the 21st Century are as follows:

- Achieve effective safeguards and security across the nuclear security enterprise through judicious stewardship in a fiscally challenged environment.
- Lead the integration and standardization of safeguards and security across the nuclear security enterprise.
- Re-establish organizational credibility with internal and external stakeholders at all levels.
- Cultivate a healthy, collaborative security culture by rebuilding NNSA Headquarters and field office relationships and foster external collaborations across the nuclear security enterprise.
- Ensure plans for physical security systems, facilities, and equipment are coordinated with recapitalization and supply chain management.
- Overcome prevalent nuclear security essential-skill vacancies within the enterprise Federal workforce.

6.1.5 Defense Nuclear Security Milestones, Objectives, and Future Plans

Key programmatic milestones, objectives, and plans involving physical infrastructure and protective force revitalization continue the positive trend outlined in the FY 2015 SSMP. In addition to DNS' efforts described in Chapter 4, "Revitalize Physical Infrastructure," the following is a summary of further ongoing efforts:

- Implement the NNSA Security Roadmap and address long-standing unresolved security-related issues.
- Assess security implementation efforts by reviewing and updating security plans and performance testing, reviewing vulnerability assessments, and revising threat and vulnerability analyses.
- Transition to and implement the Joint Nuclear Security Collaboration Initiative to provide greater consistency between NNSA and DOD regarding nuclear weapons and material protection strategies and practices.
- Focus on standardizing technologies and equipment to provide operational efficiencies for security programs.
- Address critical decision zero (approved mission need) items and upgrades that are required by prioritized necessity.
- Use Enterprise Mission Essential Task List principles to identify protective force training needs across the NNSA nuclear security enterprise and to direct appropriate and available resources to ensure training and performance improves in those areas.

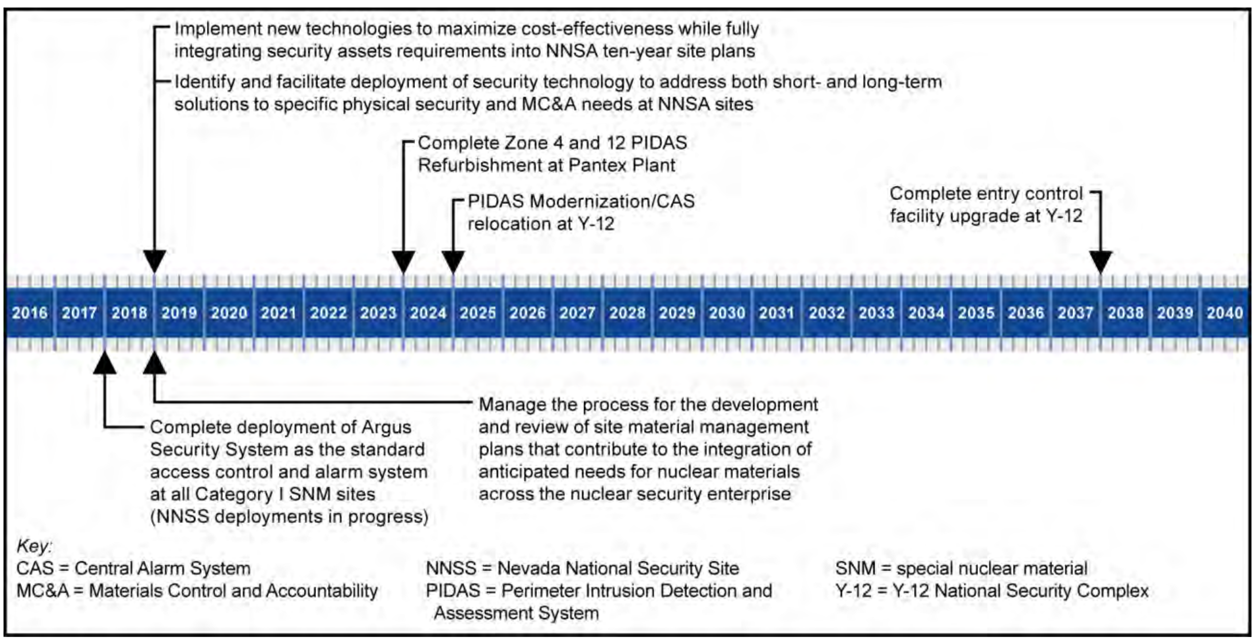

Figure 6–1. Defense Nuclear Security program milestones and objectives timeline

6.2 Information Technology and Cybersecurity Program

The Information Technology and Cybersecurity Program protects NNSA's information assets from unauthorized access and compromise by ensuring sufficient IT and cybersecurity safeguards are implemented throughout the nuclear security enterprise. In FY 2014, NNSA continued to refine the tools to manage and protect its information systems and assets within budget constraints using a risk management approach.

> ***FY 2014 Accomplishments in Information Technology and Cyber Security***
>
> - *Deployed a new security information and event management system.*
> - *Implemented a new high-bandwidth system for detecting network traffic across the nuclear security enterprise.*
> - *Implemented a system to centralize all classified connections with DOD through a single monitoring point.*

The Information Technology and Cybersecurity Program is crucial to the success of stockpile stewardship and management. IT provides the capability to streamline the work to ensure accountability of nuclear material across the nuclear security enterprise; manage the overall life cycle processes of nuclear weapons from cradle to grave; provide project communications; execute weapons response simulations using high-performance computers; and conduct other critical activities to ensure the safety, security, and effectiveness of the Nation's nuclear weapons.

Cybersecurity plays a crucial role in ensuring the IT environment meets the three key tenets of confidentiality, integrity, and availability that are at the heart of information security. Confidentiality ensures that the necessary level of secrecy is enforced at each juncture within data processing to prevent unauthorized disclosure. Integrity maintains and assures the accuracy and consistency of data over the entire life cycle by not allowing data to be modified in an unauthorized or undetectable manner. Availability ensures that the information system is usable when needed and that the systems to store and process information, the security to protect it, and the communication channels to access it are functioning correctly. Moreover, in today's increasingly complex environment, costs must be balanced against business requirements and the needs for increased automation for improved performance and enhanced asset protection.

6.2.1 Information Technology

IT is a two-edged sword. It provides enhanced mobility, increased productivity, and automation of manual activities; however, IT also provides opportunities to introduce vulnerabilities that can compromise access and allow the Nation's adversaries to obtain classified data about the stockpile and sensitive information about NNSA's and DOE's workforce. The Information Technology and Cybersecurity Program implements the tools needed to improve NNSA's ability to keep malicious activities at bay, detect unauthorized access, and defend against malevolent actors. The IT program also evaluates and adopts tools to recover and restore systems to their previous, uncompromised position, while determining what data may have been lost and providing management with an analysis of the potential damage. NNSA's three approaches to transform and modernize its IT operations are briefly summarized below.

6.2.2 NNSA Network Vision

NNSA classified and unclassified networks are being developed, implemented, maintained, and monitored in a manner that will ensure asset protection based on the category of the information and associated security concerns. Life-cycle management is being implemented to ensure network systems are available to support the stockpile stewardship mission throughout the nuclear security enterprise.

6.2.3 Transformation of Information Technology Architecture

During FY 2014, NNSA was focused on delivering the following four distinct capabilities that will provide the underlying architectural tools for secure, integrated communication:

- YOURcloud is a secure, community cloud-services broker that will enable a state-of-the-art, multi-tenant, multi-cloud platform for secure application hosting, data center consolidation, and shared services hosting. In 2014, implementation and integration work continued and testing began.
- OneNNSA is a secure, wide-area network that connects all NNSA sites to the cloud. All traffic will be encrypted with compliant algorithms that follow the Government computer security standard (FIPS 140-2) to protect the confidentiality of NNSA information. During 2014, NNSA completed the initial pilot of OneNNSA and the implementation of full enterprise-wide testing. Network operations were transferred to the DOE Associate Chief Information Officer for Energy IT Services.
- OneVoice is an agency-wide unified communications tool that provides desktop video, web conferencing, instant messaging, presence, and voice for all NNSA employees (both Federal employees and M&O contractors). This capability is integrated with an agency-wide social network to provide enhanced features for collaboration, document sharing, crowd sourcing, and knowledge retention. In 2014, implementation and integration of OneVoice was completed and enterprise-wide testing began.
- OneID is a multi-layered architecture that offers a federated (*i.e.*, decentralized), complex-wide tool to validate user identities and authorize access to DOE and NNSA applications. OneID will replace the agency's existing data-transmission network and provide the foundational infrastructure for accessing networks and shared services. The pilot of the OneID capability was completed in 2014, and implementation, integration, and enterprise-wide testing began. The ability to integrate with physical security access control systems was also demonstrated.

6.2.3.1 Joint Cybersecurity Coordination Center

Incident management reform is a key element of the Secretary of Energy's Management Excellence Initiatives. In 2010, DOE assessed its Incident Management Program and identified the need to (1) provide agile, robust, transparent, and integrated capabilities for frontline cybersecurity operations; (2) use the collective DOE expertise; and (3) meet Federal requirements for incident management and response. The Joint Cyber Security Coordination Center (JC3) was formed in 2011 to achieve these objectives. JC3, which includes NNSA engagement, will allow DOE to understand the health of its computing environment from a cybersecurity and network operations perspective. JC3 is responsible for consolidating the cybersecurity incident management capability and governance processes into a single comprehensive unit and for streamlining information sharing, reporting, and access to technical resources (24 hours a day, seven days a week), while preserving an individual organization's unique requirements and information.

In 2014, NNSA focused on improving communication and disseminating classified event information to the nuclear security enterprise and the DOE elements responsible for cybersecurity. Enhanced sensors were deployed to the sites serviced by JC3, and remote access to cybersecurity incident data was provided to NNSA sites and JC3. Governance, programmatic activities, and operations were consolidated into the DOE Office of the Chief Information Officer, and partnerships with other DOE offices (*e.g.*, Office of Electricity Delivery and Energy Reliability, Office of Intelligence and Counterintelligence, Office of the Inspector General, and Office of Independent Enterprise Assessment) were expanded.

6.2.4 Subprograms of Information Technology and Cybersecurity

The subprograms described below support all activities within the Information Technology and Cybersecurity Program.

6.2.4.1 Infrastructure

The Infrastructure Subprogram supports cybersecurity operations and activities at all NNSA sites and is based on NNSA's defense-in-depth approach to achieving cybersecurity in a highly networked environment. That approach has three major components: personnel, technology, and operations. The approach recommends a balance between the protection capability and considerations of cost, performance, and operations. That balance provides the personnel and technology to maintain a cybersecurity posture that complies with Federal, DOE, and NNSA policies and procedures, while addressing the increasing number and complexity of threats, vulnerabilities, and risks.

6.2.4.2 Enterprise Secure Computing

Enterprise Secure Computing provides the state-of-the-art classified computing infrastructure that enables effective collaboration and information sharing in a secure environment. The subprogram focuses on daily operations, infrastructure enhancements, and application deployment.

6.2.4.3 Technology Application Development

Technology Application Development is responsible for advancing policies and initiatives to support short- and long-term solutions to specific cybersecurity needs at the NNSA sites and NNSA Headquarters. Technological innovation, research, and development are critical components to protect NNSA's assets in national and global technology-driven environments. The subprogram focuses on emerging technologies and leverages existing technology resources to create a more secure environment. It also develops new strategies for cybersecurity activities across NNSA and fosters collaboration among organizations.

6.2.5 Information Technology and Cybersecurity Goals

The overarching goal is to implement a flexible, comprehensive IT and cybersecurity system to ensure the protection of NNSA's classified and sensitive information assets related to the nuclear weapons stockpile. Specific Information Technology and Cybersecurity goals include the following:

- Ensure data confidentiality, integrity, and availability.
- Implement technology designs that provide effective network monitoring, limit an intruder's ability to traverse the network, and can be updated in a timely manner to mitigate new vulnerabilities.

- Develop enhanced information security protection tools for information systems, applications, and networks within both classified and unclassified environments.
- Ensure compliance with NNSA's defense-in-depth cybersecurity strategy.

6.2.6 Information Technology and Cybersecurity Strategy

NNSA continues to maintain and improve its defenses against cyber threats that are increasing in number, complexity, and sophistication, while developing and applying advanced IT to ensure the security of the Nation's nuclear weapons and support other national security missions, such as homeland security. The NNSA sites are continuing to improve the scope and quality of their IT and cybersecurity systems by sharing ideas about asset protection and implementing NNSA guidance and policies. The long-term NNSA strategy has four components. These are summarized below.

6.2.6.1 Planning

Planning is a collaborative effort between NNSA Headquarters and the NNSA field offices to understand the threat landscape and identify weaknesses through compliance reviews and performance measurement. The information NNSA gleans is fed back into planning to generate both a long-term strategy and an annual tactical plan. The planning processes also include a cybersecurity working group and participation in the development of periodic NNSA threat statements and risk assessments.

6.2.6.2 Cybersecurity Policy and Guidance

The cybersecurity policy and guidance component establishes high-level goals and outcomes for NNSA's Information Technology and Cybersecurity Program and drives the implementation strategy. This component ensures that direction is aligned with DOE and Federal cybersecurity policy and guidance and with the planning component of NNSA's IT and cybersecurity strategy. The focus is on balancing both mission and security requirements and providing an appropriately less risk-averse process, while ensuring the right resources are applied to the more critical areas.

6.2.6.3 Architecture and Technology

The architecture and technology component of NNSA's strategy focuses on developing, installing, and managing an IT architecture that is standardized and integrated across the nuclear security enterprise. This strategic component includes architectural guidance, enterprise licensing of security tools and products, and a technology review and development process.

6.2.6.4 Services

The aim of the services component is to develop an intelligent, proactive, centralized approach to cybersecurity to mitigate security threats both at NNSA and DOE. The Information Technology and Cybersecurity Program will facilitate the adoption of new processes and policies throughout the nuclear security enterprise by providing specific services and performing key initiatives related to protecting information assets. These services include cybersecurity communications, education and awareness, asset management, advice and assistance, and awards and recognition.

6.2.7 Information Technology and Cybersecurity Challenges

The expanded use of advanced IT solutions to enhance user interactions and improve mobile computing is stretching NNSA's limited resources to implement the best security tools. Specific challenges include:

- protecting information assets from unauthorized access and compromise in the face of risks, threats, attack vector concerns that grow every day, and the reality of budget constraints;
- addressing new unfunded requirements from the Office of Management and Budget and DOE for unclassified cybersecurity efforts;
- competing with the commercial sector for qualified IT and cybersecurity personnel;
- minimizing delays in replacing and modernizing the IT and cybersecurity infrastructure to meet the production and R&D missions;
- oversight and management of increased classified computing across NNSA, as well as new Federal requirements (*e.g.*, the Homeland Security Presidential Directive); and
- minimizing the creation of disparate IT applications in favor of adopting a nuclear security enterprise-wide, platform-based approach that utilizes shared capabilities.

6.2.8 Summary of Significant Accomplishments and Plans

- Purchased and deployed a new Security Information and Event Management (SIEM) system (pronounced "sim") to provide a holistic view of an organization's IT security. SIEM combines security information management and security event management functions into a single security management system. The underlying principle of a SIEM system is that relevant data about an enterprise's security is produced in multiple locations and all the data can be looked at from a single point of view to make it easier to spot trends and see patterns that are out of the ordinary. SIEM describes a product's capabilities related to gathering, analyzing, and presenting information from network and security devices; identifying and accessing management applications; vulnerability management and policy compliance tools; operating system, database and application logs; and external threat data. A key focus is to monitor and manage user and service privileges, directory services, and other system configuration changes and to provide log auditing and review of incident responses.
- Implemented a new high-bandwidth solution to provide intelligent Traffic Visibility Networking that improves the ability to see into the network infrastructure from both an enterprise and local site perspective. The ability to share the same data stream across multiple monitoring tools allows NNSA to be more agile, secure, and cost-effective. The network infrastructure upgrade implementation provides flexibility for the enterprise architecture to test new tools by sharing data from a single point, to integrate new technology as it is developed, and to improve network monitoring. Overall, this accomplishment increases insight into the network and makes NNSA better able to defend against and respond to incidents.
- Received approval from the Defense Information Assurance Security Accreditation Working Group to stand up an independent Computer Network Defense Service Provider as only the second non-DOD civilian agency authorized. This allowed NNSA to centralize all DOD SIPRNet [Secure Internet Protocol Router Network] connections through a single monitoring point, thereby improving the overall view into potential events occurring on the classified infrastructure.

- Began conducting Command Cyber Readiness Inspections to provide insight into network defense protection and compliance with system requirements. Processes for this ongoing program were validated; these inspections will be conducted annually at selected sites.
- Completed purchase of Splunk to standardize enterprise log aggregation and enhance log data analysis. Splunk allows the collection and indexing of any machine data from virtually any source in real time. It allows NNSA to search, monitor, analyze, and visualize its data to gain new insights and intelligence. It indexes everything for deep visibility, forensics, and troubleshooting. It allows ad hoc report creation to identify trends or prove compliance controls and the ability to analyze user transactions, customer behavior, machine behavior, security threats, and fraudulent activity in real time.
- Initiated cybersecurity performance measures across all sites to improve measurement of performance against specific goals and objectives. This will drive consistent performance and allow the Chief Information Officer to focus resources in areas where performance improvement is needed.
- Progressed with the Continuous Monitoring project by establishing Phase Two requirements and beginning initial deployment. Phase Two will focus on deployment to the classified network, as well as further enhancements and deployment to the unclassified networks.
- Started work on closer coordination of physical security systems and implementation of cybersecurity requirements into these areas.
- Started work on consolidation of networks that (1) have the same function or mission objective and essentially the same operating characteristics and security needs, and (2) reside in the same general operating environment (or in the case of a distributed information system, reside in various locations with similar operating environments) to reduce operational and life-cycle costs.

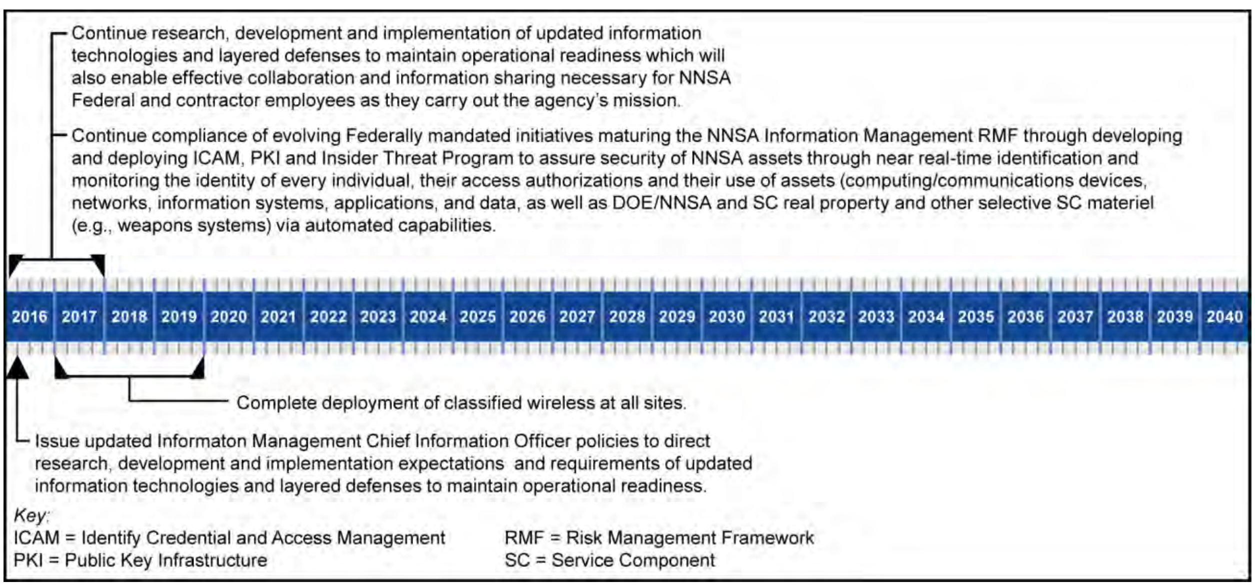

Figure 6–2. Information Technology and Cybersecurity milestones and objectives timeline

Chapter 7
Sustaining the Workforce

The future of the nuclear security enterprise depends on a skilled, diverse workforce with experience across a broad array of the sciences, including engineering, mathematics, and technology. NNSA is keenly aware that it must invest in an available, qualified, and committed workforce to fulfill its nuclear security mission. Maintaining, refreshing, and training people in essential areas of expertise are critical to ensuring the integrity of the nuclear deterrent. NNSA and its M&O partners are devoting extensive effort to sustaining and revitalizing the workforce to support the 3+2 Strategy. This chapter describes the nuclear security enterprise workforce structure, how the various entities work together to support the nuclear deterrent and meet other NNSA program and national security needs, and the challenges of sustaining that workforce. Appendix D of this year's SSMP includes descriptions of the mission, mission capabilities, infrastructure, and workforce data of the eight NNSA sites as well as workforce data on the NNSA Federal staff. These data describe site-specific mission assignments and capabilities, budget allocations, infrastructure plans, and workforce characteristics and challenges. Although not exclusively focused on Defense Programs' needs, the data reflect the way in which each of the sites leverages other national security missions, in varying degrees, to sustain the nuclear weapons mission. Specific discussion about the essential skills for sustaining that nuclear weapon mission in particular appears in Section 7.4.2 of this chapter.

> ***FY 2014 Workforce Accomplishments***
>
> - *The national security laboratories cumulatively earned nine R&D 100 awards in 2014 and garnered 53 of these coveted awards in the last five years.*
> - *NNSA's M&O partners filed more than 270 patents in FY 2014, with more than 210 granted that year.*
> - *Staff at all NNSA sites received national recognition and prestigious awards from their professional societies and technical communities.*

7.1 Introduction

NNSA and its collaborating partners face many challenges and looming issues in planning and managing the multi-faceted workforce now and well into the future. Shortages in key areas of expertise and essential skills, coupled with competition from private sector employers, are making it more difficult to recruit, hire, and retain that workforce. NNSA's ability to retain mid-career and entry-level workers is threatened by the competitive high-tech job market, with private sector employers offering higher salaries and more-attractive benefits in several disciplines. Preservation and transfer of institutional and technical knowledge prior to the exodus of retirement-eligible members are critical to the continuity of NNSA's nuclear weapons work and its capability to develop and mentor the newest members of the workforce. These issues must be managed in the face of an increasing workload to accomplish weapons modernization through LEPs while reducing the stockpile size. Adding to the complexity of planning and managing the future workforce under these circumstances are external factors such as a changing geopolitical environment, budget uncertainties, and delays in the availability of Weapons Activities funding.

7.2 The Nuclear Security Enterprise Workforce

7.2.1 Strategic Drivers

Two strategic documents inform the planning and management of the NNSA workforce. The key messages in the *DOE Human Capital Strategic Plan FY 2011 – FY 2015* (DOE 2011) and the *NNSA Strategic Plan* (DOE 2011) combine to form a clear and consistent overarching principle to manage the workforce. People are the most important asset in maintaining nuclear deterrence and achieving other national security goals: approximately 60 percent of the Weapons Activities budget is spent on M&O labor. The alignment with the DOE and NNSA strategic direction is a prime driver for workforce planning and management among NNSA and its partners. The workforce is referenced throughout the SSMP as an asset critical to accomplishing NNSA's missions, with specific references cited in Chapter 2, "Stockpile Management" with respect to Life Extension Program Planning and Execution (Section 2.1.4.1) and Stockpile Services (Section 2.4.3). Chapters 3, "Research, Development, Test, and Evaluation," 5, "Secure Transportation Asset Program," and 6, "Security" also contain references to the importance and difficulty of acquiring and retaining personnel with essential skills.

The collective nuclear security enterprise workforce is dynamic because of external factors. The makeup of the workforce will evolve because of changes in the geopolitical climate, technology, demographics, and fluctuations in scope and budget. Along with mission needs, these factors and others will drive the planning and management of the future workforce, as discussed in Sections 7.3 and 7.6.

7.2.2 Summary of Workforce Structure

The Weapons Activities workforce is composed of a diverse group of skilled and mission-focused technical, administrative, and specialty area staff and managers. The overall workforce has three basic components: the Federal workforce, the M&O partners, and the non-M&O entities, as illustrated in **Figure 7–1**. That integrated workforce is dedicated to maintaining the Nation's deterrent in a safe, secure, and effective manner.

One example of workforce integration is through personnel exchanges, which provide key interfaces among and within the Federal and M&O workforces. For example, the National Security Campus at Kansas City sends technical staff to the national security laboratories early in the design phase to learn about the design as it is being developed and to incorporate the design into manufacturability concepts along with lessons learned from past programs. M&O partners with technical expertise are routinely assigned to NNSA Headquarters and DOD locations. This exchange program provides opportunities that are mutually beneficial and improves overall communications between the Federal and M&O workforces.

In this document, workforce data are reported using the Common Occupational Classification System (COCS). Federal and M&O workforce data are reported in the standardized COCS categories, allowing consistent comparison among the sites. However, these categories are not completely descriptive of the functions within each category. For example, the broad COCS category, "General Management," also includes technical and scientific management functions, and the "Professional Administrators" category includes technical analysis and drafting design functions.

Figure 7–1. Nuclear security enterprise workforce components

7.2.2.1 Overall Workforce

At the end of FY 2014, the overall nuclear security enterprise Federal and M&O workforce had 37,071 employees. This excludes the Naval Reactors workforce, but it includes employees engaged in Defense Nuclear Nonproliferation activities. This included 34,927 M&O partners at the eight sites and 2,144 Federal employees (approximately 6 percent of the total). For the FY 2016 SSMP, NNSA changed the overall reporting of personnel to capturing actual headcount workforce data (as opposed to calculated full-time equivalent [FTE] data) to better reflect the total site work effort for the assigned mission scope.[1] The new baseline provides improved accuracy, is aligned with site human resource practices, and provides consistent data to NNSA Headquarters. Collectively, the sites reported a decrease of approximately 600 employees over the last two fiscal years. Although this is a net loss, it has not materially affected the overall ability to execute the workload. However, several individual sites have experienced more impactful losses. See Appendix D for workforce and site-specific data.

7.2.2.2 Federal Workforce

The Federal workforce consists of a mix of civilians and military officers. That collective pairing is responsible for planning, managing, and overseeing the nuclear security enterprise and is accountable to the President, the Congress, and the public. The Federal workforce performs key planning functions, such as establishing and authorizing the work scope, integrating DOD requirements, and providing program and project management, risk management, acquisition, and contract management services.

[1] *"NNSA and its partners developed new personnel reporting procedures that are closely aligned with sites' human resource data collection and more closely relate to personnel data commonly understood across the eight NNSA sites. The new methodology provides a much simpler process that is more widely recognized and matches established procedures and functions more closely to historic data routinely collected. This new methodology is supported across all eight NNSA sites and the Federal workforce to provide accurate, consistent, and timelier response to congressional legislation."*

The Federal workforce also performs fiduciary oversight, risk acceptance, product acceptance, and environmental, safety, and health oversight duties (see **Figure 7–2)**. The Federal workforce resides primarily at NNSA Headquarters in Washington, D.C., and at field offices across the eight NNSA sites. At the end of FY 2014, total Federal headcount of 2,144 included 1,587 under the NNSA Federal Salaries and Expenses (formerly called the Office of the Administrator) and 557 in the Office of Secure Transportation Asset.

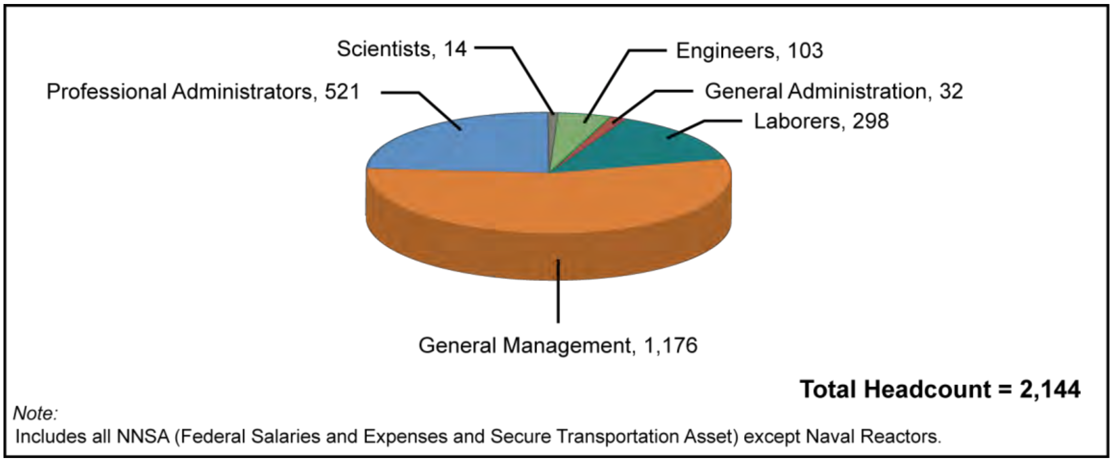

Figure 7–2. Headcount of NNSA Federal workforce by Common Occupational Classification System

A small cadre of military officers (25 to 30) is routinely stationed on active duty at NNSA within Defense Programs. The senior military leader in Defense Programs is a flag officer whose position is established by the Atomic Energy Act of 1954, as amended. These officers bring a service perspective to Weapons Activities and return to DOD at the end of their assignments with a better understanding of NNSA and the nuclear security enterprise. In some NNSA offices, they make up a not insignificant percentage of Federal staff overseeing nuclear security programs and activities.

The National Defense Authorization Act for FY 2015 capped the total number of Federal employees under NNSA Federal Salaries and Expenses at 1,690 FTEs by October 2015, excluding the Office of Secure Transportation Asset and Office of Naval Reactors. The 1,690-FTE cap represents a 14.2 percent reduction from the previous 2010 target of 1,970, which continues to show a steady downward trend with the cap. This trend is constraining the Federal workforce and yet offers an opportunity to reshape the workforce for their oversight and program management roles.[2]

7.2.2.3 M&O Workforce

The M&O workforce resides at eight Government-owned or leased nuclear security enterprise sites. Roll-ups (see Appendix D) of the workforce under COCS categories for the national security laboratories (plus the Nevada National Security Site) and the nuclear weapons production facilities are shown in **Figures 7–3** and **7–4**, respectively. The composition of the workforce has been relatively consistent since the last SSMP. The numbers of scientists, engineers, and technicians are highest among the national security laboratories, as would be expected for the R&D roles they primarily fulfill in the nuclear security enterprise. The nuclear weapons production facilities also have engineers and scientists on staff, but have higher proportions of operators and crafts to fulfill their manufacturing missions.

[2] *The current Federal staff, as of October 2014, totaled 1,587 FTEs under Federal Salaries and Expenses, which is below the cap set for October 2015.*

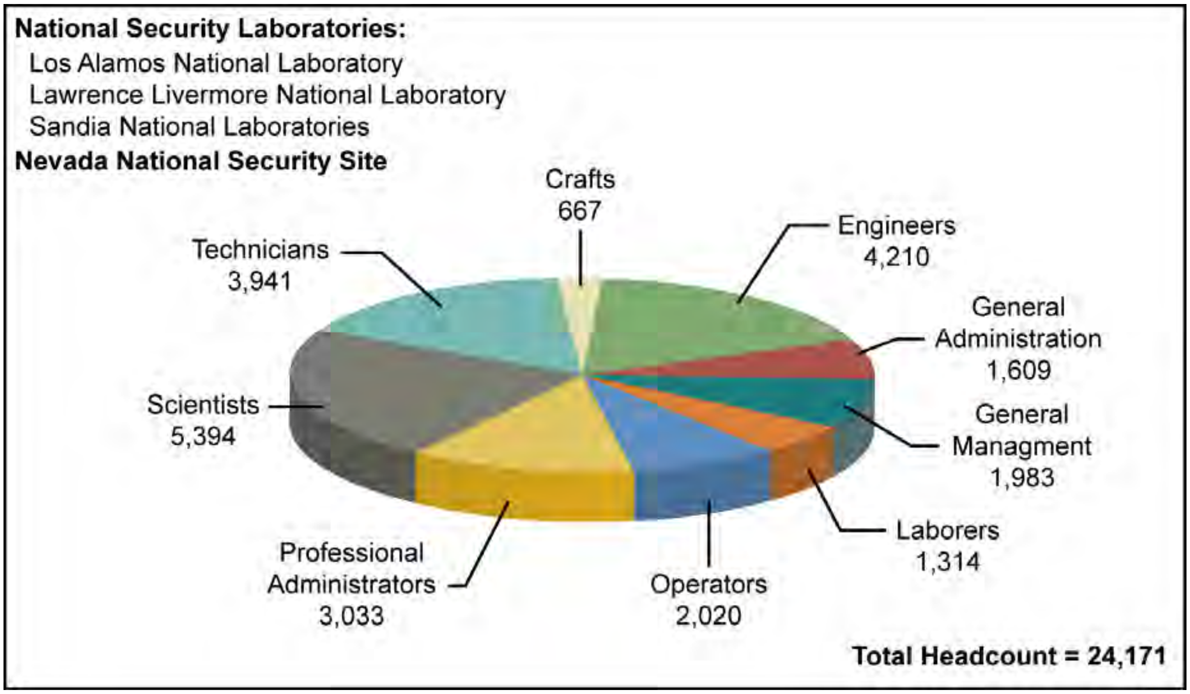

Figure 7–3. Headcount of national security laboratories and Nevada National Security Site by Common Occupational Classification System

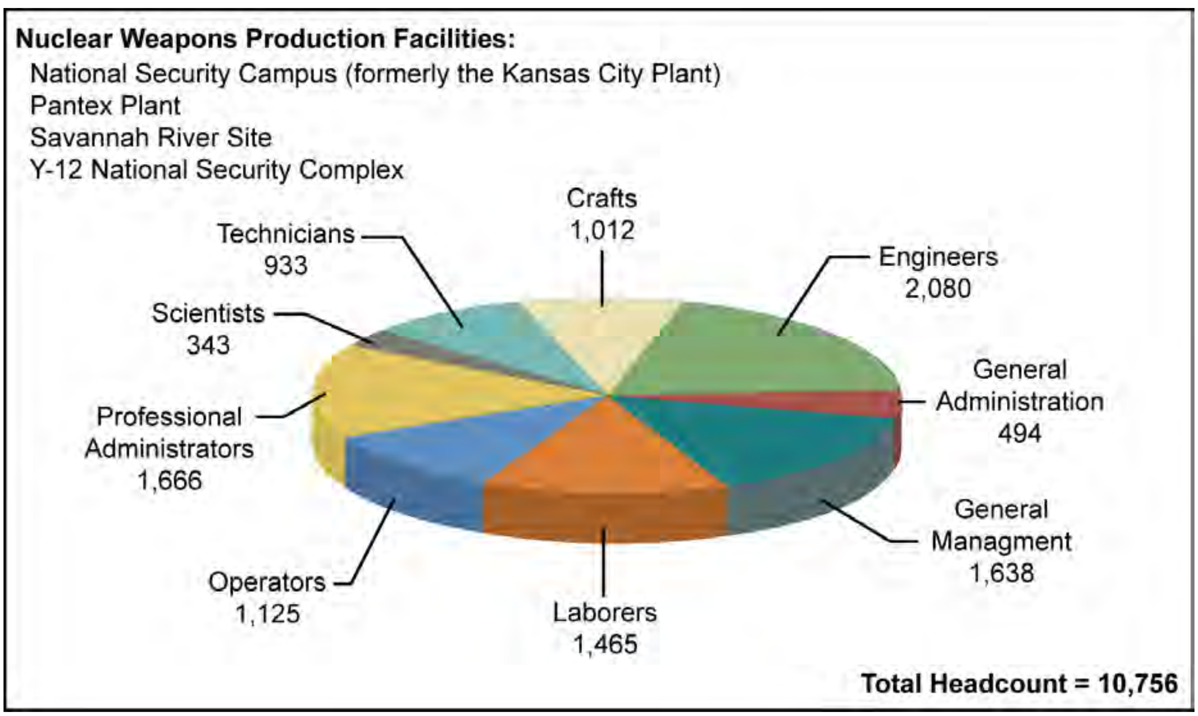

Figure 7–4. Headcount of nuclear weapons production facilities by Common Occupational Classification System

Although professional administrative personnel and general management percentages are lower than for the Federal staff, they still represent a substantial portion of the M&O workforce. This is a byproduct of the COCS code definitions and how they are grouped, as explained above (see Section 7.2.2). The COCS categories mask the numbers of scientists and engineers who are functioning in the roles of technical managers, as well as the numbers of project and program managers, as is the case for the Federal workforce.

Weapons Activities are primarily implemented through a Government-owned, contractor-operated, research, development, and production complex, along with a large commercial, academic, and industrial supply chain. Under the umbrella of the M&O partners are the three national security laboratories, which operate as Federally Funded Research and Development Centers (FFRDCs), the four nuclear weapons production facilities, and the Nevada National Security Site.

The M&O partners perform the day-to-day activities of managing and executing the efforts at the eight sites, such as R&D, design, production, test, manufacturing, surveillance, *etc.*, with oversight by the Federal workforce. The M&O workforce also partners with the Federal workforce to develop and implement strategic planning for the nuclear security enterprise.

7.2.2.4 Non-M&O Workforce

NNSA's outreach for the requisite skill set goes beyond its own ranks. In addition to having access to the expertise of M&O partners, NNSA relies on non-M&O partners to provide specialized services, access supplemental experimental assets, and leverage the R&D resources of academia. These non-M&O partners may include academic researchers, technical and management consultants, subject matter experts at private corporations, and others on an adjunct, as-needed basis. An example of a non-M&O partner is the Omega laser at the Laboratory for Laser Energetics, a unique national resource partially funded by the Government and owned and operated by the University of Rochester. The research at Omega complements high-energy-density laser R&D work at NNSA facilities (in particular, the NIF). These non-M&O partners also include some 380 support service contractors supporting the Federal staff.

7.3 Planning the Workforce

7.3.1 Federal Workforce Planning

The role of NNSA Headquarters in workforce planning is two-fold: plan for the Federal workforce and monitor the workforce planning of the M&O partners. NNSA requires its M&O partners to determine the appropriate skill mix necessary to execute stockpile stewardship and management activities, in response to changes in the workload. NNSA Headquarters works jointly with its M&O partners to collect workforce data and identify and resolve issues, particularly those that affect multiple sites.

7.3.2 Management and Operating Partner Workforce Planning

NNSA's M&O partners develop and implement workforce plans and approaches to ensure the most effective workforce is available for their respective organizations. Each NNSA site has workforce planning processes tailored to its unique needs, but the processes have similar elements. First, line organizations at the sites must translate their assigned mission into workload projections. These projections are then analyzed along with anticipated retirements and other separations to identify likely gap areas in future staffing.

The numbers of hires in required disciplines and specialized skill areas are identified over a one- to two-year time frame (see **Figure 7–5)**. Human resource organizations at the sites use this planning and other information to formulate their recruiting strategies and compare their progress against the planning baseline. They adjust hiring baseline plans for factors such as budget variability, scope uncertainty, or attrition. Any gaps between workforce availability and workload are managed by each site using a variety of mechanisms, with the intent of maintaining a steady, experienced workforce over the FYNSP and beyond. Examples of such mechanisms include:

- leveraging resources from other programs or parent company reach-back;[3]
- deferring purchases, capital investments, maintenance, travel, *etc*.;
- prioritizing work to available funding; and
- relying on exempt staff[4] flexibility.

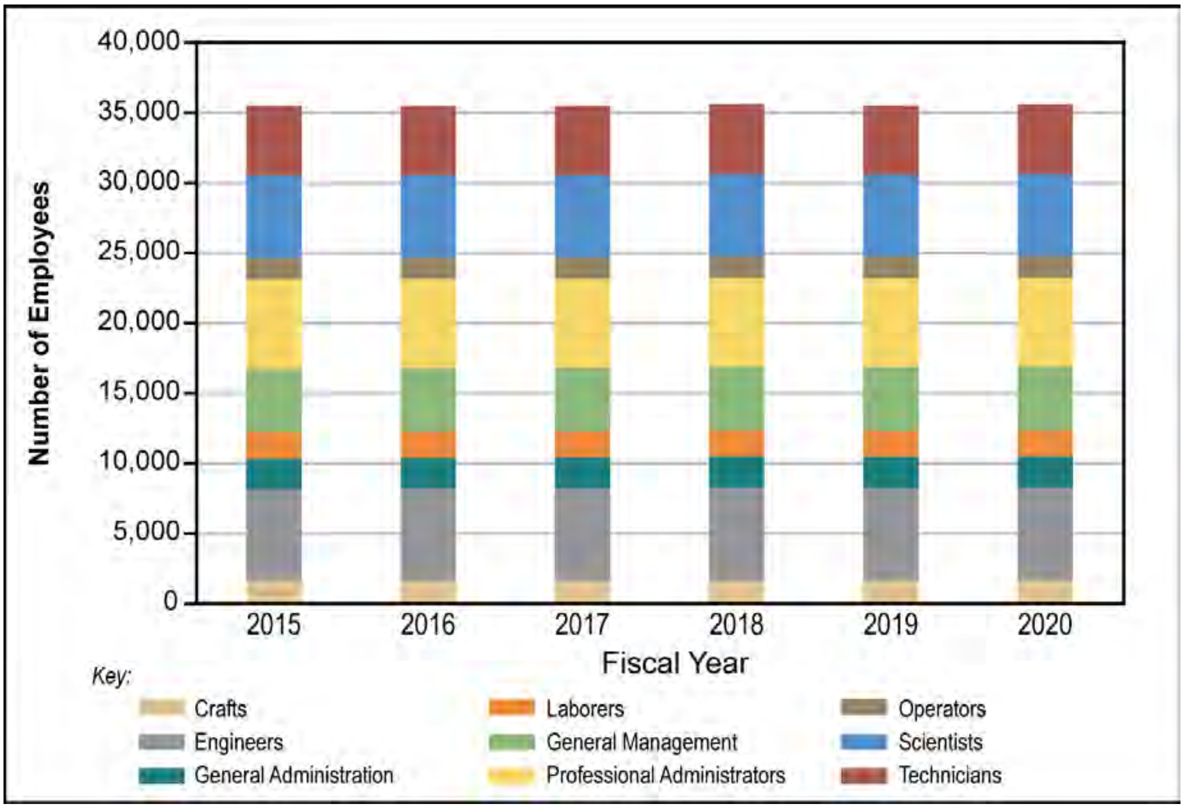

Figure 7–5. M&O workforce projections for the current Future Years Nuclear Security Program period

[3] *Parent company reach-back is the ability of operating contractors to leverage certain knowledge, skills, abilities, and business practices of the parent company to respond to M&O contractor needs, such as best practices, technical capabilities, or access to specialized resources and talent.*
[4] *Exempt employees are those who are excluded from Fair Labor Standards Act minimum wage and overtime pay requirements.*

7.4 Unique Workforce Characteristics

7.4.1 Difference of Nuclear Security Enterprise from Private Industry

The work executed by the nuclear security enterprise requires a large, diverse array of unique knowledge, skills, and capabilities, as well as the ability to perform classified R&D in the context of national security. Security background investigations constrain universities from preparing students for nuclear weapons work in an academic setting. Therefore, the entities in the nuclear security enterprise must train their new workforce intensively and to a greater extent than private industry.

7.4.2 Unique Set of Essential Skills Required for Nuclear Weapons Work

NNSA recognizes its responsibility as the Federal oversight agency to ensure strategies are in place to acquire and retain staff with the essential skills that are key to accomplishing NNSA's mission. Skills considered essential can vary over time, depending on changes in work scope and economic conditions. This time dependency and other characteristics lead NNSA to rely on its M&O partners to identify and periodically update the list of essential skills that support the NNSA mission. **Table 7–1** provides the current listing of essential skills as developed by the NNSA sites. Sites apply the NNSA definition of essential skills[5] to derive their list.

Table 7–1. Essential skills for the nuclear security enterprise

National Security Laboratories and the Nevada National Security Site	*Nuclear Weapons Production Facilities*
Nuclear design and evaluation – primary and secondary design	Engineering – electrical, mechanical, materials
Nuclear design code development	Nuclear criticality safety engineering
Physics – atomic, nuclear, and high-energy-density plasma	Fire protection engineering
Computations and simulation	Project management and controls
Engineering design and evaluation – all phases, all components	Reservoir engineering
Materials science and engineering	Material science and engineering
Manufacturing and fabrication	Radioactive materials process engineering
Lasers, pulsed power, accelerators, and gas guns	Operational and craft skills
Radiation effects sciences	Manufacturing
Reactor and radiation source operations and evaluation	Chemical processing
Electromagnetic sciences	Process and material development
Metrology	High explosive manufacturing and surveillance
Diagnostics and instrumentation systems	Engineering – welding, radar, optics
Quality assurance	Quality assurance
High explosive research, development, test, and evaluation and surveillance	Radioactive hydrogen isotope process design and evaluation

[5] *Essential skills are those required to accomplish the NNSA mission. These skills are related to the scientific, technical, engineering, operations, business, and professional disciplines. They are characterized by uniqueness, high market demand, the time to acquire and maintain proficiency, and the difficulty in recruiting and retaining individuals with those skills.*

7.4.3 Adherence to Unique Laws and Regulations for NNSA Scope

The size and composition of the nuclear security enterprise workforce, as described in Section 7.2.2, is driven primarily by mission need. However, NNSA and its partners must also comply with a set of legislative and legal requirements for managing the workforce. These include, but are not limited to, all applicable labor laws, regulations for employee safety and protection, laws governing the protection of classified information and the granting of security clearances, *etc*. While private employers deal with many of these requirements, security in particular puts an especially heavy onus on NNSA and its partners that adds complexity to the acquisition and retention of the workforce.

7.4.4 Future Issues Facing the Workforce

7.4.4.1 Evolution of Nuclear Security Enterprise Workforce since the Cold War

Events since the end of the Cold War have resulted in fluctuations in programmatic plans, scopes, and associated funding and contributed to the evolution of the workforce. The current workforce, which is statistically older than that in many other industries, is a combination of employees nearing retirement who possess Cold War–era expertise and more recent entrants with newer, fresher skills in emerging technical fields. Today, there is also a greater focus on national security with additional strategic partners. This focus has attracted new skills and maintained existing nuclear weapons skills by leveraging expertise.

7.4.4.2 Talent Management Issues Faced by the Current Workforce

NNSA and its partners face a number of challenges to workforce management: the aging workforce, budgetary fluctuations, evolving requirements of stockpile modernization through LEPs, and increased challenges in acquiring and retaining staff caused by a number of the external factors, including the geographic locations[6] of some of the sites.

7.4.4.3 Challenges in Managing the Current Workforce

The future of the U.S. nuclear deterrent and the evolving geopolitical landscape will affect the size and composition of the nuclear security enterprise workforce. The unique nature of nuclear weapons work and the inability to develop weapon designers through academia because of security background investigations will continue to be factors. A significant aspect of future planning is the ability to replace and hire new staff in time to transfer essential skills from members of the workforce who are approaching retirement. Another continuing issue is attracting and retaining staff with the essential skills to replace the contingent of retiring workers. Providing a healthy, vibrant, and modern infrastructure to attract the future workforce presents increasing challenges as infrastructure modernization competes with the growing scope of stockpile modernization through LEPs (see Chapter 4, "Revitalize Physical Infrastructure"). These demands must be addressed at flat or reduced budgets.

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[6] *Two specific examples: The Pantex Plant is located where the majority of skills relate to farming in the sparsely populated Texas Panhandle. The proximity of LLNL and the SNL, California, site to Silicon Valley presents a different challenge in terms of competition for the pool of available candidates.*

7.4.5 Summary of Current State of the Workforce at the Sites

7.4.5.1 Data and Analysis

Metrics from the sites provide insight into the current health of the workforce, emerging trends, current challenges, and likely future challenges.

Figure 7–6 provides a snapshot of the M&O workforce distribution by age. The average age of the workforce at the eight sites varies from 46 to 51 years, with the percentage of retirement-eligible employees ranging from 21 to 48 percent. Some sites (see Appendix D) portray a bimodal age distribution, with large numbers of employees in the youngest and oldest age ranges and fewer in the mid-range. These figures have generated concerns about anticipated turnover rates caused by impending retirements, as well as concerns about the transfer and preservation of knowledge.

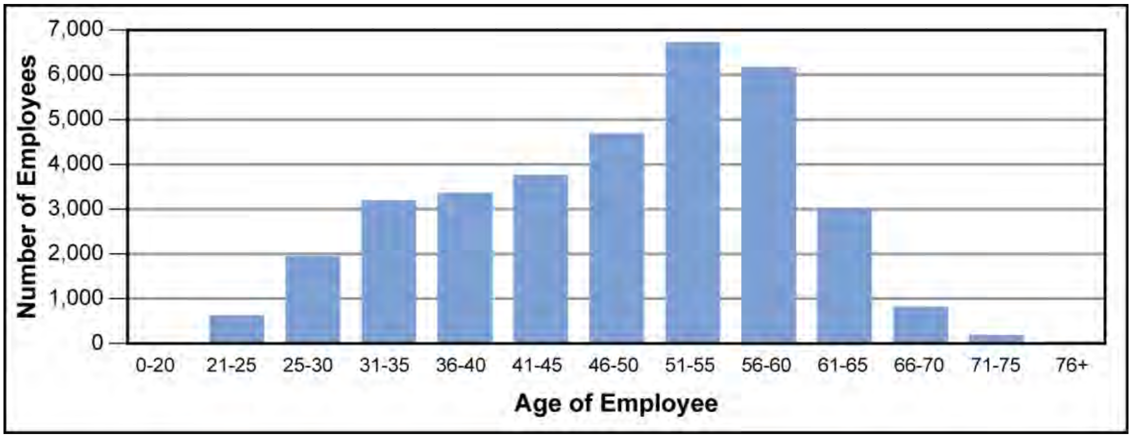

Figure 7–6. M&O headcount distribution by age

Figure 7–7 provides a snapshot of NNSA's M&O partner workforce distributed by years of service, (*i.e.,* the period from the date an employee was hired to the present). Statistics on the average length of service reveal large numbers of employees with less than ten years of service and comparable percentages of personnel with greater than 20 years of service. The average lengths of service at the sites range from 12 to 22 years. Some sites also show a bimodal distribution of lengths of service similar to that with employee ages; others show a single-mode distribution, with the mode skewed toward fewer years of service. These numbers demonstrate overall increased hiring in recent years to replace retirees and to staff emerging programs such as the B61-12 and the W88 Alt 370.

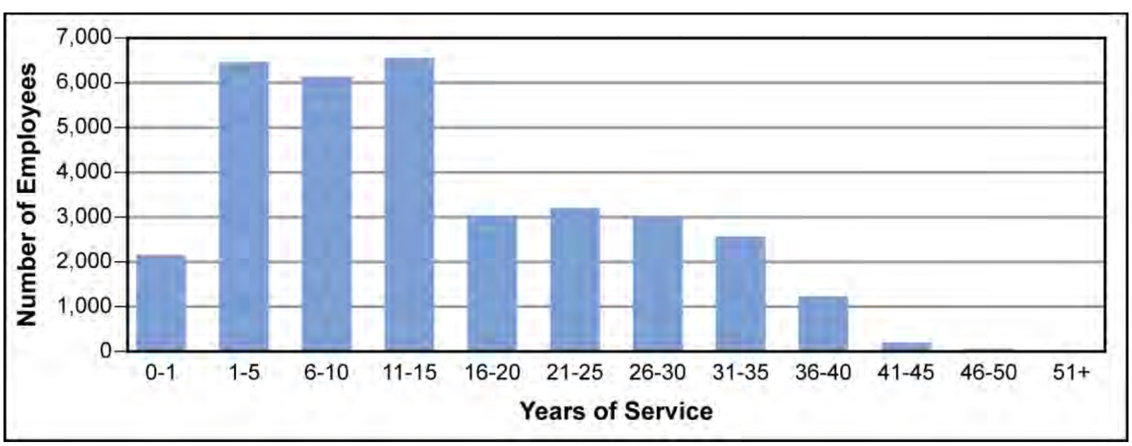

Figure 7–7. M&O headcount distribution by years of service

In spite of ongoing hiring programs at many sites, the workforce has sustained a net decrease of approximately 2 percent over the last two years caused by:

- planned attrition resulting from transition to a leased facility (*i.e.*, the National Security Campus in Kansas City),
- restructuring and voluntary separation programs (at several sites), and
- budget decreases and scope restructuring (*i.e.*, at LLNL and the Nevada National Security Site).

At several sites, the ages and years of service of those who separated voluntarily from the nuclear security enterprise workforce are indicated by small increases in voluntary separations in the 25 to 35 age group and in the zero to ten years of service range. While the voluntary separation rates are still low, the affected sites are monitoring these trends among essential skill employees carefully.

At most sites, the percentage of the workforce in later stages of their careers has been steadily increasing or remained relatively stable. Only one site has had enough early-career hiring to experience a downward trend in the percentage of employees in late career.

7.4.5.2 Workforce Issues and Implications for the Nuclear Security Enterprise

Concerns about the high average age of employees in the current workforce and the percent eligible for retirement are pervasive among the sites and NNSA. Such concerns include:

- the ability to hire in sufficient numbers at a rapid enough rate to replace the expected retirements and to staff growing modernization programs and
- the knowledge transfer and preservation prior to the departure of retirees.

Additional concerns arise when considering the bimodal age and experience distributions at many sites. As the large number of late-career employees retire, the sites will have limited numbers of mid-career employees remaining to train and mentor the large body of incoming new hires.

The larger numbers of early-career employees, coupled with trending data on voluntary separations in these low age and experience ranges, create concerns among NNSA and its M&O partners regarding the ability to retain employees in the future. Growing competition from industry and shortages of candidates in science, technology, engineering, and mathematics (STEM) essential skill areas augment these concerns.

7.5 Workforce Accomplishments

The members of the nuclear security enterprise workforce collectively demonstrate a long history of outstanding technical and professional excellence and dedication through the cumulative honors and awards earned. These include numerous awards and recognition for technical achievements in their specialty fields, as well as for contributions to their professions and their communities. Such accomplishments also demonstrate a service to the Nation through the sharing of the considerable body of intellectual property generated by the collective workforce. This section summarizes some of these accomplishments.

The three national security laboratories (LANL, LLNL, and SNL) cumulatively earned nine R&D 100 awards[7] in 2014 and garnered a total of 53 of these coveted awards over the last five years. Y-12 and the Nevada National Security Site earned two additional awards in this same five-year period. Members of the workforce at these five sites have been collaborators with other recipients on nine additional R&D 100 awards since 2010.

NNSA's M&O partners have been granted patents numbering in the hundreds in each of the last three years. Filings of technical advances and invention disclosures numbered close to 400 across the sites in 2014. NNSA sites also boast robust technology transfer programs with dozens of Cooperative Research and Development Agreements and partnership agreements. Technological advances, as evidenced by these statistics, benefit local communities and society at large by extending the innovation of the NNSA workforce to other applications within and beyond national security.

The caliber of the workforce is further demonstrated by the numbers of scientists and engineers who have received recognition and awards from their respective technical and professional societies. As one example, in 2014, four members of the nuclear security enterprise workforce were named Fellows by the American Association for the Advancement of Science. This honor recognizes awardees for scientifically or socially distinguished efforts to advance science or its applications. Nomination and selection is a rigorous, peer reviewed process. Some additional examples of such accomplishments are listed in **Table 7–2**.

Table 7–2. NNSA workforce awards and achievements for technical and professional excellence

Award/Recognition	***Description/Significance***
Gordon Bell Prize for outstanding achievement in high-performance computing	Set a new supercomputing simulation record in fluid dynamics.
Ernest O. Lawrence Award [a]	For the development and implementation of a model integrating regional and teleseismic data to yield seismic event solutions with greatly improved location accuracy, and for its applications in nuclear explosion monitoring.
RAZAR [Rapid Adaptive Zoom for Assault Rifles] scope	Enables shooter to zoom in and out faster on near and far targets in one low-power system.
2014 IMAPS [International Microelectronics Assembly and Packaging Society] award for technical contribution to the microelectronics industry	Awarded for sponsoring senior design projects, hiring and providing training for interns in microelectronics, and promoting the industry through contributions to scientific publications and journals.
2014 DOE Sustainability Award, Best in Class for Fleet Maintenance and Water Loss Mitigation	Cited for alternative fuel use, fleet right-sizing, oil change frequency driven by analysis *vs.* time interval/mileage, water conservation, *etc.*
2014 HENAAC [Hispanic Engineer National Achievement Awards Corporation] Award - Most Promising Engineer/Advanced Degree	New (less than nine years since PhD) and promising Hispanics in a STEM [science, technology, engineering, and mathematics) field whose technical work already demonstrates a promising career
$1.2M research grant from DOE SunShot initiative	Develop materials to make solar power cost-competitive with other sources of energy.

[a] The Lawrence Award honors U.S. scientists and engineers at mid-career for exceptional contributions in R&D support for DOE and its mission to advance the national, economic, and energy security of the United States.

[7] *Widely recognized as the "Oscars of Invention," the R&D 100 Awards identify and celebrate the top technology products of the year. Past winners have included sophisticated testing equipment, innovative new materials, chemistry breakthroughs, biomedical products, consumer items, and high energy density physics. The R&D 100 Awards span industry, academia, and Government-sponsored research.*

7.6 Managing the Workforce

NNSA and its M&O partners are responsible for managing the workforce to address future missions and emerging needs. To execute these responsibilities, NNSA and its partners use a talent management life cycle approach. This approach characterizes the progression from recruitment and hiring, through career development and performance, to transition out of the active workforce. Each entity in the nuclear security enterprise applies the elements of this talent management life-cycle approach, as its specific mission assignments demand, to plan and manage its workforce appropriately.

Talent management as a life cycle process is depicted in **Figure 7–8**. This model helps frame the discussion of the challenges faced by NNSA and its partners as they acquire and retain their workforce.

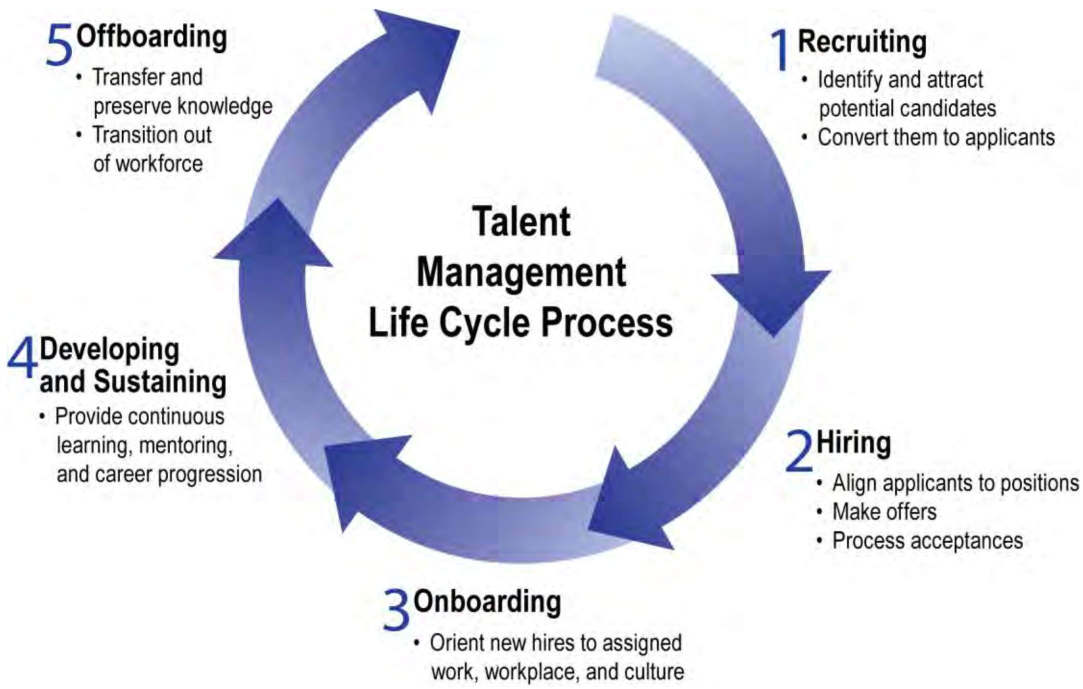

Figure 7–8. Five basic components of the talent management life-cycle process

7.6.1 Workforce Challenges

7.6.1.1 Recruiting

NNSA and its M&O partners face several challenges in recruiting the workforce of the future. Many of the best and brightest in the emerging technical talent pool are not aware of the nuclear security enterprise as a career option. For high-demand disciplines such as electrical engineering and computer science, industrial employers may offer greater compensation packages that appeal to the current generation of graduates, therefore providing significant competition for ideal candidates for NNSA and its partners.

Moreover, finding enough prospects with advanced degrees in the appropriate technical disciplines is becoming more difficult because of the demographics of engineering education in the United States.

Statistics demonstrate the limitations of the employment pool of technical graduates eligible for hire by NNSA and its partners, particularly at the national security laboratories.[8]

7.6.1.2 Hiring

Uncertain budget environments caused by continuing resolutions, sequestration, or other perturbations present significant challenges. In the past, career stability was a major selling point for NNSA and its partners to attract candidates. Many recent events, however, including the Government shutdown, have eroded the confidence of candidates in the stability and predictability of the nuclear security enterprise as a career.

At the Federal level, and to some extent among M&O partners, the length of time required to hire results in a loss of candidates to other employers. This is an artifact of Federal requirements, security background investigations, and internal processes that prolong the time between an interview and an employment offer.

Compensation packages offered by industry tend to be very attractive, especially to candidates with student debt or other fiscal concerns. While the total compensation at M&O sites is generally competitive with the industry average, it cannot compete with lucrative sign-on bonuses or other fiscal incentives from commercial entities.

7.6.1.3 Onboarding

If hiring the future workforce is challenging, keeping them engaged through the onboarding phase is equally daunting. New hires awaiting security clearances are often limited in exposure to their actual work assignments and physically isolated from their assigned work group for several months after they are hired. Keeping new hires awaiting clearances engaged without being able to give them meaningful work is a trial for employees and their managers alike. In addition, the availability of staff to orient, train, and mentor new hires may be limited because of the increased workload for weapon modernization through LEPs.

7.6.1.4 Developing and Sustaining

Retaining early- and mid-career employees with the knowledge, skills, and abilities to commit to a long-term career in the nuclear security enterprise over other commercial and Governmental opportunities is an escalating challenge. Some private-sector opportunities, especially in disciplines with the highest demand, offer very attractive compensation packages and hiring incentives that may be difficult for early-career employees to resist. The transition of some M&O partners from defined pensions to portable 401K contribution programs gives newer hires more mobility and freedom to change employers without losing benefits. Of equal concern is erosion in the perceived stability of employment within the nuclear security enterprise because of budget fluctuations, threats of sequestration, and other anomalies. A number of early-career employees have reported a discrepancy between the work content they expected before being hired and the actual work they were given to do, leaving them feeling disillusioned and less inclined to stay. All of these issues will affect retention rates for employees with two to ten years of service over the next decade.

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[8] *The percentage of MS and PhD candidates eligible to work in national security positions has been dropping. For example, at the end of 2012, the proportion of permanent U.S. residents receiving MS degrees in engineering was about 56 percent; for PhDs, it was 47 percent, and the trend is continuing downward. Furthermore, the percentage of women and minorities receiving advanced degrees in science, technology, engineering, and mathematics remains disproportionately low. (From* Engineering by the Numbers*, published by the American Society of Engineering Education, 2013.)*

Another challenge is the demographic profile of many NNSA sites, which shows a bimodal age and experience distribution among employees.[9] This profile foreshadows two looming issues. The first is a large flood of expected retirements from among the substantial portion of the workforce that is currently or will soon be eligible for retirement. The second issue is the declining numbers of mid-career technical professionals because of current demographics, compounded by the recruitment and retention issues described earlier in the subsections of Section 7.6. These two dynamics will leave fewer mentors available to carry on the traditional apprenticeship model[10] for developing new members of the workforce into fully competent technical employees. Taking both dynamics into account, the shortage of mid-career employees will pose increasingly serious challenges to performing NNSA's central mission as the nuclear security enterprise moves beyond the period from 2016 to 2020. Sites will need to develop innovative ways to educate and train early-career employees quickly and efficiently to become full contributors, as well as focus more on retention of mid-career employees.

The traditional apprenticeship model poses additional challenges in terms of future needs. In the past, apprenticeships were designed to create a cadre of deeply experienced subject matter experts in narrow areas of expertise. In the future, the nuclear security enterprise will require more individuals with both depth *and* breadth, in addition to very deep subject matter experts. Flexibility and adaptability, coupled with technical expertise, will be more in demand than technical depth by itself. The apprenticeship model will need to grow and evolve to accommodate this change.

7.6.1.5 Offboarding

The biggest current challenge for offboarding is getting process and programmatic knowledge transferred rapidly enough to stay ahead of the expected wave of retirements. The current and anticipated heavy stockpile modernization through LEPs workloads,[11] coupled with increased mentoring and leadership requirements caused by increased hiring, may also preempt the time available for employees approaching retirement to follow through with substantive knowledge transfer.

7.6.2 Plans for Addressing Workforce Challenges

7.6.2.1 Recruiting

To compete favorably with private industry benefits and compensation packages, NNSA needs to demonstrate the differentiating advantages of a nuclear weapons career to prospective employees. These advantages include:

- technically challenging work that is critical to national security;
- flexibility in work schedules;
- career mobility within and across NNSA, DOE, and their M&O partners; and
- relative employment stability, even during economic downturns.

[9] *This bimodal distribution has two "humps," with large numbers of employees in early and late career and many fewer employees in the mid-career stage.*
[10] *Traditionally, weapon designers and other technical specialists achieved competency over time through apprenticeship with an experienced technical staff member. As they advanced and learned, they became "journeymen" by mid-career and eventually "masters," as they matured in their technical specialty.*
[11] *See Chapter 2, Figure 2–10, and Section 2.4.1, Life Extension Programs and Major Alterations, for the Stockpile Life Extension Program projections through FY 2040.*

One advantage that M&O partners can leverage is the ability to reach back to their parent companies for temporary or even permanent staffing needs. The recruiting mechanisms used at the parent companies may also be leveraged by the M&O partners.

To help promote these benefits, NNSA and its partners need to increase support for outreach programs that encourage a diverse cross section of young people to enter STEM careers. Outreach events allow employees to influence future technical workers and provide positive impressions about working in or peripheral to the nuclear security enterprise.

The demographics that demonstrate the limited availability of a diverse pool of science and engineering candidates with appropriate qualifications can be approached both strategically and tactically. In the longer term, NNSA and its partners must increase involvement in outreach programs that aim to educate children, parents, and the general public as to the advantages and positive aspects of STEM careers to help secure the pipeline. For a more tactical approach, NNSA and its partners must enhance efforts to recruit at a broad variety of colleges and universities and to build partnerships with key sources of the highest-demand disciplines.

7.6.2.2 Hiring

To attract key prospects to careers in the nuclear security enterprise, all entities must communicate with these candidates as early as possible. They must offer more internships, summer institute opportunities, fellowships, and special advanced degree opportunities to capture and retain candidates early in their academic careers.

NNSA and its partners plan to increase the emphasis on local or on-site apprenticeships in essential skills in order to increase the available pool of talented technologists and craft workers, particularly at the manufacturing sites. Vigorous recruiting and partnerships with nearby vocational schools are key strategies to this approach.

NNSA and its partners anticipate a need for more technical hires in disciplines such as nanotechnology; next-generation, high-performance computing and associated computational modeling; additive manufacturing technology; and other emerging fields. Developing partnerships with specific schools that offer synergistic programs for these emerging disciplines must become a priority.

To fill the mid-career gap in its demographics, NNSA and its partners must put more emphasis on experienced hires than has been done in the past. This will have the added advantage of providing a proven work history, as well as private industry experience and a fresh perspective to NNSA's technical challenges.

Offering more-competitive total compensation packages would help close the gap for candidates who might be interested in working within the nuclear security enterprise, but are feeling the pull of cash-based incentives from commercial entities.

Programs that target former DOD personnel, especially individuals with experience in the nuclear weapons arena and with security clearances, are another key strategy for future staffing. Individuals with military experience have a proven record of serving the Nation and extremely relevant experience; they also adapt well to the culture of national security employment.

7.6.2.3 Onboarding

Some entities have been successful in designing programs to keep new employees engaged in meaningful work while they await security clearances. These model programs need to be shared across the nuclear security enterprise to help all entities develop productive assignments for their uncleared staff that will allow them to engage and learn while awaiting clearances.

NNSA entities also must transition to appropriate office accommodations for the workforce of the future. Modern facilities with more collaborative space, more digital communication connectivity, and more flexibility will better meet the needs and work styles of current graduates as they hire into the nuclear weapons community. This will allow them to interact and connect during the onboarding phase both before and after receiving clearances, resulting in higher job satisfaction.

7.6.2.4 Career Development

As with recruiting and hiring, capturing the interest of employees early in their academic careers and exposing them to the benefits of working in nuclear security is instrumental to retaining early-career employees who are now more mobile than in the past.

To combat the challenges of retention, it is paramount to use a forward-looking approach that will impact the entire life cycle of an employee's career. For example, using special hiring programs that pay for newer employees to emerge from graduate school debt-free is a very effective means of building the commitment to a long-term career in nuclear weapons.

Programs and incentives aimed at retention of mid-career employees are also essential to ensuring the development of the future workforce. These include advanced education, training, mentoring, and leadership and rotational opportunities. Mechanisms like these that enhance career development and facilitate mobility across the various entities of the nuclear security enterprise (and even to DOD) will establish higher levels of engagement and commitment from early- and mid-career employees. All of these approaches would work together to stabilize and enhance retention.

7.6.2.5 Offboarding

Enhancement of existing programs and development of additional programs for knowledge capture and transfer are critical to ensuring the expertise of seasoned employees approaching retirement is documented and preserved for future weapon designers. In particular, efforts to capture weapons knowledge prior to the retirement of late-career employees must be increased and improved to allow retrieval by future weapon designers. Some sites are increasing the use of web-based applications and technology to aid in this task.

7.7 Summary and Conclusion

The cumulative knowledge, skills, abilities, accomplishments, and caliber of today's nuclear security enterprise workforce are an irreplaceable asset that is essential to the execution of NNSA's national security mission, including maintaining the credibility of the nuclear deterrent. NNSA is fully committed to sustaining a qualified and skilled workforce to execute the work detailed in the 3+2 Strategy and will remain capable of adjusting to changes year-to-year as requirements dictate.

However, a number of challenges could affect the long-term viability of the future workforce. The ability to attract and hire employees with the knowledge, skills, and abilities needed for the future nuclear security enterprise will be impacted by the availability of qualified STEM candidates. As demand rises amidst a limited supply, NNSA and its partners will be challenged to compete against employment offers from companies that can provide more-attractive total compensation packages.

Retention of the workforce will be equally challenging in this climate of increased competition. Among the advantages that NNSA and its M&O partners offer are technically challenging, relatively stable work, with workplace flexibility and appropriate benefits. However, it is difficult to retain workers who value pay, bonuses, and public recognition for their technical achievements above the pride and satisfaction of contributing to national security. To address these issues, NNSA and its M&O partners must focus on promoting and enhancing the differentiating advantages of national security work.

NNSA needs to continue offering outstanding educational and training programs and to extend those programs that are particularly effective in attracting and retaining the high-caliber workforce that its nuclear security mission demands. In particular, career mobility throughout the nuclear security enterprise needs to be enhanced and facilitated to provide a broader variety of career paths and mobility.

Chapter 8
Future Years Nuclear Security Program Budget, Requirements Estimates, and Operations and Business Improvements

Chapter 8 provides an overview of the key elements in the Weapons Activities budget for the FY 2016 FYNSP and includes figures that display budgetary information for specific activities associated with these key elements and projected weapon system life-cycle costs for 20 years beyond the FYNSP. Chapter 8 also describes NNSA efforts to improve the effectiveness and reduce the cost of its operations and business practices. All costs displayed are in then-year dollars unless otherwise noted.

8.1 Future Years Nuclear Security Program Budget

Table 8–1 shows the FYNSP budget for Weapons Activities. The budget structure reflects a number of changes from the FY 2015 budget structure. Activities formerly funded in RTBF are now split between RTBF and a new Infrastructure and Safety line to reflect a distinction between program-specific facilities support and nuclear security enterprise site-wide support. The Readiness Program funding line has been eliminated and the activities of its only subprogram moved to a new budget line, Advanced Manufacturing Development, based on the way in which the funding was appropriated by Congress in FY 2015. More broadly, the term "Campaign" has been eliminated from the titles of NNSA's RDT&E programs to better emphasize the ongoing nature of these programs. A new funding line within Directed Stockpile Work, Nuclear Material Commodities, consolidates activities that support certain key nuclear material activities, including Domestic Uranium Enrichment, which was in a separate line in the FY 2015 SSMP. Nuclear Counterterrorism Incident Response and Counterterrorism/Counterproliferation Programs have been combined as Nuclear Counterterrorism and Incident Response and moved to the Defense Nuclear Nonproliferation budget. Additional explanations of these budget structure changes and explanations of changes to program funding levels from FY 2015 to FY 2016 can be found in the FY 2016 President's Budget Request. Changes to the subprogram funding lines within the programs displayed in Table 8–1 are described in the following SSMP sections on these programs.

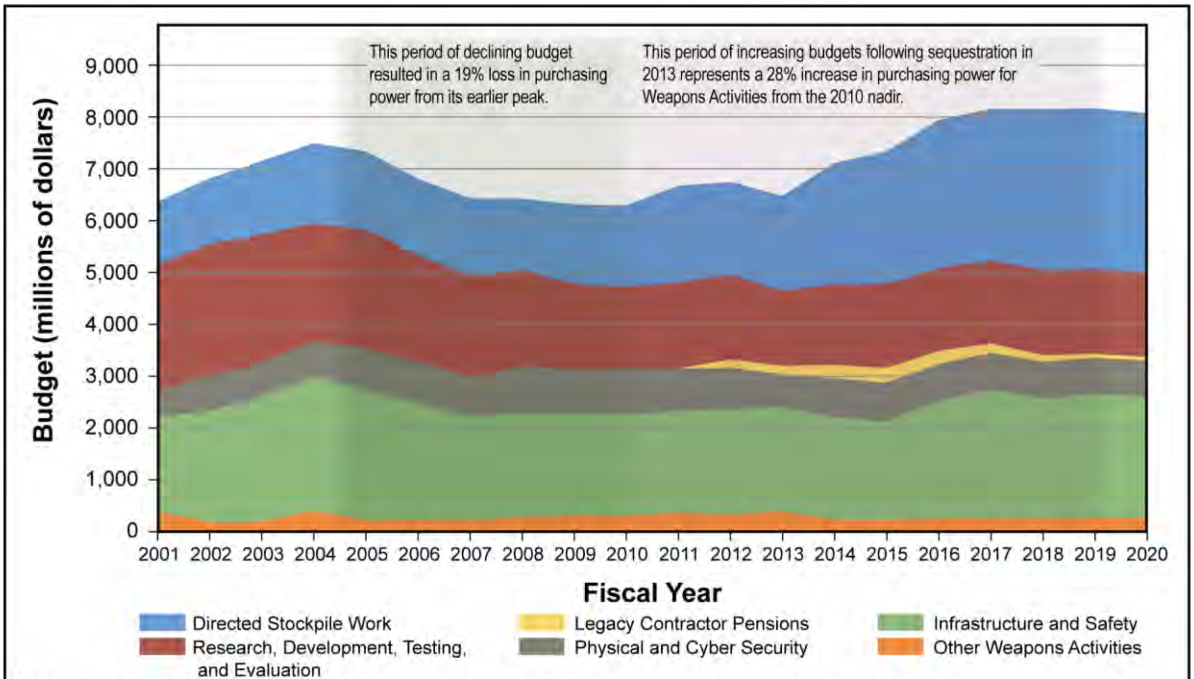
Figure 8–1 shows how the level of funding in the FY 2016 President's Budget Request over the FYNSP compares with the Weapons Activities purchasing power (in 2010 dollars) in prior years. It also displays how the general composition of this funding has varied over time. The most remarkable change over the period displayed is the increase in Directed Stockpile Work. Some amount of this change is more apparent than real because of changes in the budget structure. For example, pit production activities, originally funded as a campaign, were moved into Directed Stockpile Work as Plutonium Sustainment in FY 2008. In addition, as described above, the Tritium Readiness Program funding and some uranium sustainment funding were recently moved from RDT&E and RTBF, respectively, to Directed Stockpile Work as part of the new Nuclear Material Commodities subprogram. However, a significant amount of this increase was the result of increased funding for multiple LEPs and supporting Directed Stockpile Work programs.

Figures 8–2 through **8–10** display the pie charts for the FY 2016 budget and the tables that detail the FY 2016 FYNSP breakdown and the reference year FY 2015.

Table 8–1. Overview of Future Years Nuclear Security Program budget for Weapons Activities in fiscal years 2015 through 2020 [a]

Activity	Fiscal Year (dollars in millions)					
	2015 Enacted	2016 Request	2017 Request	2018 Request	2019 Request	2020 Request
Directed Stockpile Work	2,692.6	3,187.3	3,322.0	3,616.9	3,689.0	3,740.8
Science Program	412.1	389.6	436.6	485.9	496.2	506.7
Engineering Program	136.0	131.4	120.5	138.7	140.8	141.3
Inertial Confinement Fusion Ignition and High Yield Program	512.9	502.5	525.4	546.1	557.5	569.3
Advanced Simulation and Computing Program	598.0	623.0	636.2	649.6	663.3	677.3
Advanced Manufacturing Development	107.2	130.1	106.3	79.2	91.0	92.7
Readiness in Technical Base and Facilities	2,033.4	1,054.5	1,121.4	1,207.3	1,285.0	1,235.4
Infrastructure and Safety	0	1,466.1	1,702.5	1,477.9	1,559.2	1,607.0
Secure Transportation Asset	219.0	251.6	266.4	273.4	278.8	284.3
Site Stewardship	76.5	36.6	36.8	37.0	37.7	38.4
Nuclear Counterterrorism Incident Response [b]	177.9	0	0	0	0	0
Counterterrorism/Counterproliferation Programs [b]	46.1	0	0	0	0	0
Defense Nuclear Security	636.1	632.9	646.9	658.8	669.8	683.0
Information Technology and Cyber Security [c]	179.6	157.6	155.0	156.8	162.0	166.0
Legacy Contractor Pensions	307.1	283.9	206.5	157.1	87.4	87.4
Domestic Uranium Enrichment Research, Development and Demonstration [d]	97.2	0	0	0	0	0
Adjustments [e]	(51.4)	0	0	0	0	0
Weapons Activities Total	***8,180.4***	***8,847.0***	***9,282.3***	***9,484.6***	***9,717.7***	***9,829.7***

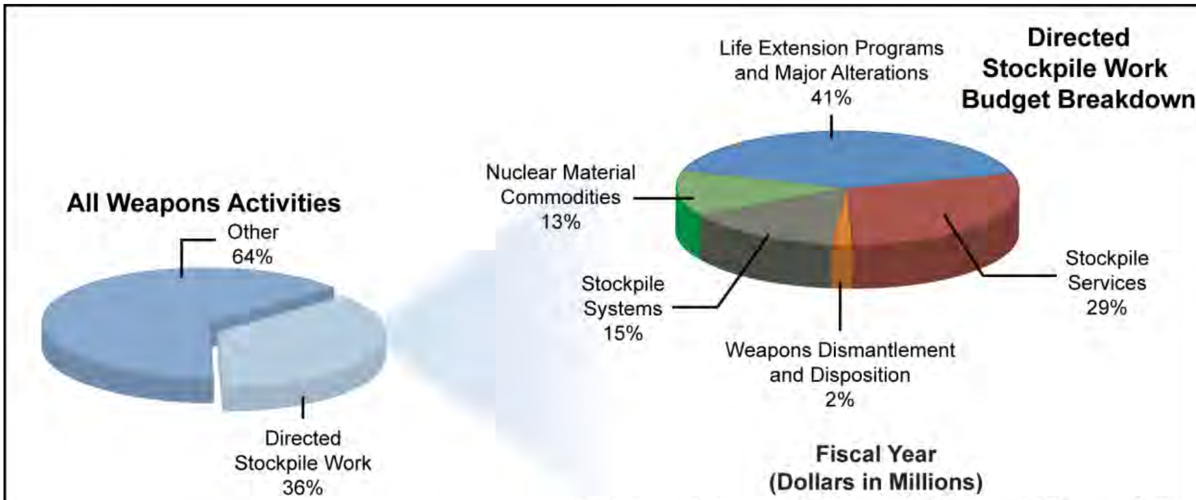
[a] Totals may not add because of rounding.
[b] Funding for this program has been moved to Defense Nuclear Nonproliferation budget.
[c] Formerly called Chief Information Officer Activities.
[d] Domestic Uranium Enrichment was moved to Nuclear Material Commodities within Directed Stockpile Work and is funded in the President's Budget Request for FY 2016 – FY 2020 at $100 million per year.
[e] Adjustments include rescissions and use of prior-year balances.



Note: Nuclear Counterterrorism Incident Response and Counterterrorism/Counterproliferation funding has been backed out of the Other Weapons Activities totals for the FY 2001-2015 period to make those years comparable to the FY 2016 FYNSP funding levels, which no longer include these programs as part of Weapons Activities.

Figure 8–1. Weapons Activities historical purchasing power — fiscal years 2001 through 2020

8.2 Directed Stockpile Work Budget



Fiscal Year (Dollars in Millions)

	2015	2016	2017	2018	2019	2020
Life Extension Programs and Major Alterations	1,077.0	1,302.5	1,395.8	1,594.9	1,546.8	1,579.1
Stockpile Systems	531.1	482.4	472.0	514.9	526.4	544.3
Weapons Dismantlement and Disposition	50.0	48.0	48.3	50.0	52.4	51.8
Stockpile Services	1,034.5	939.3	968.5	1,046.6	1,159.4	1,136.3
Nuclear Material Commodities	0.0	415.0	437.4	410.4	404.0	429.4
Total Directed Stockpile Work	2,692.6	3,187.3	3,322.0	3,616.9	3,689.0	3,740.8

Figure 8–2. Directed Stockpile Work funding schedule for fiscal years 2015 through 2020

As noted in Section 8.1, Directed Stockpile Work includes a new subprogram, Nuclear Material Commodities, which consolidates a number of nuclear material activities previously found elsewhere: Uranium Sustainment, Plutonium Sustainment (formerly in Stockpile Services), Tritium Sustainment (formerly Tritium Readiness in Stockpile Services), and Domestic Uranium Enrichment. The Stockpile Systems and Stockpile Services budget lines in Figure 8–2 include Surveillance Program funding in the amounts shown for FY 2014 through 2019 in **Table 8–2**.

Table 8–2. Surveillance Program funding for fiscal years 2010 through 2020

	Fiscal Year (dollars in millions)										
	2010	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
Surveillance Program Funding	181	239	239	217	225	236	230	234	248	263	252

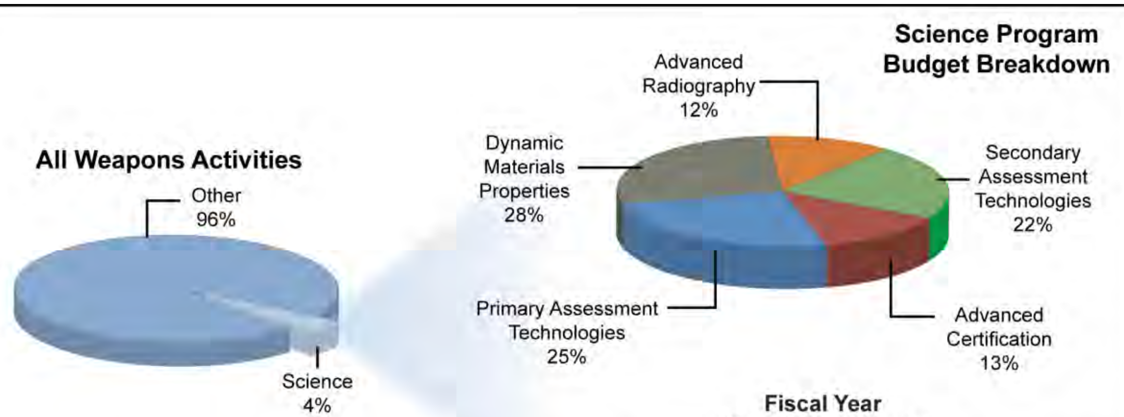
Table 8–3 shows the estimated costs in the Tritium Sustainment subprogram to support current tritium requirements estimates. NNSA is in the process of conducting an interagency, bottoms-up review of tritium requirements that will be certified by the Nuclear Weapons Council and submitted to Congress, as directed in FY 2015 congressional budget language, by April 30, 2015. Any adjustments to the Tritium Sustainment resource requirements arising from this review will be addressed as part of programming for the FY 2017 budget submission.

Table 8–3. Estimated Tritium Sustainment resource requirements

	Fiscal Year (dollars in millions)							
	2014	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2016–2020***
Requirements	83.5	140.1	107.3	126.8	140.2	120.4	123.0	617.7
President's Budget/Future Years Nuclear Security Program	83.5	140.1	107.3	126.8	140.2	120.4	123.0	617.7
Surpluses/shortfalls	0	0	0	0	0	0	0	0

8.3 Research, Development, Testing, and Evaluation Budget

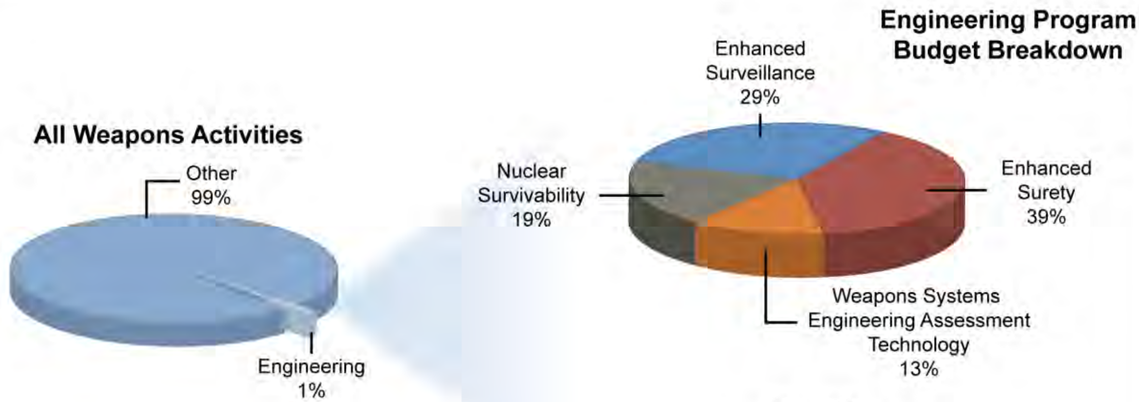
8.3.1 Science Program



	Fiscal Year (Dollars in Millions)					
	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Advanced Certification	58.7	50.7	54.9	59.3	64.1	69.2
Primary Assessment Technologies	109.0	98.5	104.8	113.1	122.2	127.0
Dynamic Materials Properties	109.0	109.0	129.8	130.0	140.0	140.0
Advanced Radiography	47.0	47.0	55.8	91.4	77.9	78.5
Secondary Assessment Technologies	88.3	84.4	91.3	92.0	92.0	92.0
Total Science	412.1	389.6	436.6	485.9	496.2	506.7

Figure 8–3. Science Program funding schedule for fiscal years 2015 through 2020

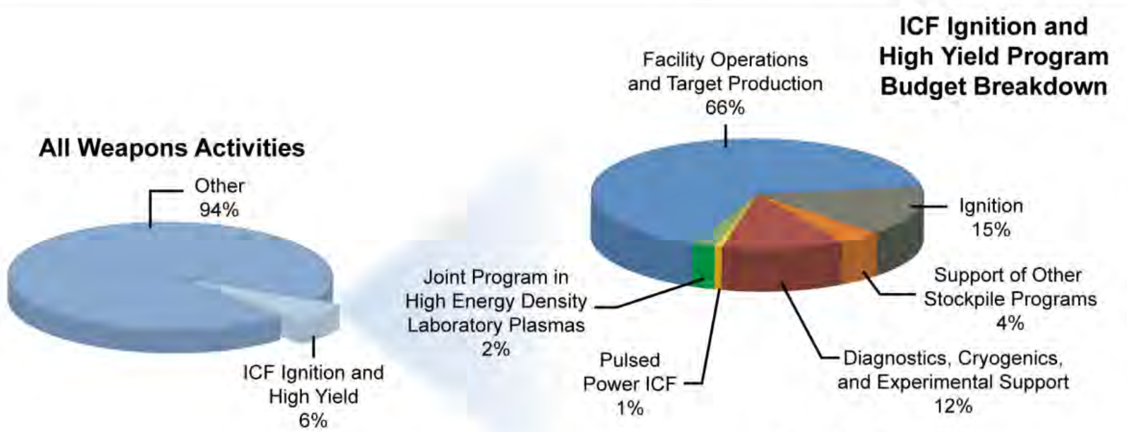
8.3.2 Engineering Program



Fiscal Year (Dollars in Millions)	2015	2016	2017	2018	2019	2020
Enhanced Surety	52.0	50.8	37.2	44.4	45.8	44.1
Weapon Systems Engineering Assessment Technology	20.8	17.4	16.0	22.0	20.7	21.2
Nuclear Survivability	25.4	24.5	26.1	28.2	29.2	29.9
Enhanced Surveillance	37.8	38.7	41.2	44.1	45.2	46.1
Total Engineering	136.0	131.4	120.5	138.7	140.8	141.3

Figure 8–4. Engineering Program funding schedule for fiscal years 2015 through 2020

8.3.3 Inertial Confinement Fusion Ignition and High Yield Program

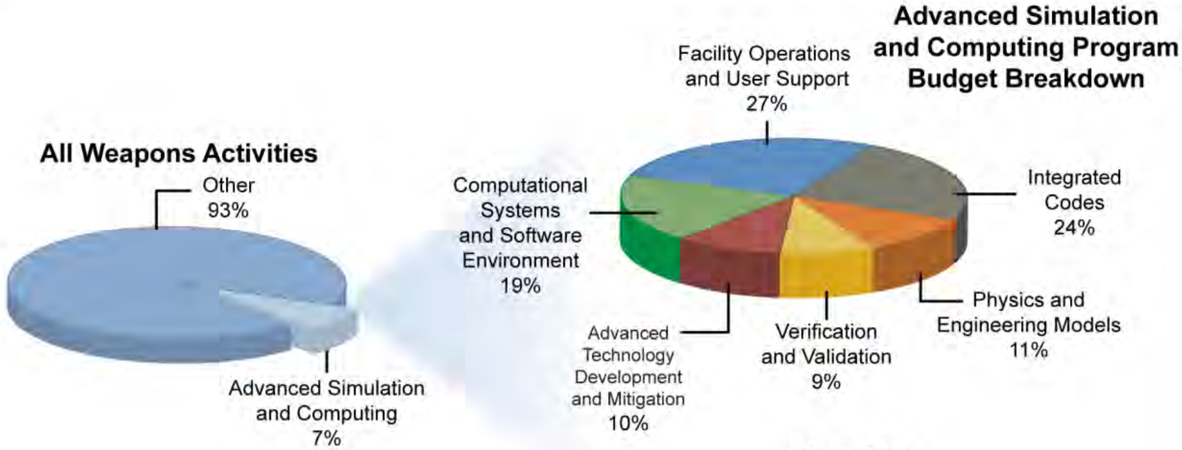


Fiscal Year (Dollars in Millions)	2015	2016	2017	2018	2019	2020
Diagnostics, Cryogenics, and Experimental Support	61.3	58.6	68.1	76.8	80.8	84.8
Pulsed Power ICF	5.0	5.0	4.9	4.9	4.9	4.9
Joint Program in High Energy Density Laboratory Plasmas	9.1	8.9	9.5	9.9	10.0	10.0
Facility Operations and Target Production	335.9	333.8	344.1	353.5	358.4	363.7
Ignition	78.0	73.3	75.4	77.1	79.0	81.0
Support of Other Stockpile Programs	23.6	22.8	23.4	23.9	24.4	25.0
Total ICF Ignition and High Yield	512.9	502.5	525.4	546.1	557.5	569.3

Key:
ICF = Inertial Confinement Fusion

Figure 8–5. Inertial Confinement Fusion Ignition and High Yield Program funding schedule for fiscal years 2015 through 2020

8.3.4 Advanced Simulation and Computing Program

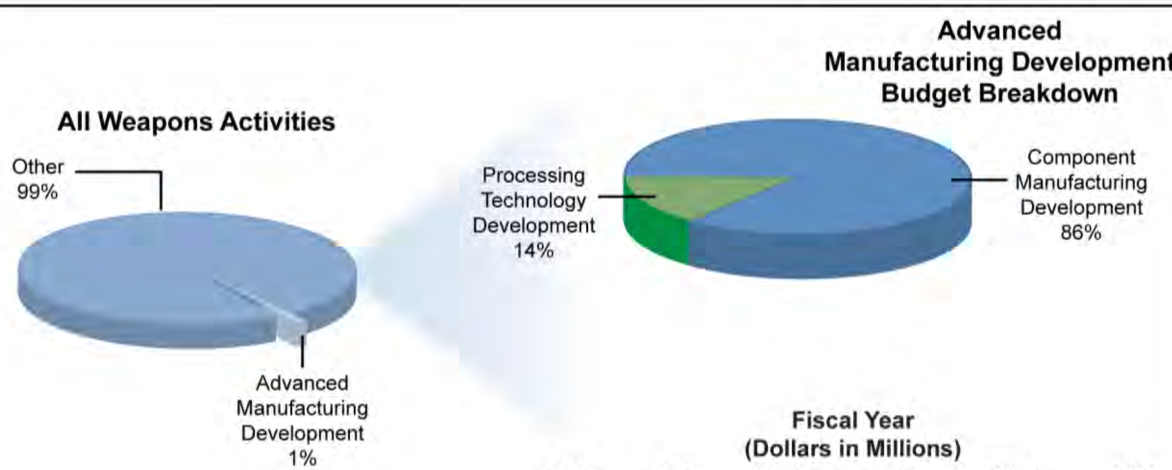


Fiscal Year (Dollars in Millions)

	2015	2016	2017	2018	2019	2020
Integrated Codes	149.2	149.2	151.2	153.2	154.2	160.5
Physics and Engineering Models	68.4	67.8	70.7	72.4	73.8	75.3
Verification and Validation	52.9	52.9	55.9	59.0	60.2	61.4
Computational Systems and Software Environment	109.2	120.8	128.1	130.0	135.0	140.0
Facility Operations and User Support	168.3	168.3	165.4	170.0	175.0	175.0
Advanced Technology Development and Mitigation	50.0	64.0	65.0	65.0	65.0	65.0
Total Advanced Simulation and Computing	598.0	623.0	636.2	649.6	663.3	677.3

Figure 8–6. Advanced Simulation and Computing Program funding schedule for fiscal years 2015 through 2020

8.3.5 Advanced Manufacturing Development

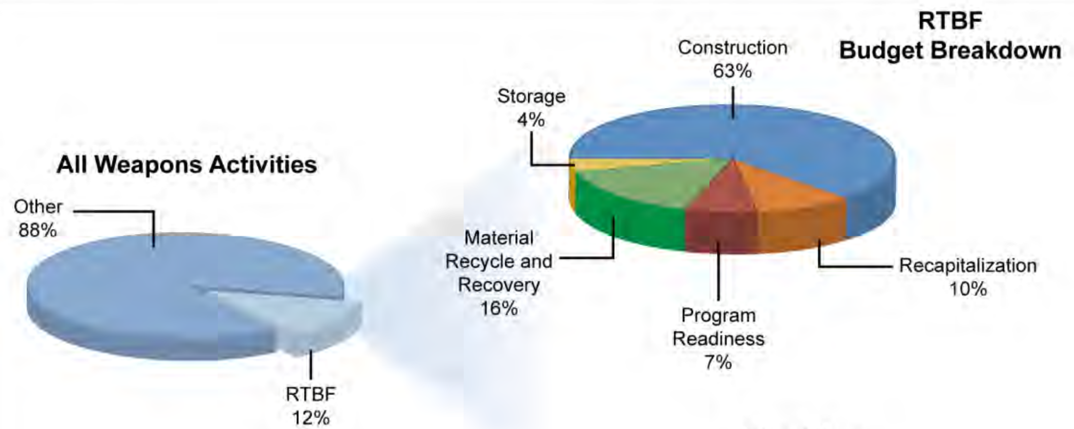


Fiscal Year (Dollars in Millions)

	2015	2016	2017	2018	2019	2020
Additive Manufacturing	12.6	0.0	0.0	0.0	0.0	0.0
Component Manufacturing Development	75.0	112.3	86.7	57.1	62.8	64.0
Processing Technology Development	19.6	17.8	19.6	22.1	28.2	28.7
Total Advanced Manufacturing Development	107.2	130.1	106.3	79.2	91.0	92.7

Figure 8–7. Advanced Manufacturing Development funding schedule for fiscal years 2015 through 2020

8.4 Readiness in Technical Base and Facilities



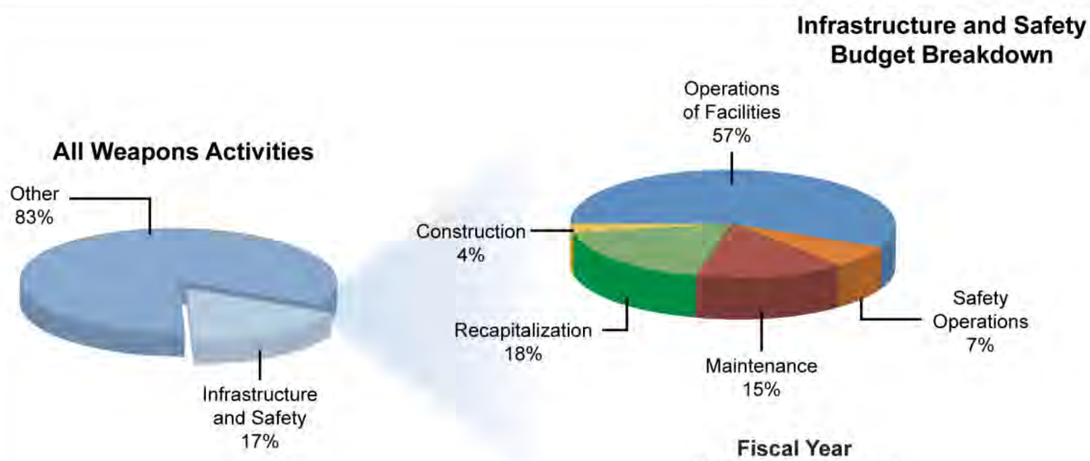
Fiscal Year (Dollars in Millions)

	2015	2016	2017	2018	2019	2020
Operations of Facilities	896.0	0.0	0.0	0.0	0.0	0.0
Program Readiness	68.0	75.2	75.2	77.2	77.2	77.2
Material Recycle and Recovery	126.0	173.9	144.7	145.3	141.6	146.1
Containers	26.0	0.0	0.0	0.0	0.0	0.0
Storage	40.8	40.9	37.3	39.1	38.2	41.0
Maintenance and Repair of Facilities	227.0	0.0	0.0	0.0	0.0	0.0
Recapitalization	224.6	104.3	111.3	101.7	119.1	110.7
Construction	425.0	660.2	752.9	843.9	908.9	860.4
Total RTBF Programs	2,033.4	1,054.5	1,121.4	1,207.3	1,285.0	1,235.4

Key:
RTBF = Readiness in Technical Base and Facilities

Figure 8–8. Readiness in Technical Base and Facilities funding schedule for fiscal years 2015 through 2020

8.5 Infrastructure and Safety

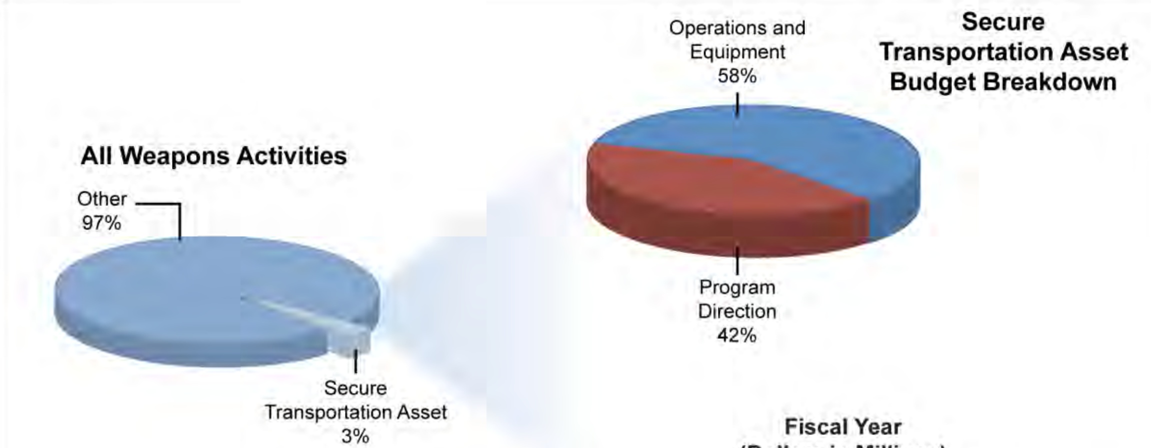


Fiscal Year (Dollars in Millions)

	2015	2016	2017	2018	2019	2020
Operations of Facilities	0.0	830.8	846.0	865.4	902.6	924.2
Safety Operations	0.0	107.7	109.7	112.4	110.8	114.8
Maintenance	0.0	227.0	227.8	234.6	242.8	255.3
Recapitalization	0.0	257.7	423.9	214.5	253.1	263.7
Construction	0.0	42.9	95.0	51.0	50.0	49.0
Total Infrastructure and Safety	0.0	1,466.1	1,702.5	1,477.9	1,559.2	1,607.0

Figure 8–9. Infrastructure and Safety funding schedule for fiscal years 2015 through 2020

8.6 Secure Transportation Asset

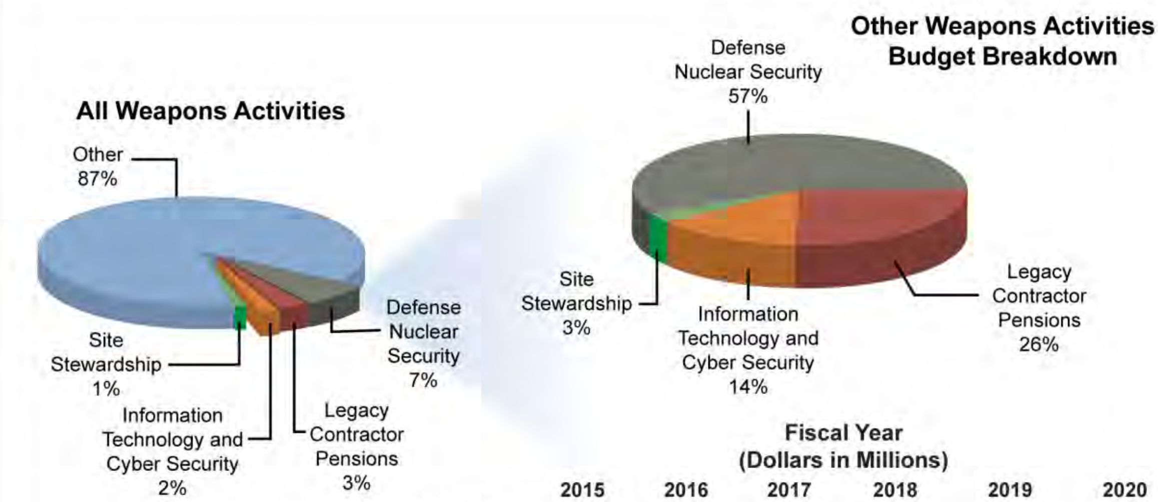


Fiscal Year (Dollars in Millions)	2015	2016	2017	2018	2019	2020
Operations and Equipment	121.9	146.3	157.8	162.7	166.0	169.2
Program Direction	97.1	105.3	108.6	110.6	112.8	115.1
Total Secure Transportation Asset	219.0	251.6	266.4	273.4*	278.8	284.3

*Numbers may not add due to rounding.

Figure 8–10. Secure Transportation Asset funding schedule for fiscal years 2015 through 2020

8.7 Other Weapons Activities



Fiscal Year (Dollars in Millions)	2015	2016	2017	2018	2019	2020
Site Stewardship	76.5	36.6	36.8	37.0	37.7	38.4
Nuclear Counterterrorism Incident Response	177.9	0.0	0.0	0.0	0.0	0.0
Counterterrorism/Counterproliferation Programs	46.1	0.0	0.0	0.0	0.0	0.0
Defense Nuclear Security	636.1	632.9	646.9	658.8	669.8	683.0
Information Technology and Cyber Security	179.6	157.6	155.0	156.8	162.0	166.0
Legacy Contractor Pensions	307.1	283.9	206.5	157.1	87.4	87.4
Domestic Uranium Enrichment Research, Development and Demonstration	97.2	0.0	0.0	0.0	0.0	0.0
Adjustments	(51.4)	0.0	0.0	0.0	0.0	0.0
Total Other Weapons Activities	1,469.1	1,111.0	1,045.2	1,009.7	956.9	974.8

Figure 8–11. Other Weapons Activities funding schedules for fiscal years 2015 through 2020

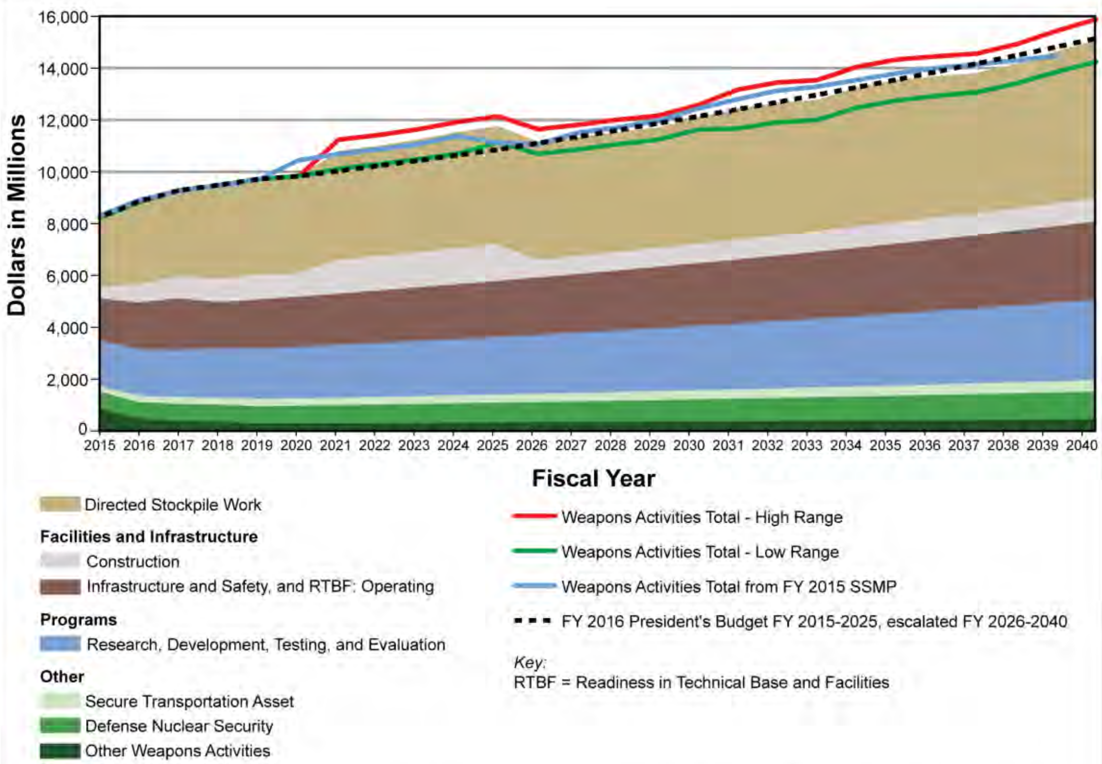
8.8 Other Fiscal Issues

Pension Cost Growth

The Administration's FY 2016 Budget Request will continue to cover the total pension reimbursement and legacy contractor pension costs. The Weapons Activities portion of this cost is estimated to be about $620 million in FY 2016.

8.9 Estimates of Requirements beyond the Future Years Nuclear Security Program

For the cost projections beyond the FYNSP, other than specific projects, an escalation of 2.24 percent per year is assumed (based on numbers provided by the Office of Management and Budget for 2014) after FY 2020.[1] **Figure 8–12** shows the Weapons Activities funding for FY 2016 through FY 2025 included in the FY 2016 President's Budget and escalated amounts for FY 2025 through FY 2040.



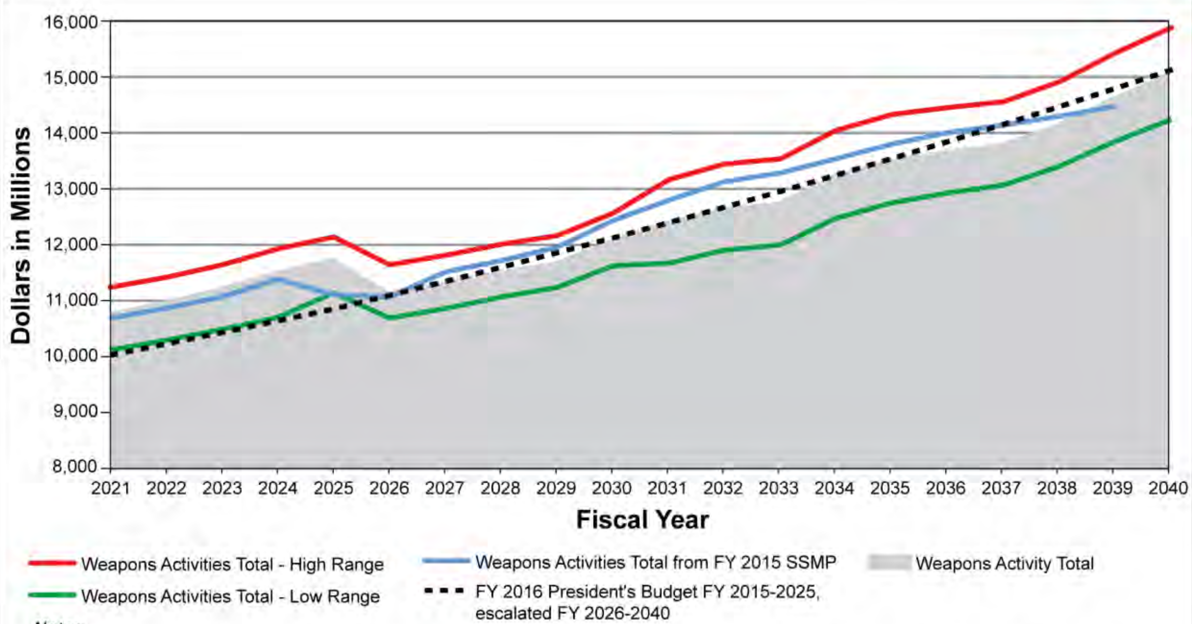
Notes:
The cost estimates for the currently approved stockpile work, as recommended by the Nuclear Weapons Council and adopted by the Administration, and estimated infrastructure modernization efforts exceed the projected budgetary resources for the Weapons Activities account in several years beyond FY 2020. The program of work and relative priorities for the nuclear security enterprise will be reassessed, as fiscal conditions dictate, through the annual budget and policy formulation processes to ensure that programs and budgets remain aligned.

Figure 8–12. Estimate of out-year budget requirements for NNSA Weapons Activities in then-year dollars

[1] *Projection of budget requirements for these efforts in this way assumes the continued manageability of whatever risks are present during the FYNSP at the same level of effort as, typically, represented by the funding level of the last year of the FYNSP.*

The "Construction" total for FY 2016 through FY 2020 shown in Figure 8–12 includes all construction funded by RTBF and Infrastructure and Safety (I&S). It includes funding for all the projects listed on the Integrated Project List found in Chapter 4, Figure 4–4. The high versus low lines on the figure reflect uncertainties in the estimated budget requirements for LEPs and the construction projects. While these two categories of activities constitute about 24 percent of total Weapons Activities over FY 2021 through FY 2040, they have the greatest uncertainty. The figure also displays a blue line representing the total shown in the FY 2015 SSMP so that a comparison can be made between Figure 8–12 in this chapter and Figure 8–11 in the FY 2015 SSMP. The dashed black line in Figure 8–12 is the FY 2016 President's Budget for FY 2016 through 2025, with the FY 2025 total escalated at the same 2.24 percent as used in the estimates for FY 2026 through 2040 to evaluate the out-year affordability of the total Weapons Activities account. **Figure 8–13** in this section shows, in greater detail, the uncertainties of the out-year budget requirements for Weapons Activities.

The nominal cost of the overall program for FY 2021 through FY 2040 in Figure 8–13 falls within +8.4 and -2.5 percent of the escalated (dashed black) FY 2020 line. The uncertainty (resulting from construction and LEPs) ranges from +6.1 percent to -7.2 percent. The period in which there does appear to be a potential affordability issue is FY 2021 through FY 2025 during which NNSA is simultaneously executing four to five LEPs and several major construction projects, including the Uranium Processing Facility. Most of the increase from FY 2020 to FY 2021 (and sustained through FY 2025) is driven by an increase in construction. The FY 2017 programming process will need to address this potential issue.



Notes:
The cost estimates for the currently approved stockpile work, as recommended by the Nuclear Weapons Council and adopted by the Administration, and estimated infrastructure modernization efforts exceed the projected budgetary resources for the Weapons Activities account in several years beyond FY 2020. The program of work and relative priorities for the nuclear security enterprise will be reassessed, as fiscal conditions dictate, through the annual budget and policy formulation processes to ensure that programs and budgets remain aligned.

Figure 8–13. Detail of out-year budget requirements for Weapons Activities of the NNSA in then-year dollars

The following subsections explain in detail the cost basis for significant elements in Figure 8–13: Stockpile Sustainment (Section 8.9.1), Life Extension Programs and Major Alterations (Section 8.9.2), and Construction Costs (Section 8.9.3). In the FYNSP period, the match to the budget has largely been achieved by taking efficiencies, programmatic restructurings, and some reduction in the DOD requirements.

8.9.1 Stockpile Sustainment

Sustainment costs include assessment activities, limited life component exchanges, required and routine maintenance, safety studies, periodic repairs, resolution and timely closure of SFIs, military liaison work, and surveillance to assure the stockpile remains safe, secure, and effective. These costs are incurred every year that a weapon is in the active stockpile.

Figure 8–14 shows in then-year dollars the annual sustainment cost for FY 2016 through FY 2040 attributable to a particular warhead, and the average cost over FY 2003 through FY 2015. The FY 2021 through FY 2040 costs incorporate an update to the preliminary assessment of the additional sustainment costs to be incurred during the 3+2 stockpile transition, as well as the two-years-earlier W80-4 LEP schedule.

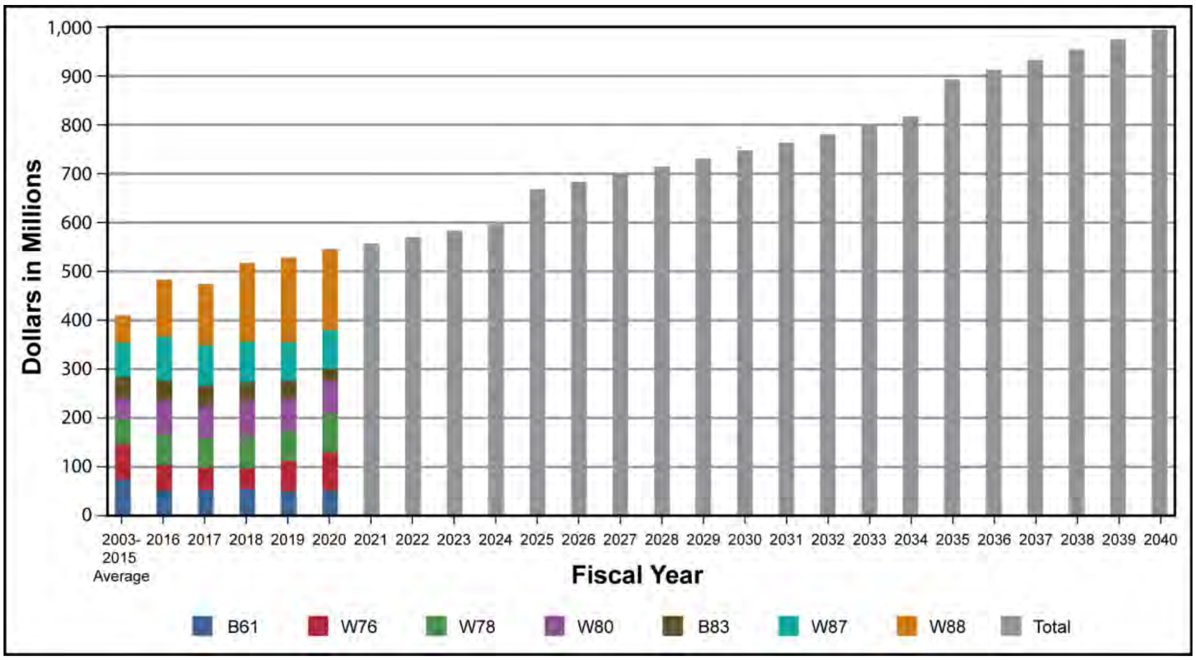


Figure 8–14. Estimate of warhead specific sustainment costs

8.9.2 Life Extension Programs and Major Alterations

The Defense Programs' Office of Cost Policy and Analysis is responsible for the model development and preparation of estimates in this section.[2]

LEPs, which are not part of stockpile sustainment, are undertaken to extend the life of a warhead for several additional decades. Major alterations make component changes to warheads (which may not address all aging issues such that they would be considered a life extension) and also have significant

[2] *A technical paper containing additional detail on the LEP cost model methodology is available upon request.*

costs. Both LEPs and major alterations may be subject to Selected Acquisition Report (SAR) requirements to Congress. **Figures 8–15** through **8–21** show the estimated cost to NNSA for LEPs or major alterations for the FY 2015 through FY 2040 period. High and low independent cost estimates were developed for all LEPs. These are planning estimates intended to inform the Planning, Programming, Budgeting, and Execution process, budgeting studies, and general conceptual planning.

These independent cost estimates are based on:

- W76-1 actual costs to date for RDT&E and Production
- A standard Work Breakdown Structure with comparisons of RDT&E scope and complexity by LEP program office experts and subject matter experts to the W76-1
- Estimates of Other Program Money and DOD costs by program office experts[3]
- RDT&E, Other Program Money, and DOD costs distributed and spread using standard, well-known Rayleigh profiles for the development period
- Production costs distributed using the nonlinear cost growth profile exhibited by the W76-1 actual cost-quantity relationship

The high and low lines on each LEP cost figure (included for all systems except the nearly complete W76-1) reflect the cost estimate uncertainties. All programs have unforeseen technical issues, budget fluctuations, and even the level of component maturity available at a future date. The published ranges account for this.

One important note is that early-stage LEPs can experience occasional but significant scope additions or redefinitions, possibly resulting in substantial cost range changes. This potential for differences in planning assumptions exists because LEPs in Phase 6.1 or 6.2 operate with considerable design uncertainty. For example, the current W80-4 estimate assumes there will be moderate nuclear explosives package refurbishment. As design options are downselected, the estimate may result in changes to the cost and program scope. Major differences in year-to-year planning assumptions will hopefully be minimal and exclusively for early-stage programs, but if and when they occur NNSA will publish them in the subsequent SSMP.

In the previous FY 2014 and FY 2015 SSMPs, the estimates were informed primarily by LEP Federal Program Managers and select subject matter experts, who evaluated relative scope complexity by Work Breakdown Structure element between the W76-1 and their respective LEPs. However, the estimates presented here reflect complexity factors scored by both the Federal Program Managers and, for the first time, a broad ranging and highly integrated team of subject matter experts from the national security laboratories and the nuclear weapons production facilities. This integrated team of subject matter experts and Federal Program Managers provided significant technical expertise on each LEP and major alteration. Coupled with the scope and scheduling experience of the Federal Program Managers, this year's LEP estimates are believed to reflect more inclusive ranges of costs and relative uncertainties.

[3] *The SSMP figures here attempt to account for all costs needed to execute each LEP or major alteration, regardless of the color of money. This is why the cost model is designed to estimate funding streams not only for the LEP line items, but for earlier stage technology maturation activities covered by Other Program Money and even DOD, if applicable. As the overall program integrator, the Federal Program Manager assists in identifying the Other Program Money and DOD funding needed for their respective LEP to be successful.*

As in previous SSMPs, the nominal estimates (reflected in each figure's bars) are the costs from either the Weapon Design and Cost Report, the most recent SAR, or, if the LEP is too early to have generated such estimates, the midpoint between the high and low cost model estimate values. The modeled high and low cost ranges have also been included on select graphs with their Weapon Design and Cost Report and/or SAR point estimates to emphasize that, for those programs, some cost uncertainty still exists in their execution.

For each figure, an associated table displays the high, low, and nominal estimated total cost to NNSA and DOD[4] in both constant FY 2015 and then-year dollars. These are in **Tables 8–4** to **8–11**. The total estimated cost is provided since three programs (the IW-1, -2, and-3) fall outside the 25-year window for the FY 2016 SSMP. While figures are in then-year dollars, total estimated costs in current constant-year (FY 2015) dollars are also provided to assist in comparing LEPs scheduled over different timeframes.[5]

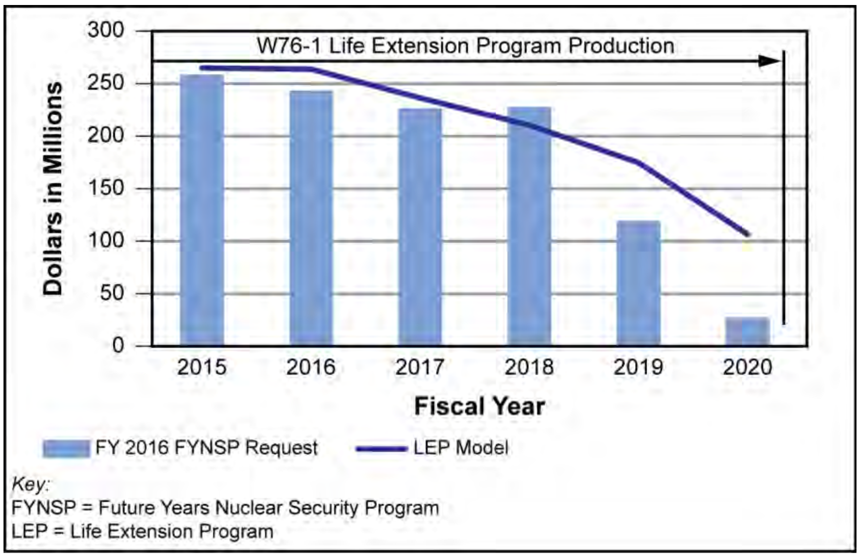


Figure 8–15. W76-1 life extension program cost FY 2015 to completion

Table 8–4. Total estimated cost for W76 life extension program

FY 1999–FY 2020 (Dollars in Millions)	NNSA		DOD	
	FY 2015 Dollars	Then-Year Dollars	FY 2015 Dollars	Then-Year Dollars
SAR Value [a]	4,397	3,697	Not in NNSA SAR	Not in NNSA SAR

[a] W76-1 Selected Acquisition Report (SAR) values are reported in FY 2002 dollars. Those values are converted for this table to FY 2015 dollars.

[4] *The DOD costs are for weapon components for which DOD is responsible, such as arming and fuzing. While not budgeted or executed by NNSA, these estimated costs are published to be as transparent as possible of the "all in" costs for each LEP.*

[5] *For LEPs for which no SAR or Weapon Design and Cost Report has been prepared, only the cost range is provided. It should be noted that when a SAR or Weapon Design and Cost Report value is provided, this represents only the costs associated with Phase 6.3 and forward without Other Program Money, based on reporting requirements.*

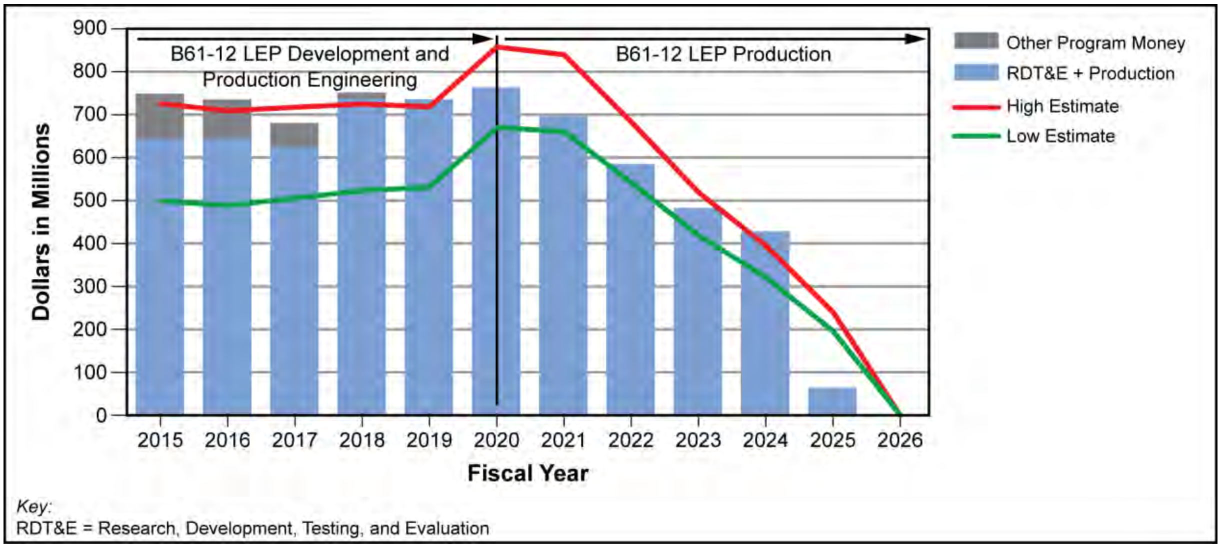


Figure 8–16. B61-12 life extension program cost FY 2015 to completion

Table 8–5. Total estimated cost for B61-12 life extension program

FY 2009–FY 2025 (Dollars in Millions)	NNSA		DOD	
	FY 2015 Dollars	Then-Year Dollars	FY 2015 Dollars	Then-Year Dollars
High	9,278	9,789	207	220
Low	6,765	7,176	55	58
SAR Value [a]	6,839	7,372	Not in NNSA SAR	Not in NNSA SAR

[a] The B61-12 Selected Acquisition Report (SAR) values are reported in FY 2012 dollars. Those values are converted for this table to FY 2015 dollars. Also, SAR values do not include Other Program Money costs. However, the September 2014 B61-12 SAR did report a total of $763 million in then-year dollars for OPM costs that should be added to the SAR then-year dollars totals for NNSA to make them comparable, in addition to $125 million in leveraged work being performed by the W88 Alt 370 effort. The numbers reported here do not match those in the latest published SAR because of adjustments for a new cost accounting model at Pantex and Y-12 that have been applied to the FY 2016 through FY 2020 numbers but have not yet been applied to the FY 2021 through FY 2025 numbers.

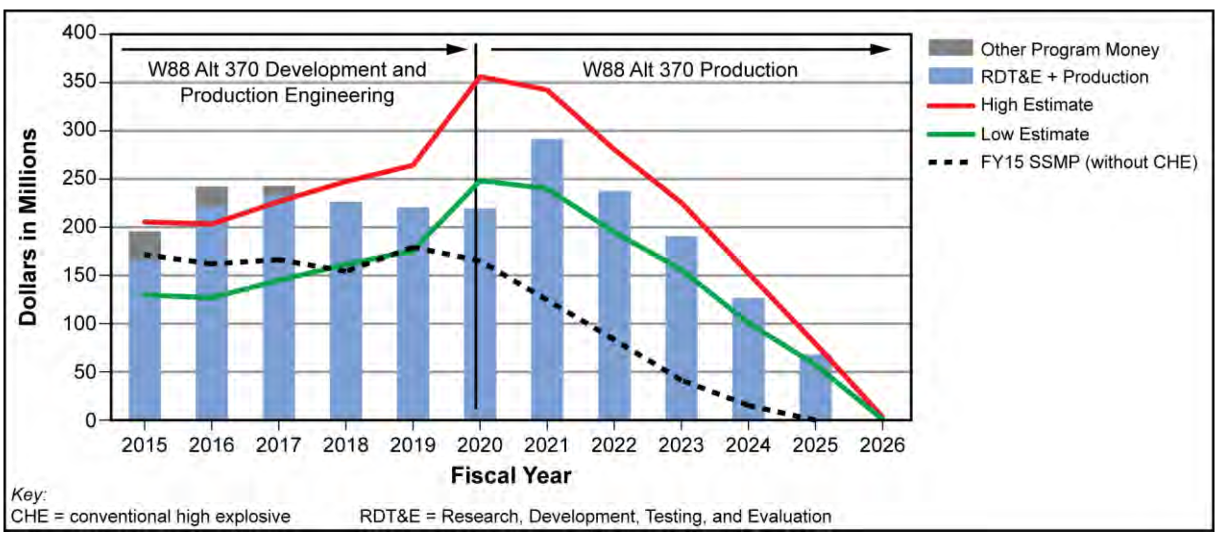


Figure 8–17. W88 Alt 370 (with CHE refresh) cost FY 2015 to completion

Table 8–6. Total estimated cost for W88 Alt 370

FY 2015–2025 (Dollars in Millions)	NNSA		DOD	
	FY 2015 Dollars	Then-Year Dollars	FY 2015 Dollars	Then-Year Dollars
High	2,690	2,928	981	1,072
Low	1,922	2,081	826	899
Budget Requirement [a]	N/A	2,579	N/A	986

[a] The W88 Alt 370 Selected Acquisition Report has not yet been updated to reflect the addition of the conventional high explosive refresh scope. What is reflected here is based on FY 2016 FYNSP numbers and the Office of Cost Analysis and Cost Assessments cost models.

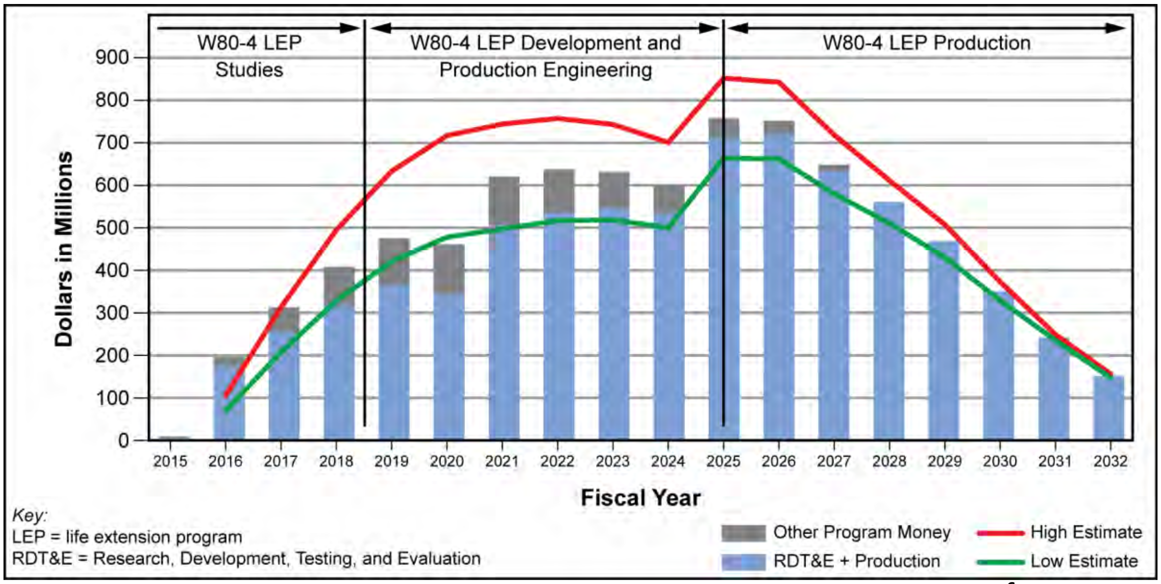


Figure 8–18. W80-4 life extension program cost FY 2015 to completion[6]

Table 8–7. Total estimated cost for W80-4 life extension program

FY 2015–2032 (Dollars in Millions)	NNSA		DOD	
	FY 2015 Dollars	Then-Year Dollars	FY 2015 Dollars	Then-Year Dollars
High	7,845	9,486	207	252
Low	5,798	7,073	55	67
Budget Requirement	N/A	8,258	N/A	160

[6] *W80-4 estimates were based on the uncertainties associated with the B61-12. These uncertainties were carried through in the subject matter experts' and Federal Program Managers' comparative analysis of complexity.*

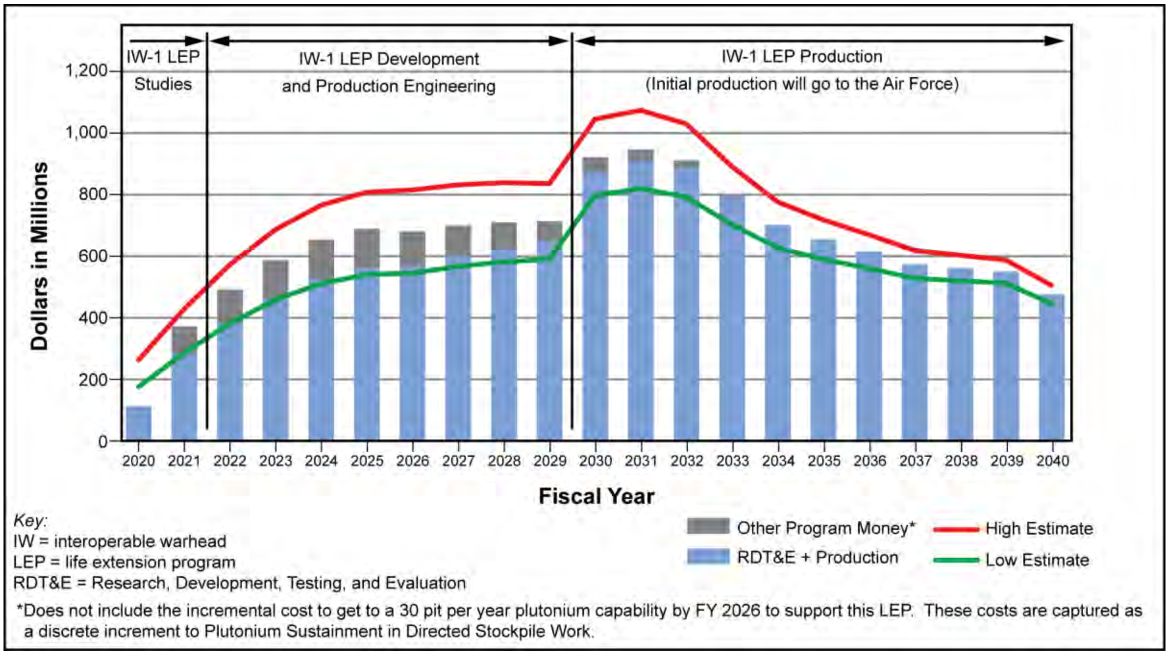


Figure 8–19. IW-1 life extension program cost FY 2020 through FY 2040

Table 8–8. Total estimated cost for IW-1 life extension program

FY 2013–2014, FY 2020–2043 (Dollars in Millions)	*NNSA*		*DOD*	
	FY 2015 Dollars	*Then-Year Dollars*	*FY 2015 Dollars*	*Then-Year Dollars*
High	11,682	16,434	3,152	4,469
Low	8,755	12,482	1,051	1,510
Budget Requirement	N/A	14,352	N/A	2,989

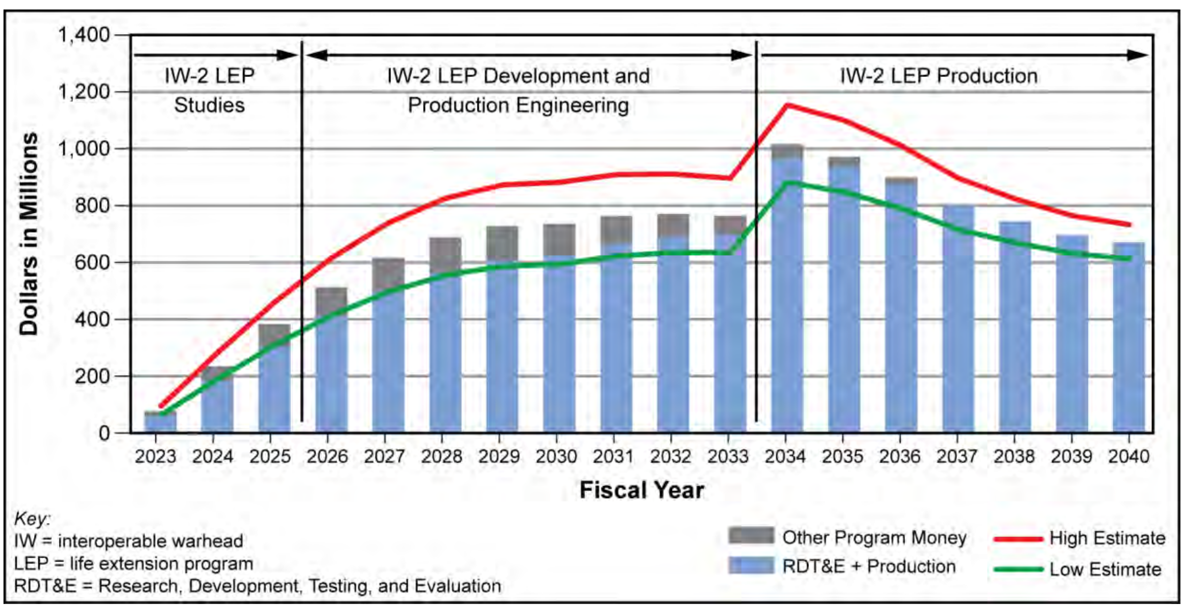


Figure 8–20. IW-2 life extension program cost FY 2023 through FY 2040

Table 8–9. Total estimated cost for IW-2 life extension program

FY 2023 – 2049	*NNSA*	*DOD*

(Dollars in Millions)	FY 2015 Dollars	Then-Year Dollars	FY 2015 Dollars	Then-Year Dollars
High	12,139	19,004	3,152	4,966
Low	9,227	14,661	1,051	1,681
Budget Requirement	N/A	16,833	N/A	3,323

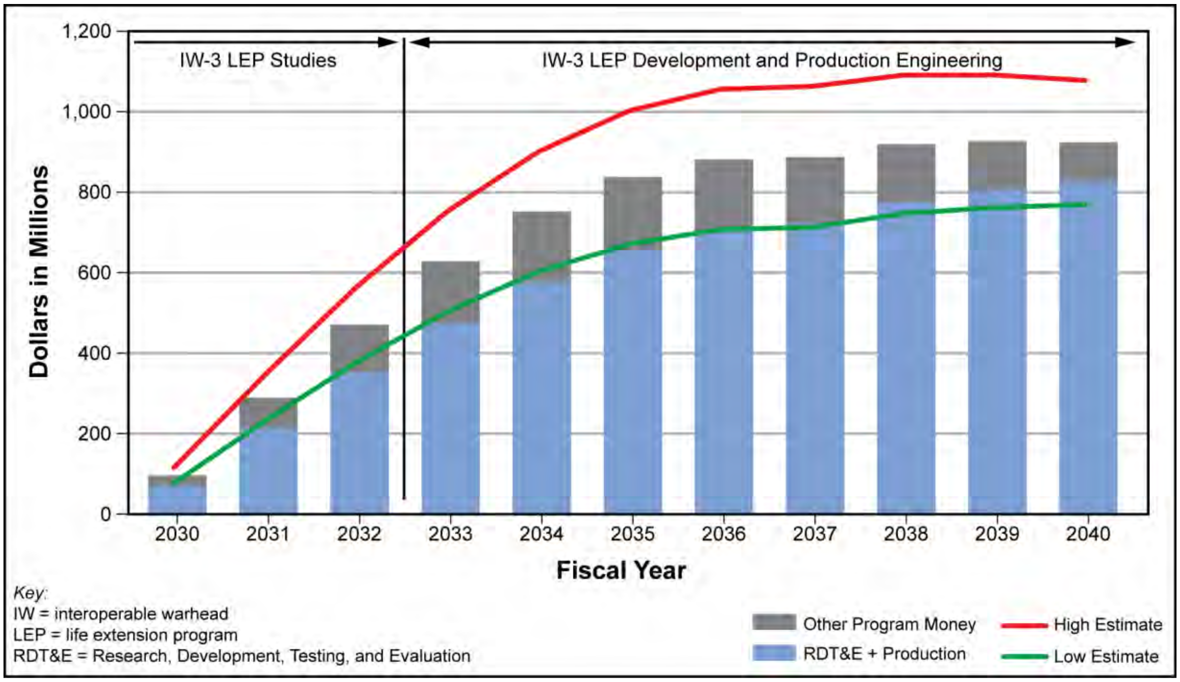


Figure 8–21. IW-3 life extension program cost FY 2030 through FY 2040

Table 8–10. Total estimated cost for IW-3 life extension program

FY 2030 – 2057 (Dollars in Millions)	NNSA		DOD	
	FY 2015 Dollars	Then-Year Dollars	FY 2015 Dollars	Then-Year Dollars
High	11,047	20,425	3,152	5,882
Low	8,547	16,078	1,051	1,995
Budget Requirement	N/A	18,252	N/A	3,938

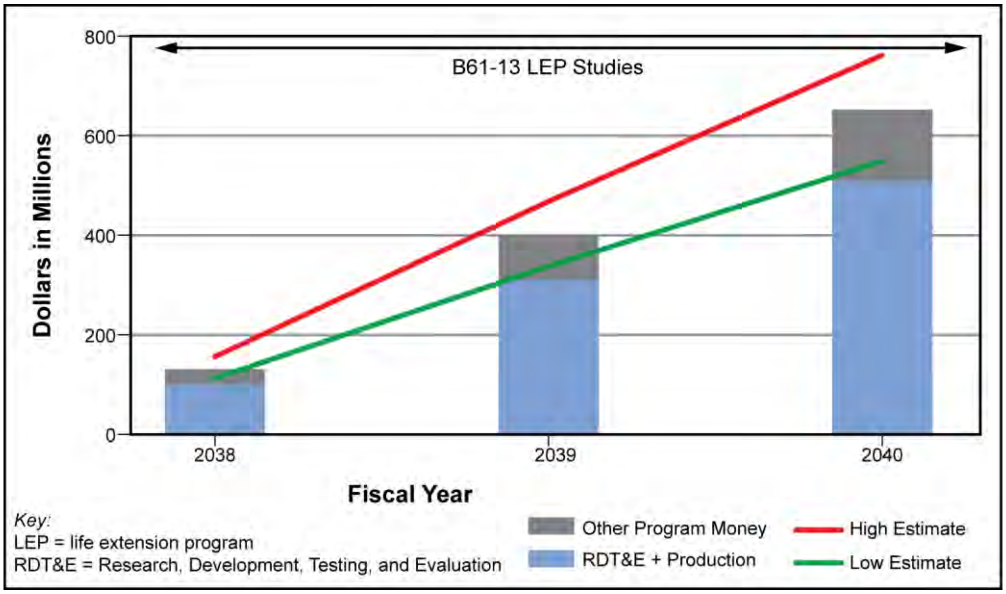


Figure 8–22. B61-13 life extension program cost FY 2038 through FY 2040

Table 8–11. Total estimated cost for B61-13 life extension program

FY 2030 – 2057 (Dollars in Millions)	*NNSA*		*DOD*	
	FY 2015 Dollars	*Then-Year Dollars*	*FY 2015 Dollars*	*Then-Year Dollars*
High	11,323	23,293	207	430
Low	8,606	17,807	207	432
Budget Requirement	N/A	20,550	N/A	431

Figure 8–23 is a one-chart summary of the total projected nuclear weapons life extension costs from FY 2015 through FY 2040 based on the LEP schedule reflected in Chapter 2, Figure 2–10, of this FY 2016 SSMP. Figure 8–23 includes the direct LEP costs and OPM, both of which are incremental to an adequately funded, operationally essential set of base activities. The dotted line shows the LEP cost reflected in the FY 2015 SSMP.

The principal differences between the FY 2015 and FY 2016 LEP estimates are as follows:

- The complexity factors used in the LEP cost model reflect both Federal Program Manager and subject matter expert input, as described earlier. In most cases this new process resulted in a higher factor score and cost estimate.[7]
- The LEP production model was updated with actual W76-1 production quantities and costs for FY 2013 and FY 2014. As the two years were collectively in line with previous W76-1 production costs, this update resulted in only a minor change to any LEP estimate.
- The assumed escalation factor was increased from last year's 2.11 percent to the updated OMB published 2.24 percent value. This resulted in only a minor change to the majority of programs.
- The two-years-earlier schedule for the W80-4 warhead resulted in a significant profile change (although not a change to the overall W80-4 program cost in and of itself).

[7] The new LEP cost model process also resulted in wider complexity and scope ranges, particularly for earlier stage programs like the IW-1, 2, and 3. This widening of uncertainty, which should be expected for earlier stage programs than for ones further in design, has given Defense Programs confidence in the new complexity factor scoring process.

- The addition of a CHE refresh to the W88 Alt 370 program resulted in a significant cost addition for that program.
- The assumed separate Air Force and Navy fuzes for the IW programs substantially increased the DOD portions of the IW-1, IW-2, and IW-3 estimates.
- The initial publication of a B61-13 program estimate now falls inside the 25-year SSMP time frame.

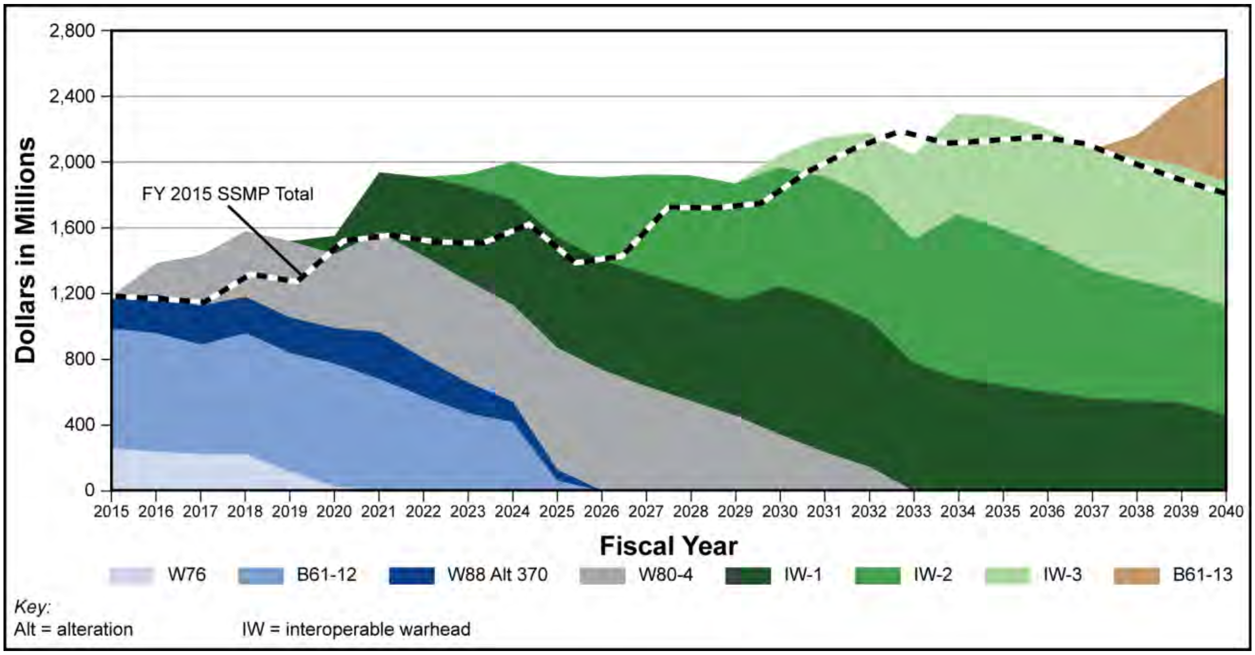


Figure 8–23. Total U.S. projected nuclear weapons life extension costs for fiscal years 2015 through 2040 (then-year dollars)

8.9.3 Construction Costs

The budget requirement estimate for construction in FY 2021 and beyond, as part of the Construction total included in Figure 8–12, is based on the set of projects in the NNSA Integrated Project List, as shown in Chapter 4, Figure 4–4, in this FY 2016 SSMP. Because of the preliminary planning status for many of these projects, they have been binned into one of three cost ranges. For those projects estimated to cost greater than $500 million, upper bounds were estimated based on the best available data. The projects in the Integrated Project List that will start beyond the FYNSP have also been binned in the five-year period in which they are expected to start, based on "hard requirements" for their completion or general priority. Construction funding for each of these periods is based on the total cost of the projects started in that period spread over the five years of the period.[8] **Table 8–12** shows the low, high, and midpoint total cost for executing projects on the Integrated Project List that are scheduled for FY 2020 and beyond. As can be seen in this table, there is significant uncertainty in these construction costs because of the immaturity of planning for these projects. Most of them have not achieved CD-0 Mission need under DOE Order 413.3.

[8] *For projects whose construction period exceeds five years, the project cost was split over two five-year periods.*

Table 8–12. Total cost and average annual cost of construction for fiscal years 2020 through 2040

FY 2015 Dollars in Millions	*Low*	*High*	*Midpoint*
Total Integrated Project List cost	9,232	17,795	14,178

The low and high average annual costs were used along with those for LEPs to generate the low and high lines on Figure 8–12 in order to provide some sense of the uncertainty in the total budget requirements, based on these two components for which there is the greatest uncertainty.

8.10 Operations and Process Improvements

NNSA is committed to improving its processes and operations continuously to achieve greater efficiency, reliability, and quality. In doing so, NNSA generates additional resources to support vital national security interests. In the recent past, these improvements have included efforts to streamline DOE orders and directives to eliminate duplication. In other cases, NNSA has worked with its national security laboratories and nuclear weapons production facilities to incentivize efficiencies and cost savings, where possible, through the M&O contracts.

In a letter to Congress this past November, the Administrator reaffirmed this commitment to make the nuclear security enterprise more efficient and announced the implementation of an annual process within NNSA as a management tool to drive progress in this area. Specifically, each year beginning in 2015, NNSA will issue an annual report identifying the efficiencies achieved during the prior year, areas for continuous improvement in the current year, and any specific enterprise-wide or site-specific initiatives that it may pursue. Preparation of this report will include asking the national security laboratories and nuclear weapons production facilities to recommend specific changes NNSA could make from an oversight and governance perspective (such as has been done with orders and directives) that would enhance productivity, including how to make transactional oversight less costly and burdensome for all parties. The results of NNSA efforts to achieve efficiencies, particularly those whose savings can be quantified, will be addressed in the report. What will continue to be included in the SSMP and what can be found below are examples of the more-qualitative improvements being pursued.

8.10.1 Update of the *Phase 6.x Process*

The *Phase 6.x Process* is a DOD and DOE process to plan and manage the joint activities required to execute an LEP (see Chapter 2, Section 2.1.4.1, for a further description). In response to a Government Accounting Office report (GAO-11-387), a Nuclear Weapons Council Action Officer group reviewed and updated the joint *Procedural Guideline for the Phase 6.x Process,* dated April 19, 2000. This group included representatives from all the members of the Nuclear Weapons Council. The review process focused on streamlining and clarifying the descriptions and requirements of each phase to be more in line with current LEP, alteration, and modification activities and to anticipate future activities, as well as to address the Government Accounting Office recommendations. This review is now awaiting the Nuclear Weapons Council's approval of its proposed changes to the process.

8.10.2 Additive Manufacturing

NNSA has an interest in applying new manufacturing processes and tools to allow the accomplishment of mission activities more quickly and less expensively. Additive Manufacturing, also known as 3D printing, has the potential to revolutionize production on a global scale and, in particular, could significantly benefit the nuclear security enterprise. Additive Manufacturing benefits to the stockpile include reduction of risk to program schedule and improved cost performance. The extent to which the products of Additive Manufacturing technologies can be used in the stockpile is still being determined; however, in the near term, applications include rapid prototyping, joint test assembly components, tooling production, and production of pads and cushions. As confidence is gained in the use of Additive Manufacturing, other applications may be possible. Additional information on this effort can be found in Chapter 2, Section 2.4.5.

8.10.3 Defense Programs Cost Improvement Initiative

Defense Programs has taken several steps in recent years to improve its cost-estimating capabilities through its Cost Improvement Initiative launched in 2013, including the issuance of cost-estimating guidelines consistent with industry and Government Accounting Office best practices. These guidelines, which are currently being piloted, include details on creating clear program requirements, documenting a basis of estimate, and creating multi-year and total life-cycle profiles for planning and budgeting purposes. In parallel, Defense Programs has also established a centralized cost database to capture detailed cost actuals using a standardized Work Breakdown Structure, which will assist in future program estimates.

8.10.4 General Purpose Infrastructure Planning and Management

In response to the challenge of managing aging infrastructure in a resource-constrained environment, NNSA is taking a number of actions to implement infrastructure program management tools to ensure accurate data is used for decision making, to perform an infrastructure assessment, and to align resource allocations with priorities. Deployment of the BUILDER Sustainment Management System and G2 program management software, as well as introduction of an MDI and an Enterprise Risk Management approach, are all described in more detail in Chapter 4, Section 4.2.4.1.

Chapter 9
Conclusion

This DOE NNSA Fiscal Year 2016 SSMP, together with its classified Annex, is a key planning document of the nuclear security enterprise. It represents the 25-year strategic program of record that captures the plans developed across numerous NNSA programs and organizations to maintain and modernize the stockpile through LEPs and revitalize the aging physical infrastructure. This SSMP was generated by the NNSA Federal workforce, in collaboration with its eight M&O partners; the highly skilled and specialized workforce of these partners is responsible for executing the technical activities described in this FY 2016 SSMP. The plans detailed in the document were also coordinated with DOD through the Nuclear Weapons Council, where most requirements originate for ensuring the Nation's nuclear deterrent remains safe, secure, and effective. In addition, the program and budget is also vetted with the DOD annually in the interagency budget process. The SSMP is published each year in response to specific statutory requirements to support the President's Budget Request to Congress with respect to Weapons Activities. As with previous SSMPs, this NNSA plan will be updated annually as new requirements and challenges arise.

FY 2014 was a year of accomplishment for the NNSA program of record described in this year's SSMP. The stockpile continued to be maintained as safe, secure, and effective without underground testing. The multiple LEPs underway made progress toward their first production unit dates, and the W76-1 LEP passed the halfway point in total production. Warhead dismantlement remained on track to meet the NNSA goal to dismantle, by FY 2022, all weapons retired prior to FY 2009. The research, development, testing, and evaluation programs advanced NNSA's understanding of weapons physics, component aging, and material properties. These achievements, as well as previous progress, have enabled evaluation of life extension alternatives for enhanced warhead safety and security, resolution of a number of questions that could impact confidence in warhead performance, and extension of neutron generator lifetimes to allow greater maintenance scheduling flexibility.

As part of revitalizing the physical infrastructure, the multi-year movement of non-nuclear component manufacturing operations out of the aged Kansas City Plant to the newly built and leased National Security Campus in Kansas City was completed with no impact to ongoing LEPs or warhead maintenance. Construction of the HE Pressing Facility at the Pantex Plant was completed under budget. These accomplishments, taken together with the myriad others reported in this SSMP, demonstrate NNSA's effective stewardship of the Nation's nuclear deterrent.

Plans for the future include the following highlights:

- Complete production of W76-1 LEP warheads in FY 2019.
- Deliver the B61-12 LEP first production unit in FY 2020.
- Deliver the W88 Alt 370 first production unit (with CHE refresh) in FY 2020.
- Advance the W80-4 LEP first production unit by two years to FY 2025.

- Implement a disciplined, modular approach for constructing the Uranium Processing Facility at Y-12 and the CMRR-NF at LANL.
- Initiate the W78/88-1 LEP in FY 2020.

By the end of the next five years, the nuclear security enterprise will be well on its way to implementing the 3+2 Strategy for a smaller, interoperable (for missile warheads) stockpile with upgraded safety and security. NNSA will have made further advances in understanding weapons physics, aging, and material properties based upon experiments, modeling, and simulations in alignment with the PCF. Warhead technologies will be matured in conformance with the CMF and the new Systems Integration Framework to reduce risks in the execution of what are already high-cost LEPs. The potential and challenge of using additive manufacturing for nuclear weapons components production will have been evaluated and, if merited, that capability will be pursued. Modifications of existing facilities will have been made at LANL to allow cessation of programmatic operations in the outdated Chemistry and Metallurgy Research facility so that ramp-up of operations can begin to produce 30 war reserve pits in FY 2026. New assessment, maintenance, and planning tools will be in place to allow maximum effective use of NNSA's infrastructure resources. In addition, these activities and the others described in this SSMP, along with the workforce management approaches described in Chapter 7 and Appendix D, will have sustained NNSA's highly skilled and experienced workforce, without which stockpile stewardship would not be possible.

Unforeseen technological challenges, new requirements, and geopolitical events may occur that could affect the priorities on which this strategic plan is built. NNSA's major challenges will be continuing to balance requirements to meet the near-term needs of the stockpile, sustaining or recapitalizing aging infrastructure, and advancing the understanding of the stockpile as it continues to age and new manufacturing processes are adopted. NNSA will continue to work closely with DOD through the Nuclear Weapons Council and with Congress to adjust its long-term plans to ensure the Nation's deterrent remains safe, secure, and effective for as long as nuclear weapons exist.

Appendix A
Requirements Mapping

A.1 National Nuclear Security Administration Response to Statutory Reporting Requirements and Related Requests

The FY 2016 SSMP consolidates a number of statutory reporting requirements and related congressional requests. This appendix maps the statutory and congressional requests to their respective SSMP chapter and section.

A.2 Ongoing Requirements

50 U.S. Code Sec. 2521	*NNSA Response*
Sec. 2521. Stockpile stewardship program (a) Establishment The Secretary of Energy, acting through the Administrator for Nuclear Security, shall establish a stewardship program to ensure – (1) the preservation of the core intellectual and technical competencies of the United States in nuclear weapons, including weapons design, system integration, manufacturing, security, use control, reliability assessment, and certification; and (2) that the nuclear weapons stockpile is safe, secure, and reliable without the use of underground nuclear weapons testing.	*Unclassified* All Chapters
(b) Program elements The program shall include the following:	
(1) An increased level of effort for advanced computational capabilities to enhance the simulation and modeling capabilities of the United States with respect to the performance over time of nuclear weapons.	*Unclassified* Chapter 3, Section 3.6.2; Appendix C
(2) An increased level of effort for above-ground experimental programs, such as hydrotesting, high-energy lasers, inertial confinement fusion, plasma physics, and materials research.	*Unclassified* Chapter 3, Sections 3.5. 3.6, 3.7
(3) Support for new facilities construction projects that contribute to the experimental capabilities of the United States, such as an advanced hydrodynamics facility, the National Ignition Facility, and other facilities for above-ground experiments to assess nuclear weapons effects.	*Unclassified* Chapter 3, Sections 3.5. 3.6, 3.7; Chapter 4, Section 4.3.3
(4) Support for the use of, and experiments facilitated by, the advanced experimental facilities of the United States, including - (A) the National Ignition Facility at Lawrence Livermore National Laboratory; (B) the Dual Axis Radiographic Hydrodynamic Testing facility at Los Alamos National Laboratory; (C) the Z Machine at Sandia National Laboratories; and (D) the experimental facilities at the Nevada National Security Site.	*Unclassified* Chapter 3, Sections 3.5.3.6, 3.7

50 U.S. Code Sec. 2521	NNSA Response
(5) Support for the sustainment and modernization of facilities with production and manufacturing capabilities that are necessary to ensure the safety, security, and reliability of the nuclear weapons stockpile, including - (A) the nuclear weapons production facilities; and (B) production and manufacturing capabilities resident in the national security laboratories.	*Unclassified* Chapters 2, Section 2.4.6; Chapter 4, Section 4.4
(1) With respect to exascale computing—	
(a) PLAN REQUIRED.—The Administrator for Nuclear Security shall develop and carry out a plan to develop exascale computing and incorporate such computing into the stockpile stewardship program under section 4201 of the Atomic Energy Defense Act (50 U.S.C. 2521) during the 10-year period beginning on the date of the enactment of this Act.	*Unclassified* Chapter 3, Section 3.6.2; Appendix C
(b) MILESTONES.—The plan required by subsection (a) shall include major programmatic milestones in— (1) the development of a prototype exascale computer for the stockpile stewardship program; and (2) mitigating disruptions resulting from the transition to exascale computing.	*Unclassified* Chapter 3, Section 3.6.2; Appendix C
(c) COORDINATION WITH OTHER AGENCIES.—In developing the plan required by subsection (a), the Administrator shall coordinate, as appropriate, with the Under Secretary of Energy for Science, the Secretary of Defense, and elements of the intelligence community (as defined in section 3(4) of the National Security Act of 1947 (50 U.S.C. 3003(4))).	*Unclassified* Chapter 3, Section 3.6.2; Appendix C
(d) INCLUSION OF COSTS IN FUTURE-YEARS NUCLEAR SECURITY PROGRAM.—The Administrator shall— (1) address, in the estimated expenditures and proposed appropriations reflected in each future-years nuclear security program submitted under section 3253 of the National Nuclear Security Administration Act (50 U.S.C. 2453) during the 10-year period beginning on the date of the enactment of this Act, the costs of— (A) developing exascale computing and incorporating such computing into the stockpile stewardship program; and (B) mitigating potential disruptions resulting from the transition to exascale computing; and (2) include in each such future-years nuclear security program a description of the costs of efforts to develop exascale computing borne by the National Nuclear Security Administration, the Office of Science of the Department of Energy, other Federal agencies, and private industry.	*Unclassified* Appendix C
(e) SUBMISSION TO CONGRESS.—The Administrator shall submit the plan required by subsection (a) to the congressional defense committees with each summary of the plan required by subsection (a) of section 4203 of the Atomic Energy Defense Act (50 U.S.C. 2523) submitted under subsection (b)(1) of that section during the 10-year period beginning on the date of the enactment of this Act.	
(f) EXASCALE COMPUTING DEFINED.—In this section, the term ‘‘exascale computing’’ means computing through the use of a computing machine that performs near or above 10 to the 18th power floating point operations per second.	

50 U.S. Code Sec. 2522	NNSA Response
Sec. 2522. Report on stockpile stewardship criteria	
(a) Requirement for criteria The Secretary of Energy shall develop clear and specific criteria for judging whether the science-based tools being used by the Department of Energy for determining the safety and reliability of the nuclear weapons stockpile are performing in a manner that will provide an adequate degree of certainty that the stockpile is safe and reliable.	*Unclassified* Chapter 3, Section 3.4.2 ——— *Classified* Chapter 3, Section 3.2
(b) Coordination with Secretary of Defense The Secretary of Energy, in developing the criteria required by subsection (a), shall coordinate with the Secretary of Defense.	

50 U.S. Code Sec. 2523	*NNSA Response*
Sec. 2523. Nuclear weapons stockpile stewardship, management, and infrastructure plan	
(a) Plan requirement The Administrator, in consultation with the Secretary of Defense and other appropriate officials of the departments and agencies of the Federal Government, shall develop and annually update a plan for sustaining the nuclear weapons stockpile. The plan shall cover, at a minimum, stockpile stewardship, stockpile management, stockpile surveillance, program direction, infrastructure modernization, human capital, and nuclear test readiness. The plan shall be consistent with the programmatic and technical requirements of the most recent annual Nuclear Weapons Stockpile Memorandum.	*Unclassified* All Chapters
(b) Submissions to Congress	
(1) In accordance with subsection (c), not later than March 15 of each even-numbered year, the Administrator shall submit to the congressional defense committees a summary of the plan developed under subsection (a).	*N/A*
(2) In accordance with subsection (d), not later than March 15 of each odd-numbered year, the Administrator shall submit to the congressional defense committees a detailed report on the plan developed under subsection (a).	*Unclassified* All chapters
(3) The summaries and reports required by this subsection shall be submitted in unclassified form, but may include a classified annex.	
'**(c) ELEMENTS OF BIENNIAL PLAN SUMMARY**.—Each summary of the plan submitted under subsection (b)(1) shall include, at a minimum, the following:	*N/A*
(1) A summary of the status of the nuclear weapons stockpile, including the number and age of warheads (including both active and inactive) for each warhead type.	*N/A*
(2) A summary of the status, plans, budgets, and schedules for warhead life extension programs and any other programs to modify, update, or replace warhead types.	*N/A*
(3) A summary of the methods and information used to determine that the nuclear weapons stockpile is safe and reliable, as well as the relationship of science-based tools to the collection and interpretation of such information.	*N/A*
(4) A summary of the status of the nuclear security enterprise, including programs and plans for infrastructure modernization and retention of human capital, as well as associated budgets and schedules.	*N/A*
(5) Identification of any modifications or updates to the plan since the previous summary or detailed report was submitted under subsection (b).	N/A
(6) Such other information as the Administrator considers appropriate.	*N/A*
(d) ELEMENTS OF BIENNIAL DETAILED REPORT.—Each detailed report on the plan submitted under subsection (b)(2) shall include, at a minimum, the following:	
(1) With respect to stockpile stewardship and management—	
(A) the status of the nuclear weapons stockpile, including the number and age of warheads (including both active and inactive) for each warhead type;	*Unclassified* Chapter 1, Section 1.2; Chapter 2, Section 2.1 ——— *Classified* Chapter 2, Sections 2.2, 2.4.1
(B) for each five-year period occurring during the period beginning on the date of the report and ending on the date that is 20 years after the date of the report— (i) the planned number of nuclear warheads (including active and inactive) for each warhead type in the nuclear weapons stockpile; and (ii) the past and projected future total lifecycle cost of each type of nuclear weapon;	*Unclassified* Chapter 8, Sections 8.9.1, 8.9.2 ——— *Classified* Chapter 2, Sections 2.1.1, 2.1.2

50 U.S. Code Sec. 2523	*NNSA Response*
(C) the status, plans, budgets, and schedules for warhead life extension programs and any other programs to modify, update, or replace warhead types;	*Unclassified* Chapters 2, Sections 2.3, 2.4; Chapter 8, Section 8.9.2 ——— *Classified* Chapter 2, Section 2.3
(D) a description of the process by which the Administrator assesses the lifetimes, and requirements for life extension or replacement, of the nuclear and non-nuclear components of the warheads (including active and inactive warheads) in the nuclear weapons stockpile;	*Unclassified* Chapter 2, Section 2.2.1
(E) a description of the process used in recertifying the safety, security, and reliability of each warhead type in the nuclear weapons stockpile;	*Unclassified* Chapter 2, Sections 2.1.1, 2.1.2, 2.4.3, 2.5.1; Chapter 3, Sections 3.4.2, 3.5.1, 3.6.1, 3.6.4
(F) any concerns of the Administrator that would affect the ability of the Administrator to recertify the safety, security, or reliability of warheads in the nuclear weapons stockpile (including active and inactive warheads);	*Unclassified* Chapter 2, Section 2.1.2; Chapter 3, Section 3.3 ——— *Classified* Chapter 2, Section 2.3
(G) mechanisms to provide for the manufacture, maintenance, and modernization of each warhead type in the nuclear weapons stockpile, as needed;	*Classified* Chapter 2; Chapter 3, Section 3.1.3
(H) mechanisms to expedite the collection of information necessary for carrying out the stockpile management program required by section 2524 of this title, including information relating to the aging of materials and components, new manufacturing techniques, and the replacement or substitution of materials;	*Unclassified* Chapter 2, Sections 2.2.1, 2.2.2, 2.4.5
(I) mechanisms to ensure the appropriate assignment of roles and missions for each national security laboratory and nuclear weapons production facility, including mechanisms for allocation of workload, mechanisms to ensure the carrying out of appropriate modernization activities, and mechanisms to ensure the retention of skilled personnel;	*Unclassified* Chapter 2, Section 2.1.4; Chapter 7, Section 7.3.2
(J) mechanisms to ensure that each national security laboratory has full and complete access to all weapons data to enable a rigorous peer-review process to support the annual assessment of the condition of the nuclear weapons stockpile required under section 2525;	*Unclassified* Chapter 2, Section 2.4.3
(K) mechanisms for allocating funds for activities under the stockpile management program required by section 4204, including allocations of funds by weapon type and facility; and	*Unclassified* Chapters 4, Section 4.4; Chapter 8, Sections 8.1, 8.9
(L) for each of the five fiscal years following the fiscal year in which the report is submitted, an identification of the funds needed to carry out the program required under section 2524.	*Unclassified* Chapter 8, Section 8.1

50 U.S. Code Sec. 2523	*NNSA Response*
(2) With respect to science-based tools—	
(A) a description of the information needed to determine that the nuclear weapons stockpile is safe and reliable;	*Unclassified* Chapter 2, Section 2.1.1 Chapter 3, Section 3.4.2 ——— *Classified* Chapter 3, Section 3.2
(B) for each science-based tool used to collect information described in subparagraph (A), the relationship between such tool and such information and the effectiveness of such tool in providing such information based on the criteria developed pursuant to section 2522(a) of this title; and	*Unclassified* Chapter 3, Section 3.4.2 ——— *Classified* *Chapter 3,* *Section* 3.2
(C) the criteria developed under section 2522(a) of this title (including any updates to such criteria).	
(3) An assessment of the stockpile stewardship program under section 2521 (a) of this title by the Administrator, in consultation with the directors of the national security laboratories, which shall set forth—	
(A) an identification and description of— (i) any key technical challenges to the stockpile stewardship program; and (ii) the strategies to address such challenges without the use of nuclear testing;	*Unclassified* Chapter 3, Section 3.3 ——— Classified Chapter 3, Section 3.2
(B) a strategy for using the science-based tools (including advanced simulation and computing capabilities) of each national security laboratory to ensure that the nuclear weapons stockpile is safe, secure, and reliable without the use of nuclear testing;	*Unclassified* Chapter 3 ——— *Classified* Chapter 3, Section 3.2
(C) an assessment of the science-based tools (including advanced simulation and computing capabilities) of each national security laboratory that exist at the time of the assessment compared with the science-based tools expected to exist during the period covered by the future-years nuclear security program; and	*Unclassified* Chapter 3, Section 3.3 ——— *Classified* Chapter 3, Section 3.2
(D) an assessment of the core scientific and technical competencies required to achieve the objectives of the stockpile stewardship program and other weapons activities and weapons-related activities of the Administration, including—	*Unclassified* Chapter 7, Section 7.4.2
(i) the number of scientists, engineers, and technicians, by discipline, required to maintain such competencies; and	*Unclassified* Appendix D
(ii) a description of any shortage of such individuals that exists at the time of the assessment compared with any shortage expected to exist during the period covered by the future-years nuclear security program.	*Unclassified* Appendix D

50 U.S. Code Sec. 2523	NNSA Response
(4) With respect to the nuclear security infrastructure—	
(A) a description of the modernization and refurbishment measures the Administrator determines necessary to meet the requirements prescribed in—	*Unclassified* Chapter 4, Section 4.3
(i) the national security strategy of the United States as set forth in the most recent national security strategy report of the President under section 404a of this title if such strategy has been submitted as of the date of the plan;	
(ii) the most recent quadrennial defense review if such strategy has not been submitted as of the date of the plan; and	
(iii) the most recent Nuclear Posture Review as of the date of the plan;	
(B) a schedule for implementing the measures described under subparagraph (A) during the 10-year period following the date of the plan; and	*Unclassified* Chapter 4, Section 4.2.4
(C) the estimated levels of annual funds the Administrator determines necessary to carry out the measures described under subparagraph (A), including a discussion of the criteria, evidence, and strategies on which such estimated levels of annual funds are based.	*Unclassified* Chapter 8, Sections 8.4, 8.5, 8.9
(5) With respect to the nuclear test readiness of the United States—	
(A) an estimate of the period of time that would be necessary for the Administrator to conduct an underground test of a nuclear weapon once directed by the President to conduct such a test;	*Unclassified* Chapter 3, Section 3.2
(B) a description of the level of test readiness that the Administrator, in consultation with the Secretary of Defense, determines to be appropriate;	*Unclassified* Chapter 3, Section 3.2
(C) a list and description of the workforce skills and capabilities that are essential to carrying out an underground nuclear test at the Nevada National Security Site;	*Unclassified* Chapter 3, Section 3.2
(D) a list and description of the infrastructure and physical plants that are essential to carrying out an underground nuclear test at the Nevada National Security Site; and	*Unclassified* Chapter 3, Section 3.2
(E) an assessment of the readiness status of the skills and capabilities described in subparagraph (C) and the infrastructure and physical plants described in subparagraph (D).	*Unclassified* Chapter 3, Section 3.2
(6) A strategy for the integrated management of plutonium for stockpile and stockpile stewardship needs over a 20-year period that includes the following:	
(A) An assessment of the baseline science issues necessary to understand plutonium aging under static and dynamic conditions under manufactured and nonmanufactured plutonium geometries.	*Unclassified* Chapter 3, Section 3.4.2 ——— *Classified* Chapter 3, Section 3.2.1
(B) An assessment of scientific and testing instrumentation for plutonium at elemental and bulk conditions.	*Unclassified* Chapter 3, Sections 3.1, 3.5.3, 3.6.1, 3.6.4 ——— *Classified* Chapter 3, Section 3.2.1

50 U.S. Code Sec. 2523	***NNSA Response***
(C) An assessment of manufacturing and handling technology for plutonium and plutonium components.	*Unclassified* Chapter 2, Section 2.4.6; Chapter 4, Section 4.3.3
(D) An assessment of computational models of plutonium performance under static and dynamic loading, including manufactured and nonmanufactured conditions.	*Unclassified* Chapter 3, Section 3.6.2 ——— *Classified* Chapter 3, Section 3.2.1
(E) An identification of any capability gaps with respect to the assessments described in subparagraphs (A) through (D).	*Unclassified* Chapter 3, Sections 3.3, 3.4.2 ——— *Classified* Chapter 3, Section 3.2
(F) An estimate of costs relating to the issues, instrumentation, technology, and models described in subparagraphs (A) through (D) over the period covered by the future-years nuclear security program under section 2453 of this title.	*Unclassified* Chapter 8, Section 8.3
(G) An estimate of the cost of eliminating the capability gaps identified under subparagraph (E) over the period covered by the future-years nuclear security program.	*Unclassified* Chapter 8, Section 8.3
(H) Such other items as the Administrator considers important for the integrated management of plutonium for stockpile and stockpile stewardship needs.	*Unclassified* Chapter 2, Section 2.4.6; Chapter 4, Section 4.3.3
(7) Identification of any modifications or updates to the plan since the previous summary or detailed report was submitted under subsection (b).	*Unclassified* Executive Summary
(f) DEFINITIONS.—In this section: (1) The term 'budget', with respect to a fiscal year, means the budget for that fiscal year that is submitted to Congress by the President under section 1105(a) of Title 31. (2) The term 'future-years nuclear security program' means the program required by section 2453 of this Title.	
(3) The term 'nuclear security budget materials', with respect to a fiscal year, means the materials submitted to Congress by the Administrator in support of the budget for that fiscal year. (4) The term 'quadrennial defense review' means the review of the defense programs and policies of the United States that is carried out every four years under section 118 of Title 10. (5) The term 'weapons activities' means each activity within the budget category of weapons activities in the budget of the Administration.	
(6) The term 'weapons-related activities' means each activity under the Department of Energy that involves nuclear weapons, nuclear weapons technology, or fissile or radioactive materials, including activities related to— (A) nuclear nonproliferation; (B) nuclear forensics; (C) nuclear intelligence; (D) nuclear safety; and (E) nuclear incident response.''	

50 U.S. Code Sec. 2524	*NNSA Response*
Sec. 2524. Stockpile management program (a) Program required	
The Secretary of Energy, acting through the Administrator for Nuclear Security and in consultation with the Secretary of Defense, shall carry out a program, in support of the stockpile stewardship program, to provide for the effective management of the weapons in the nuclear weapons stockpile, including the extension of the effective life of such weapons. The program shall have the following objectives:	
(1) To increase the reliability, safety, and security of the nuclear weapons stockpile of the United States.	*Unclassified* Chapter 2, Section 2.1.4
(2) To further reduce the likelihood of the resumption of underground nuclear weapons testing.	*Unclassified* Chapter 3, Section 3.4
(3) To achieve reductions in the future size of the nuclear weapons stockpile.	*Unclassified* Chapter 1, Section 1.3 ——— *Classified* Chapter 2, Section 2.5.2
(4) To reduce the risk of an accidental detonation of an element of the stockpile.	*Unclassified* Chapter 2, Section 2.2 ——— *Classified* Chapter 2, Section 3.2.3
(5) To reduce the risk of an element of the stockpile being used by a person or entity hostile to the United States, its vital interests, or its allies.	*Unclassified* Chapters 2, Section 2.2; Chapter 6, Section 6.1.5
(b) Program limitations In carrying out the stockpile management program under subsection (a), the Secretary of Energy shall ensure that -	
(1) any changes made to the stockpile shall be made to achieve the objectives identified in subsection (a); and	*Unclassified* Chapter 2, Section 2.2
(2) any such changes made to the stockpile shall - (A) remain consistent with basic design parameters by including, to the maximum extent feasible, components that are well understood or are certifiable without the need to resume underground nuclear weapons testing; and (B) use the design, certification, and production expertise resident in the nuclear security enterprise to fulfill current mission requirements of the existing stockpile.	*Unclassified* Chapter 2, Section 2.2
(c) Program budget In accordance with the requirements under section 2529 of this Title, for each budget submitted by the President to Congress under section 1105 of Title 31, the amounts requested for the program under this section shall be clearly identified in the budget justification materials submitted to Congress in support of that budget.	*Unclassified* Chapter 8, Section 8.1

A.3 Other Requirements

FY 2015 National Defense Authorization Act, Pu L. 113-66	*NNSA Response*
Section 3112 of this Act adds the following section to 50 U.S.C. 2521- Section 4219—Plutonium Pit Production Capacity (a) REQUIREMENT—Consistent with the requirements of the Secretary of Defense, the Secretary of Energy shall ensure that the nuclear security enterprise-- (1) during 2021, begins production of qualification plutonium pits; (2) during 2024, produces not less than 10 war reserve plutonium pits; (3) during 2025, produce no less than 30 war reserve plutonium pits; (4) during 2026, produces not less than 30 war reserve plutonium pits; and (5) during a pilot period of not less than 90 days during 2027 (subject to produce war reserve plutonium pits at a rate sufficient to produce 80 pits per year. In a coordinated manner, DOE and DOD may slip this requirement up to 2 years. (b) AUTHORIZATION OF TWO-YEAR DELAY OF DEMONSTRATION REQUIREMENT—The Secretary of Energy and the Secretary of Defense may jointly delay, for not more than two years, the requirement under subsection 2 (a)(5) if— (1) the Secretary of Defense and the Secretary of Energy jointly submit to the congressional defense committees a report describing— (A) the justification for the proposed delay; (B) the effects of the proposed delay on stockpile stewardship and modernization, life extension programs, future stockpile strategy, and dismantlement efforts; and (C) whether the proposed delay is consistent with national policy regarding creation of a responsive nuclear infrastructure; and (2) the Commander of the United States Strategic Command submits to the congressional defense committees a report containing the assessment of the Commander with respect to the potential risks to national security of the proposed delay in meeting (A) the nuclear deterrence requirements of the United States Strategic Command; and (B) national requirements related to creation of a responsive nuclear infrastructure. (c) ANNUAL CERTIFICATION.—Not later than March 1, 2015, and each year thereafter through 2027, the Secretary of Energy shall certify to the congressional defense committees and the Secretary of Defense that the programs and budget of the Secretary of Energy will enable the nuclear security enterprise to meet the requirements under subsection (a)	*Unclassified* Message from the Secretary; Chapter 2, Section 2.4.6; Chapter 4, Section 4.3.3 ——— *Classified* Chapter 2, Section 2.1.2
Section 3118 of this Act amends Section 3123 of the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112–239), as amended by section 3126 of the National Defense Authorization Act for Fiscal Year 2014 (Public Law 113-966) to add the following requirement- (3) Annual Certification—Not later than March 1 of each year through 2025, the Secretary shall certify in writing to the congressional defense committees and the Secretary of Defense that Phase 1 under subsection (a) of the project referred in that subsection will— (A) Not exceed the total cost set forth in paragraph (1) (as adjusted pursuant to paragraph (2), if so adjusted); and (B) meet a schedule that enables, by not later than 2025— (i) uranium operations in building 9212 to cease; and (ii) uranium operations in a new facility constructed under the project to begin.	*Unclassified* Message from the Secretary; Chapter 2, Section 2.4.6; Chapter 4, Section 4.3.3
Section 3119—Production of Nuclear Warhead for Long-Range Standoff Weapon (a) First Production Unit. The Secretary of Energy shall deliver a first production unit for a nuclear warhead for the long-range standoff weapon by not later than September 30, 2025.	*Unclassified* Chapter 2, Sections 2.1.4, 2.4.1, 2.5.2 ——— *Classified* Chapter 2, Section 2.6

FY 2015 National Defense Authorization Act, Pu L. 113-66	*NNSA Response*
Sec. 3123 Identification of amounts required for uranium technology sustainment in budget materials for fiscal year 2016 The Administrator for Nuclear for Nuclear Security shall include, in the budget justification materials submitted to Congress in support of the budget of the President for fiscal year 2016 (as submitted to Congress under section 1105(a) of title 31, United States Code), specific identification, as a budgetary line item, of the amounts required for uranium technology sustainment in support of the nuclear weapons stockpile in a manner that minimizes the use of plant-directed research and development funds for full-scale technology development past a technology readiness level of 5 (as defined in Department of Energy Guide 413.3–4A (relating to technology readiness assessment).	*Unclassified* Chapter 8, Section 8.1

Appendix B
Research, Development, Testing, and Evaluation Subprograms

Chapter 3 discussed the Research, Development, Testing, and Evaluation (RDT&E) activities that underpin stockpile stewardship. This appendix provides more-detailed information regarding the subprograms of the various programs that are described in Section 3.5 of that chapter. All of these subprograms help maintain the technical staff through challenging work that builds competencies that are critical to stockpile stewardship and avoiding technological surprise.

B.1 Science Program

B.1.1 Advanced Certification Subprogram

The Advanced Certification subprogram focuses on enabling certification of the evolving stockpile in the absence of nuclear testing. This subprogram develops tools and methods that support assessment activities associated with the current stockpile as well as certification of future stockpile options for safety and security. Advanced Certification provides a strong focal point for the key research, development, testing, and evaluation deliverables that enable life-extension certification activities. The subprogram integrates scientific and technological advances that are supported by the Science, Engineering, ASC, and ICF Programs with input from studies to understand the impacts of aging phenomena and design options on weapon performance; enhance the weapons certification process; refine computational tools and methods; advance physical understanding of surety mechanisms; understand failure modes; assess advanced manufacturing processes; and respond to technological surprise and changes in stockpile requirements.

B.1.2 Primary Assessment Technologies Subprogram

The Primary Assessment Technologies subprogram provides capabilities for the annual assessment of stockpile primaries, design and certification of life extension programs, improvements in primary safety and security, and resolution of SFIs. A principal focus is continuing to develop predictive capabilities to model boost, a process that is key to proper functioning of nuclear weapons. Another principal focus is providing the capability to assess the impacts of plutonium aging and changes associated with stockpile LEPs, such as the reuse of components and incorporation of safety improvements (*e.g.,* the use of insensitive high explosives rather than conventional high explosives). Primary Assessment Technologies also helps provide the intelligence community with capabilities to assess foreign nuclear weapon activities.

B.1.3 Dynamic Materials Properties Subprogram

The Dynamic Materials Properties subprogram develops and maintains the capabilities to inform modern, physics-based models that describe and predict the behavior of weapon-related materials at extreme conditions of pressure, temperature, stress, strain, and strain rates. This subprogram provides the data and essential materials knowledge to address issues for the Annual Assessment of the stockpile, to evaluate and model the effects of the aging of materials, and to evaluate the effects of material replacement and pit reuse for LEP options. Materials include plutonium, uranium, nonradioactive metals, high explosives, ceramics, polymers, foams, and gases. Surrogate materials are studied to aid understanding and develop data without the use of special nuclear materials. Surrogates are also used to develop and qualify advanced diagnostics prior to fielding nuclear materials. Dynamic Materials Properties also develops new experimental techniques for providing data at extreme conditions and compares that data with calculations of "first principles" theories for material behavior. Dynamic materials experiments are conducted at a number of NNSA facilities, including PF-4, Z, LANSCE, NIF, JASPER, and other laser and gun facilities as well as in small-scale laboratories to test and characterize materials. This subprogram is closely coordinated with the other subprograms of the Science Program as well as with the ASC, ICF, Engineering, and Directed Stockpile Work Programs and with the DOD/DOE Joint Munitions Program.

B.1.4 Advanced Radiography Subprogram

In the absence of nuclear testing, predictive capabilities for stockpile stewardship rely on the development of advanced platforms and diagnostics to enable reliable, repeatable experimental data. The Advanced Radiography subprogram develops technologies and diagnostics, including sources, targets, and imaging systems, to diagnose hydrodynamic and subcritical experiments at the Nevada National Security Site as well as platforms and diagnostics for other dynamic materials experiments. These technologies improve the quality and reliability of scientific results at DARHT at LANL, the FXR radiographic facility at LLNL, Z, the Cygnus radiographic source at the Nevada National Security Site's U1a Complex, and Proton Radiography (pRad) at LANSCE. A key focus of the subprogram is evaluating methods to enhance capabilities for subcritical experiments with plutonium in order to measure the final stages of a primary implosion.

B.1.5 Secondary Assessment Technologies Subprogram

The Secondary Assessment Technologies subprogram provides capabilities that increase confidence in the assessment of secondary performance to enable a broad range of LEPs options and the resolution of SFIs. A principal focus is to provide the scientific basis to quantify full system performance margins and associated uncertainties. For stockpile systems, this assessment will enable the acceptance of existing secondaries and other nuclear explosive package components for reuse, as well as development of the qualification methodology for performance of remanufactured canned subassembly components. Another focus is developing predictive capabilities to quantify weapon outputs and the interaction with the environment of both stockpile and non-stockpile systems. Improved predictions of secondary performance depend on the development, in conjunction with the ICF Program, of advanced experimental platforms. Secondary Assessment Technologies has strong programmatic coupling to other subprograms in the Science Program, *e.g.,* to HED facilities supported by the Science and ICF Programs (NIF, Omega, and Z), and to advanced computing platforms supported by the ASC Program.

B.2 Advanced Simulation and Computing Program

B.2.1 Integrated Codes Subprogram

The Integrated Codes subprogram produces large-scale, IDCs for physics and engineering stockpile assessments to support design studies, maintenance analyses, LEPs, alterations, SFIs, and weapons dismantlement activities. It also maintains selected legacy codes and is responsible for emerging and specialized codes that support the weapons mission. The IDCs represent the repository of data from experiments on NNSA's wide range of facilities and legacy underground nuclear tests, as well as the accumulated experience of the Directed Stockpile Work program user community. Predictive capabilities and national security missions will be achieved through the advances realized in these codes.

B.2.2 Physics and Engineering Models Subprogram

The Physics and Engineering Models subprogram develops microscopic and macroscopic models of physics and material properties for special-purpose physics codes to investigate specific phenomena in detail. The latter are used in cases for which experimental data are difficult or impossible to obtain. The subprogram partners with the Integrated Codes subprogram to perform initial validation and incorporate new models into IDCs. The subprogram also partners with the Verification and Validation subprogram on final assessment of models in IDCs. Extensive integration occurs between the subprogram and experiments executed by the Science, ICF, and Engineering Programs.

B.2.3 Verification and Validation Subprogram

The Verification and Validation subprogram is a bridge between the modeling and development community and the Directed Stockpile Work Program user community. It brings these communities together to evaluate the capability of IDCs and provide a predictive capability for applications. Verification activities demonstrate that the weapons codes are correctly solving equations related to the physics and engineering models. Validation activities ensure that the codes are solving the correct equations, *i.e.,* that the models themselves are correct. Together, these subprogram activities provide a technically rigorous, credible foundation for computational science and engineering calculations by developing and implementing tools that provide confidence in simulations of high-consequence nuclear stockpile problems. The subprogram also develops and implements uncertainty quantification methodologies to support quantification of margins and uncertainties for weapon assessment.

B.2.4 Advanced Technology Development and Mitigation Subprogram

The Advanced Technology Development and Mitigation subprogram was created to help *develop* advanced computing technologies to support stockpile stewardship and to mitigate the effects of these new computer technologies on IDCs. Market and technology forces are disrupting the computing ecosystem in a manner that is not conducive to scientific computing. These changes, such as multi-core chips and unbalanced memory capacity and bandwidth, will impact the full spectrum of high performance computing (HPC). As a result, the continued viability of the current generation of NNSA's IDCs, produced during an era of relative stability in HPC technologies, is being threatened. The subprogram addresses the need to adapt current IDCs and build new IDCs that are attuned to the emerging technologies, engage in codesign ventures with industry to evolve operating systems and other support software, and work with HPC vendors to deploy technologies that are useful for stockpile stewardship.

B.2.5 Computational Systems and Software Environment Subprogram

The Computational Systems and Software Environment subprogram builds integrated, balanced, and scalable computational capabilities. The complexity and scale of weapons simulations require the ASC Program to lead the mainstream HPC community by investing in and influencing the evolution of computing environments. The subprogram provides the stability to ensure productive system use and protect NNSA's investment in secure simulation codes. Within the next decade, enhanced predictive capabilities, delivery of quantified margins and uncertainties, and achievement of Directed Stockpile Work deliverables will demand exascale computing. This subprogram will continue to provide for acquisition and implementation of commodity technology class systems, such as the tri-laboratory Commodity Technology Systems, as well as advanced technology systems, such as Cielo and Sequoia (current systems) and Trinity and Sierra (future systems).

B.2.6 Facility Operations and User Support Subprogram

The Facility Operations and User Support subprogram provides the physical facility and operational support for production computing, storage, and services to enable effective use of the ASC Program's tri-laboratory (LANL, LLNL, SNL) computing resources. Designers, analysts, and code and model developers provide the functional and operational requirements. The scope of operations includes planning, integration, and deployment; continued product support; procurement of equipment and media; quality and reliability activities; and collaborations. The subprogram covers physical space, power, and local- and wide-area networking. The user support functions include computer center hotline and help desk services, account management, web-based system documentation, system status information tools, user training, trouble ticketing systems, and application analyst support at the three national security laboratories.

B.3 Engineering Program

B.3.1 Enhanced Surety Subprogram

The Enhanced Surety subprogram develops state-of-the-art technologies to incorporate into stockpile weapon systems for advanced safety, security, use control, and integrated surety and explores visionary leading-edge technologies for these purposes. Enhanced Surety develops and matures viable technology insertion options that improve safety (by preventing accidental detonation), security (by expanding and strengthening physical protection boundaries), and use control (by permitting use of nuclear weapons only when authorized).

B.3.2 Weapon Systems Engineering Assessment Technology Subprogram

The Weapon Systems Engineering Assessment Technology subprogram develops the diagnostics, hardware engineering assessment tools, methodologies, test data, and engineering analysis used to maintain appropriate performance and safety margins through the life cycle of the stockpile. The subprogram provides the linkage between capabilities in engineering sciences, computational simulation, test and evaluation, and weapon system qualification. This subprogram has been crucial to the transformation of weapon assessment and qualification *via* testing according to a framework based on validated predictive capabilities that involve multiple, complex physics models and environments.

B.3.3 Nuclear Survivability Subprogram

The Nuclear Survivability subprogram provides tools and technologies to design and qualify components or subsystems to meet requirements for radiation, space, and other hostile environments. Activities include providing nuclear warhead output and experimental capabilities to determine survivability by developing and validating models and experimental survivability assessment tools for nuclear components; assuring that stockpile-to-target-sequence requirements for x-ray effects can be met with adequate confidence and cost-effectiveness; and developing approaches, technologies, and infrastructure for the qualification of microelectronics, microsystems, and other non-nuclear components.

B.3.4 Enhanced Surveillance Subprogram

The Enhanced Surveillance subprogram assesses the impact of material behavior changes on weapon performance and safety. This joint science and engineering effort provides material, component, and subsystem lifetime assessments and develops predictive capabilities for early identification and assessment of stockpile aging issues. The subprogram identifies aging issues with sufficient lead time to ensure NNSA has the refurbishment capability and capacity in place when required. Typically, the lifetime assessments include efforts to understand basic aging mechanisms and interactions of materials in components, assemblies, and subassemblies. Accelerated aging experiments are used to obtain data beyond that available from traditional stockpile surveillance. Experiments are also used to validate broader, age-aware models developed to support lifetime assessments and predictions pertinent to LEPs. In addition, the subprogram provides new or improved diagnostic techniques and technologies to detect and quantify aging degradation and other potential defects in the stockpile. The capabilities and knowledge gained are applied to assess and develop candidate replacement materials (through separate technology and component maturation program efforts) for future stockpile insertion.

B.4 Inertial Confinement Fusion Ignition and High Yield Program

B.4.1 Ignition Subprogram

Demonstration of thermonuclear ignition in the laboratory, including its development as a platform in a regime that is not accessible in any other way, will provide the means to address key weapons issues and validate the simulation codes that are used to assess and certify the stockpile. Ignition remains a major goal for NNSA and DOE. The Ignition subprogram supports research activities to optimize prospects for achieving ignition at NIF, as well as development of and applications for robust ignition, advanced ignition, and burning plasma platforms. Experiments on NNSA's HED facilities are supported by detailed theoretical designs and two- and three-dimensional simulations of ignition targets. The near-term emphasis is on developing the physics understanding to improve the target designs and demonstrate ignition. In the longer term, advanced ignition concepts may provide higher yield and/or gain compared to current indirect-drive concepts. The subprogram also develops advanced experimental capabilities to create and study matter under extreme conditions that approach those in nuclear explosions.

B.4.2 Support of Other Stockpile Programs Subprogram

HED physics and weapon-relevant experiments at ICF's suite of facilities are essential to assess and certify the stockpile and validate models and simulation codes to provide knowledge relevant to nuclear weapons performance. The Support of Other Stockpile Programs subprogram leverages the experience of ICF researchers to execute these nuclear-weapons-relevant experiments. This expertise includes the development of laser, target, platform, and diagnostic capabilities at NIF, Omega, Z, and supporting facilities. In experiments for the Science and Directed Stockpile Work Programs and other stockpile program elements the focus is on material properties, hydrodynamics, and radiation transport.

B.4.3 Diagnostics, Cryogenics, and Experimental Support Subprogram

Science-based weapons assessment and certification require advanced experimental capabilities and diagnostics to create and study matter under extreme conditions. The subprogram develops and deploys specialized technologies needed to execute experiments on ICF facilities for ignition, national security, and fundamental science applications. Efforts of the subprogram include the design and engineering of a complex array of diagnostic and measurement systems and associated information technology subsystems for data acquisition, storage, retrieval, visualization, and analysis. A major activity in FY 2016 is implementing a cost-effective National HED Diagnostics Plan to develop the highest-priority diagnostics for national security applications.

B.4.4 Pulsed Power Inertial Confinement Fusion Subprogram

This technical effort advances the science of magnetically driven implosions as a means to achieve HED for Stockpile Stewardship Program applications and as a promising path to nuclear-weapons-relevant physics environments and high fusion yield. A mixture of focused and integrated experiments are addressing key physics uncertainties and improving the design of targets for the Magnetized Liner Inertial Fusion approach to fusion ignition. Specific activities include experiments on Z, at Omega, and NIF; designing and building targets; improving simulation tools; and developing the diagnostic and capability infrastructure to study magnetically driven implosions. An objective of the Pulsed Power Inertial Confinement Fusion subprogram is to determine the requirements for an advanced pulsed-power driver that would achieve robust ignition and single-shot high yield.

B.4.5 Joint Program in High Energy Density Laboratory Plasmas Subprogram

This joint program with the DOE Office of Science supports NNSA's stockpile stewardship mission by conducting HED physics research and strengthens NNSA's RDT&E activities. The subprogram provides support for external users at Omega through the National Laser Users' Facility Program and a joint solicitation with the Office of Science for High Energy Density Laboratory Plasmas research at universities and DOE laboratories. It includes some support for Stockpile Stewardship Academic Alliances activities and other university programs related to High Energy Density Laboratory Plasmas research. It also supports academic programs to steward the study of laboratory HED plasma physics, maintain a cadre of qualified HED researchers, and develop the next generation of stockpile stewards for the future.

B.4.6 Facility Operations and Target Production Subprogram

The Facility Operations and Target Production subprogram provides infrastructure and operations support of ICF HED facilities to conduct experiments for stockpile assessment and certification as well as broader goals for NNSA's Stockpile Stewardship Program. It supports the experimental operation of NIF, Omega, and Z and the fabrication of sophisticated targets related to weapons physics experiments and ICF experiments, as well as the operation of the Trident facility at LANL, ICF external reviews, and facility users' meetings.

Appendix C
Exascale Computing

This appendix outlines the Advanced Simulation and Computing (ASC) Program plan for developing a usable exascale[1] computing system (that is, a computing system that has a hundred-fold increase in sustained application code performance over today's computing systems) for stockpile stewardship. This plan is an update to the approach outlined in the FY 2015 SSMP (Chapter 3, Section 3.7.2, and Appendix F) and is being submitted in coordination with the DOE Office of Science's Advanced Scientific Computing Research (ASCR) program, which partners with NNSA in exascale computing activities.

C.1 Introduction

The computational simulation capability provided by ASC is a key integrating element used for weapon physics and engineering assessments of the Nation's stockpile. The IDCs, including the models, algorithms, and related physical databases developed for these codes, embody much of the experimental data obtained by NNSA since the 1992 nuclear test moratorium, as well as legacy underground nuclear test data and the accumulated experience of the DSW Program. The IDCs are a principal tool used across the stockpile for design studies, maintenance analyses, qualification, Annual Assessment Reports, LEPs, alterations, modifications, SFIs, warhead safety assessments, and weapons dismantlement.

The current predictive capability of IDCs is a result of both scientific and engineering advances and the extraordinary increases in computing capability over the past decades. While IDCs support most of today's missions, they will need to be more predictive to support future missions. Aging of weapon components, advanced and additive manufacturing techniques, and changes resulting from alterations and LEPs are moving the stockpile further from the data collected in underground nuclear tests. Predictive capability is currently limited by approximations in the physics models, the inability to resolve critical geometric and physics features at very small length scales, and the need to quantify margins and uncertainties. Making progress on these limitations requires NNSA to move beyond today's computer systems to usable exascale computing systems, which will remove the need for some approximations, allow simulations to run at substantially smaller length scales, and enable more accurate quantification of margins and uncertainties.

The historical trend in raw computing performance improvement suggests that an exascale system could be built by 2018. However, a series of reports over the last five years indicate that the resulting system would require more than 200 megawatts of power (resulting in estimated energy costs of $200 million to $300 million per year), would have an extremely high failure rate because of the very large number of components (causing simulations to stop after only 10 or 20 minutes of computation), would have limited memory per computing processor (dramatically reducing the effectiveness of today's stockpile stewardship codes), and would be extremely difficult to program (requiring new

[1] An exascale computer would perform at least 10^{18} floating point operations per second, which is more than 50 times faster than the petascale-class computers that are currently the backbone of NNSA's computing resources. Petascale computers perform at least 10^{15} floating point operations per second.

algorithms and programming techniques) [see Section C.11, 1-6]. Consequently, exascale solutions built from off-the-shelf components are not expected to be viable for stockpile stewardship applications in the next decade.

Developing usable exascale computing capabilities for stockpile stewardship requires a research, development, and engineering effort that will:

- develop computing systems that provide a hundred-fold increase in sustained application code performance over current ASC systems;
- reduce power requirements to a factor of ten below recent projections; and
- address high failure rate problems, memory per processor issues, and programming challenges.

These challenges are already present in today's quickly evolving computer systems. To partially address these challenges, ASC has started an Advanced Technology Development and Mitigation (ATDM) subprogram, mentioned in Chapter 3 and Appendix B. ATDM will mitigate the impact of computing technology changes to IDCs by beginning to rewrite the IDCs for next-generation systems and by engaging early with computer hardware vendors to work on application performance solutions of critical importance to the stockpile stewardship mission. ATDM is expected to address some of the most pressing issues for stockpile stewardship associated with next-generation computing architectures.

This plan will be executed in close collaboration with DOE's ASCR. Each organization will contribute in their primary areas of expertise: ASC in applied development and total system engineering, and ASCR in long-lead-time R&D of enabling technologies. Collaborative teams comprised of a mix of DOE laboratories, small and large HPC vendors, and universities selected through peer review processes will conduct research, development, and engineering. Within the Federal Government, DOE will coordinate with other organizations that have historically made major investments in developing and deploying HPC, such as the National Security Agency, National Science Foundation, DOD, and Defense Advanced Research Projects Agency.

To meet the needs of the weapons program, NNSA must continue to acquire advanced systems at a strategically determined schedule, which is funded through established core program funds. These funds amount to between $40 million and $100 million annually (averaging $65 million). Developing and adapting the IDCs to next-generation exascale computer architectures is part of ASC's core mission and would continue to be funded outside of a national exascale initiative.

The details of the plan for achieving exascale computing, including background information, technical challenges, exascale requirements, approach and strategy, current activities, management, budget and major milestones, risk management, and the relationship to the National Strategic Computing Initiative, are presented in the remainder of this appendix.

C.2 Background

Computer hardware and architectures are evolving rapidly because of market pressures created by mobile computing devices and other consumer electronics that are not focused on HPC. Because of physical limits, it is no longer economically feasible for manufacturers to continue the historic trend of making computer circuits faster as component sizes shrink. The industry is responding by incorporating more processing cores on a single chip, resulting in "multi-core" chips. This is driving an unprecedented degree of parallelism, that is, many cores running together in parallel to complete a single computation. In addition, the historically slow improvement of memory systems relative to the fast improvement of computing speed has resulted in memory systems becoming primary drivers in cost and power consumption. For example, the fact that Sequoia, ASC's highest-performing computer system, has many more computing cores than Cielo, ASC's previous highest-performing system, gives Sequoia significantly greater capacity to perform stockpile work. However, each core runs the current IDCs two to five times more slowly because of the difficulty of adapting the IDCs to the higher degree of on-chip parallelism, the slower speed of the individual cores, and the reduced capacity of the memory system per core. All of these causes for reduced performance were a consequence of cost and power considerations.

The decline in code performance on new systems like Sequoia is a clear indicator that issues associated with next-generation computing systems that are on the path to exascale must be addressed. Current challenges are only expected to get worse by continuing many-core system and hierarchical memory trends. These challenges are being partially addressed through the new ATDM subprogram within ASC, but can only be fully addressed within the next decade by an enhanced effort to achieve capable exascale computing.

C.3 Technical Challenges

Pursuing increased capabilities on the path to exascale will be difficult. Impediments to advancing HPC capabilities include the need for significant changes, both in the underlying hardware architecture of these systems and the many layers of software required to use them. To address these challenges, researchers must work together to design and develop the needed architectures, storage, operating systems, languages, libraries, and application software. Over the last eight years, a series of workshops, advisory committee studies, vendor technology surveys, and studies by various Federal agencies [see Section C.11, 1-16] have documented the following major challenges:

- **Energy Challenge.** Science and engineering applications, like the stockpile IDCs, require relatively large amounts of memory per computing core, and memory systems, specifically data movement, will soon dominate the energy budget. Based on current technology, scaling today's systems to an exascale level would consume more than a gigawatt of power, roughly half the output of Hoover Dam. Reducing the power requirement by a factor of at least ten below current projections for such systems will require significant effort.
- **Memory and Storage Challenge.** Memory density is doubling every three years compared to processor logic, which is doubling every two years. Today, it takes about ten times more energy to bring two numbers from memory into the processor than it takes to perform the subsequent arithmetic operation. By 2020, this ratio is expected to reach 50 times, making data movement very expensive compared to calculations. System vendors must develop, to the extent required, memory and storage architectures that are energy efficient and provide high-rate access to high capacity memory. To limit demands on the memory systems, application codes must be implemented with new approaches that focus less on limiting computation (as they historically have) and more on limiting data movement.
- **Resilience Challenge.** Today's highest-performing ASC system has approximately 1.5 million computing cores. Because of physical and economic constraints, the speed of each computing core is unlikely to change in the future, which means that an exascale system could have as many as 1 billion cores. An immediate consequence is that the frequency of errors for the overall system will increase dramatically, while timely identification and correction of errors will become much more difficult. HPC vendors must deliver a more fault-tolerant hardware and software infrastructure that will enable applications to develop ways to cope with these errors.

- **Parallelism Challenge.** To make effective use of the unprecedented levels of parallelism that will be present in exascale systems, the mathematical models, numerical methods, and software implementations all require new conceptual and programming paradigms. Next-generation systems must be designed to provide efficient exploitation of this concurrency and must provide the appropriate tools for application developers.

C.4 Usable Exascale System Requirements

The system characteristics to meet the technical challenges discussed above are listed in **Table C–1** below.

Table C–1. Proposed usable exascale system requirements compared to the latest ASC system

	January 2015 (ASC)	*Proposed Exascale Targets*
System peak performance	20 petaflops	> 1,000 petaflops (code performance 100 times that of current ASC systems)
System power	8 megawatts	~20 megawatts
System memory	1.6 petabytes	> 64 petabytes
Storage	15 petabytes	500 to 1,000 petabytes
I/O aggregate bandwidth	0.3 terabytes/second	60 terabytes/second
Job Mean Time To Interruption	25 hours	25 hours (with resiliency techniques)

ASC = Advanced Simulation and Computing Program
I/O = input/output

Code performance that executes actions 100 times faster than on current ASC systems is very significant. This requirement involves substantially more than delivering new computer hardware. A revamped software stack, including an operating system, programming models, libraries, and both modified and new IDCs, must be developed and delivered to leverage the new computer hardware. The IDCs, together with the underlying software and hardware stacks, must cope with the large number of interruptions expected on an exascale system, must execute efficiently with the delivered memory, and must use the unprecedented degree of parallelism.

C.5 Approach and Strategy

Historically, the HPC industry delivered new leading-edge systems every four to five years. However, usable exascale capabilities will require more than incremental improvements to current technologies. A usable exascale system will be much more difficult to achieve than previous generations of computing systems; however, these barriers can be overcome by adapting and augmenting past ASC and ASCR strategies. Those strategies have included research programs at universities, vendor-laboratory partnerships, development of hardware prototype systems (test beds), and strategic system acquisitions. Because of the complexity of exascale computing, these past strategies must be augmented by new efforts. The key thrusts of the new strategic approach are outlined below. Each thrust must be closely integrated with the other thrusts, as appropriate.

C.5.1 System Integration Research, Development, and Engineering

Computer processor vendors make substantial investments in well-defined technology paths. For HPC, they rely on partnerships and collaborations with system integrators and application developers to achieve the full potential of their technologies. As a result, HPC system integrators have significant experience in managing multiple partners on complex projects. The strength and depth of these partnerships will be critical to meeting the technical challenges that were discussed in Section C.3.

C.5.2 Hardware and Software Technology Research and Development

Hardware Technology. This activity will support cross-cutting research projects in industry, laboratories, and academia that are aimed at early-stage technology development to reduce the technical risks associated with exascale technologies that can meet mission application needs. These technologies include the processor, its memory subsystem, network interfaces, and the interconnection network. Software components specific to these hardware technologies, such as compilers or operating systems for the specific processors, must also be developed.

Software Technology. To achieve the full potential of exascale computing, a software stack must be developed that includes new programming models and metrics to evaluate system status, with a focus on new and revised implementations of applications. The scope of the software effort will span the spectrum of operating systems, runtimes for scheduling, memory management, file systems, and performance monitoring, as well as power management, resilience, computational libraries, compilers, programming models, and application frameworks. The software technology effort will not focus solely on exascale systems. Scalability, programmability, resilience, and code portability must be enabled to have the greatest impact on future HPC systems at any scale.

C.5.3 Exascale Co-Design

Given the challenges of achieving usable exascale computing, application code developers must recognize the trends and opportunities of emerging architecture designs and technologies; at the same time, platform providers must gain deeper understanding of the intended uses of the computers. This system-level design process between application developers and hardware developers is referred to as the co-design process. The co-design process seeks to ensure that future architectures are well suited to the target applications so that stockpile IDCs can take advantage of the emerging computer architectures. Through ASC and ASCR investments, some “Co-Design Centers” already have begun and will continue to perform exploratory research to co-design hardware and architecture, software stacks, and numerical methods and algorithms for mission applications, as well as to use co-design to determine technical tradeoffs in the design of exascale hardware, system software, and application codes.

C.6 Current Activities

ASC is currently collaborating with ASCR to address exascale challenges through the following activities:

System Integration Research, Development and Engineering. The ASC computing strategy [see Section C.11, 17] describes an ongoing acquisition plan for advanced technology and commodity technology systems. The advanced technology systems are expected to meet the mission requirements of the most challenging engineering and physics simulations for the stockpile. These systems are carefully designed to integrate new technologies that provide benefits beyond those available in existing commodity offerings. ASC plans to acquire new advanced technology computing platforms every two and a half years by replacing older systems once every five years at LANL and LLNL. The advanced technology platforms are harbingers and potentially prototypes of exascale architectures and will force IDCs to adapt to the new technology. Although important, these acquisitions and adaptive techniques are not sufficient to achieve a usable exascale system for stockpile stewardship. Focused hardware and software technology R&D and exascale co-design activities are also needed.

Hardware and Software Technology R&D. To ensure that exascale computing platforms will be suitable for evolving IDCs, directed vendor R&D is needed. Starting in FY 2012, DOE has awarded contracts to HPC vendors to address critical hardware and software technologies. These contracts, executed in collaboration with ASCR, are part of the "*DesignForward"* and "*FastForward"* programs and will continue through FY 2017. The *FastForward* program focuses on the long-lead-time R&D for exascale node and memory architectures. The *DesignForward* program focuses on exascale system networking technologies, conceptual design, and engineering issues. Together, the programs seek to maximize efficiencies in energy and concurrency while increasing the performance and reliability of key applications for both ASC and ASCR. The goal is to begin addressing the technologies most likely to impact HPC system performance over the next two to ten years.

Activities in ASC's ATDM subprogram address the need to explore the IDC transformations necessary for current and future "disruptive"[2] computer technologies. In FY 2015, each of the three NNSA national security laboratories began to develop a new IDC code to investigate new programming techniques. During this initial year, milestones will be achieved to identify the most promising program structures and to develop interfaces for input/output staging technologies. Subsequent-year milestones and other activities within ATDM have been designed to build upon each other to illuminate future architectural paths up to and including exascale for IDCs. The key long-term milestones are discussed in the next section.

A complementary effort to these IDC R&D activities is the creation of a viable software environment for next-generation codes. The needs and gaps identified in a milestone for a pre-exascale environment in FY 2015 will be incorporated as tasks in the ASC Implementation Plans that cover the FY 2016 FYNSP. These efforts in programming environments and tools, data analysis, input/output systems, networks and interconnects, and system monitoring will not fully support exascale computing, but they will be necessary as the HPC technology ultimately evolves to exascale.

Exascale Co-Design. The unifying foundation for all of these endeavors is co-design. The ASC tri-laboratory (LANL, LLNL, and SNL) co-design project began in 2012. The project members have completed a series of milestones since 2013. An important project activity is to interact with vendors, in particular those under the *DesignForward* and *FastForward* program contracts. Key communication vehicles for these interactions are the small proxy applications developed and supported by the co-design project teams to represent the computational or communication features of the IDCs. The proxy applications are used during "deep dives" held at vendor sites. The goal of the proxy applications and these deep dives is to influence vendor hardware and software capabilities and gain a deeper understanding of the architectural trends and their implications for the ASC code base. Enabled by these interactions, in FY 2014, ASC completed a milestone to study application performance on a set of emerging technologies. In FY 2015, ASC is focusing on developing ways to improve IDC performance on these technologies while retaining portability to future ASC computing systems.

[2] *These computer technologies are termed "disruptive" because they disrupt the computing ecosystem in a manner that is not conducive to scientific computing.*

C.7 Collaborative Management

As discussed in the introduction, ASC is partnering with DOE's ASCR to address exascale computing challenges.[3] ASCR is driving advances in science through the use of increasing HPC capabilities. Recognizing the strengths and synergies available through collaboration, ASC and ASCR have committed to joint planning and execution of several projects to tackle a common set of problems and achieve common objectives. This joint collaboration will eliminate duplication, focus the vendor community, decrease costs by increasing acquisition volumes, and improve solutions through the broad, combined experience and strengths of the two programs.

The approach is a single strategy to enable multiple missions. Joint activities include *FastForward*, *DesignForward*, HPC system procurement, and exascale planning. Shared co-design efforts have been selected for their broad impact on DOE mission applications. However, each mission area (ASC and ASCR) will continue to have its own unique challenges that must be addressed for full utilization of exascale resources. The development of new algorithms and approaches for applications will continue to be funded through ASC's Integrated Codes and ATDM subprograms, and ASCR's Scientific Discovery through Advanced Computing program will be funded through its Computer Science and Facilities portfolio. Budget authority for the current advanced technologies work, which is congruent with the path to exascale, continues to reside within the respective ASC and ASCR Programs.

C.8 Budget and Major Milestones

With the exception of platform acquisitions, funding for NNSA's advanced technologies work, which is congruent with the path to exascale, is through ATDM. This subprogram provides for development of new solutions to partially address the exascale technical challenges and to mitigate the risk that ASC codes will not run effectively on future HPC platforms. The activities in each year are scheduled to be consistent with the available funding. The budget also covers the ASC contributions to *FastForward* and *DesignForward* program contracts for stimulating HPC-specific technologies.

IDCs must fully use future exascale systems for stockpile calculations. The requirement in Table C–1 that IDC code performance be 100 times faster on an exascale system than on current ASC systems presents one of the greatest challenges to achieving usable exascale computing. In addition to the strategy outlined in Sections C.5 and C.7, ASC will tackle this challenge by adapting existing IDCs to new computing architectures and developing next-generation IDCs with fundamentally different infrastructures that are specifically designed for future computing architectures. ASC has developed several key milestones to ensure its code performance objective is achieved. These milestones represent advances in codes and computing systems to achieve a viable path to exascale, but provide enough technology that the codes have historically counted on to allow a smooth transition.

[3] *The NNSA Office of Defense Programs and the DOE Office of Science established a Memorandum of Understanding (MOU) in April 2011 to coordinate exascale computing activities. Under this MOU, the responsibility for an exascale initiative would be shared by the DOE Under Secretary for Science and the NNSA Administrator. A DOE Exascale Joint Coordination Group, established and led by the Director of ASC and the Director of ASCR, would ensure accountability of the Federal funds used, clarify lines of authority and reporting, and leverage existing infrastructure and resources.*

System Readiness Milestone (FY 2017). Deliver the Advanced Technology System (ATS)-1 (Trinity, at LANL) for production use.

System Readiness Milestone (FY 2019). Deliver ATS-2 (Sierra, at LLNL) for production use.

Code Performance Milestone (FY 2019). Demonstrate agile code development by running a single simulation (one for each laboratory) that is relevant to stockpile stewardship on at least 50 percent of the Knights Landing portion (composed of next-generation hardware) of ATS-1 within two years of the system's readiness for production simulations on the classified network.

Code Assessment Milestone (FY 2019). Evaluate both existing and next-generation IDCs for accuracy, efficiency, and scalability of the simulation results on the ATS-1 and ATS-2 computing platforms.

Code Performance Milestone (FY 2021). Demonstrate agile code development by running a single simulation (per laboratory) relevant to stockpile stewardship on at least 50 percent of ATS-2 within two years of the system's readiness for production simulations on the classified network. In addition, demonstrate that a single simulation can achieve significantly better performance than the same simulation on previous ASC platforms.

System Readiness Milestone (FY 2021). Deliver ATS-3 for production use.

Code Performance Milestone (FY 2023). Demonstrate agile code development by running a single simulation (per laboratory) relevant to stockpile stewardship on at least 50 percent of ATS-3 within two years of the system's readiness for production simulations on the classified network. In addition, demonstrate that a single simulation can achieve significantly better performance than the same simulation on previous ASC platforms.

In addition to the milestones outlined above, ASC is a key part of virtually every PCF pegpost (see Chapter 3, Figure 3–2, in the FY 2015 SSMP and Chapter 3, Figure 3–2, in this FY 2016 SSMP). Those pegposts will put additional focus on delivering effective platforms and codes to meet the needs of the stockpile.

The purpose of ATDM and the milestones described above is not to deliver a working exascale platform, but instead to help guide and develop advanced computing technologies for next-generation platforms and to mitigate the effects of these new technologies on the IDCs. As such, ATS-3, which will be ready for production use in FY 2021, is not expected to be an exascale system. However, to the degree that future budgets allow, NNSA participation in the (see Section C.10) may allow deployment of a usable exascale system within the next decade.

C.9 Risk Management

Key programmatic risks and associated mitigation approaches related to achieving exascale computing are identified in **Table C–2**.

Table C–2. Risks in achieving exascale computing

Risk	*Mitigation Strategy*
Exascale platform architecture is not usable by IDCs or does not deliver desired performance improvements for IDCs.	Develop proxy applications for IDCs and follow proven processes for co-design. Develop new IDCs with fundamentally different infrastructures for future computing technologies. Track success per baseline metrics and interim target values throughout the project.
Exascale platform uses too much power.	Increase the likelihood that required technological breakthroughs and advances will occur by funding multiple potential technologies.
Exascale platform is unreliable.	Invest in robust, multi-layered approaches (hardware, operating systems, system software infrastructure, application codes, *etc.*) to manage or resolve faults.
Exascale platform architecture departs significantly from expected designs after investment in R&D of software, tools, and algorithms based on expected designs.	Develop clearly defined communication channels with vendors and use those channels to communicate regularly and effectively to ensure that participants are well informed regarding the evolving architectures and new directions.
Software environments do not satisfy IDC needs.	Determine workload requirements by developing proxy applications. Engage vendors, ASCR laboratories, and universities to encourage development of software environments that meet proxy application requirements.
Proxy applications do not sufficiently represent full IDC requirements.	Obtain hardware prototype systems (test beds) and regularly test and determine differences between proxy application performance and IDC performance. Identify weaknesses and modify proxy applications, IDCs, and/or metrics appropriately.
Key algorithms that do not scale may not have timely, suitable alternatives.	Invest in early exploratory algorithms research and in multiple research paths for the most critical algorithms.
Vendor default	Engage multiple vendors in research, development, and acquisitions.

ASCR = Office of Science Advanced Scientific Computing Research
IDC = Integrated Design Codes
R&D = research and development

C.10 Conclusion

The computational simulation capability that ASC provides in the form of IDCs is a key integrating element for weapon physics and engineering assessments of the Nation's stockpile. Although the current predictive capability of IDCs is sufficient for today's mission, issues such as aging, advanced and additive manufacturing, and other changes to the stockpile will require IDCs to be more predictive. A critical element for improved predictive capability is next-generation computing, specifically exascale computing.

However, developing a usable exascale computing system is a tremendous challenge. Driven by market forces in consumer electronics and faced with physical limitations in microprocessors, the computing industry is driving toward immensely complex computer architectures composed of massive, multi-core processors with inadequate memory systems. NNSA's ASC is navigating this complex landscape by working aggressively with computer vendors and co-designing hardware, software, and IDCs and by developing software technologies to mitigate the impact on IDCs. ASC is making steady progress. When the NSCI is funded, this progress will accelerate substantially and will increase the clout of HPC within the marketplace by providing “trickle-down” benefits for both the nuclear security enterprise and the desktop computer user community.

NNSA’s plan to address these challenges, as outlined in this appendix, is being and will continue to be executed in close collaboration with DOE’s ASCR to leverage the strengths of each organization.

C.11 References

1. *Top Ten Exascale Research Challenges*, DOE ASCAC Subcommittee Report (February 10, 2014).
2. *Technical Challenges of Exascale Computing,* JASON Report JSR-12-310 (April 2013).
3. *Report of the Task Force on High Performance Computing of the Secretary of Energy Advisory Board* (August 10, 2014).
4. *The Future of Computing Performance, Game Over or Next Level*, National Research Council of the National Academies' Report (2011).
5. *Exascale Software Study: Software Challenges in Extreme Scale Systems,* DARPA (September 14, 2009).
6. *Exascale Computing Study: Technology Challenges in Achieving Exascale Systems,* DARPA Technical Report (2008).
7. *Modeling and Simulation at the Exascale for Energy and the Environment Town Hall Meetings Report,* Workshop report from the Grand Challenges Series of Workshops, Lawrence Berkeley National Laboratory (April 17-18, 2007).
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9. *Challenges for the Understanding the Quantum Universe and the Role of Computing at the Extreme Scale* Workshop report from the Grand Challenges Series of Workshops, Menlo Park, CA (December 9-11, 2008).
10. *Forefront Questions in Nuclear Science and the Role of Computing at the Extreme Scale,* Workshop report from the Grand Challenges Series of Workshops, Washington, D.C. (January 26-28, 2009).
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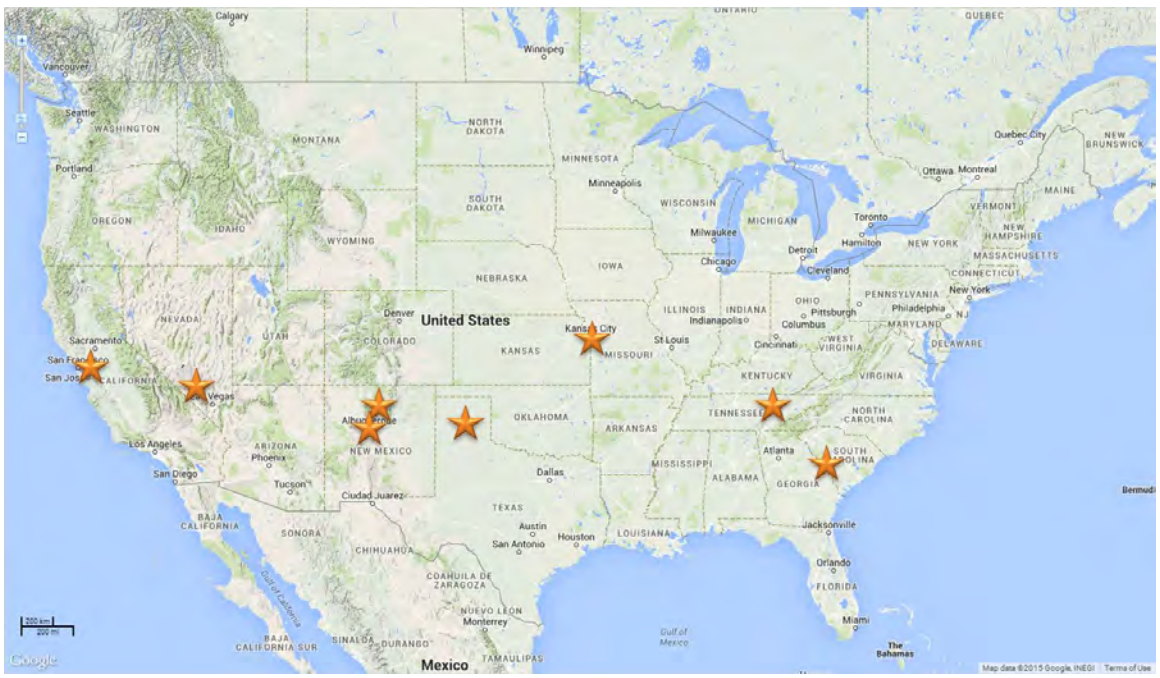
12. *Science-Based Nuclear Energy Systems Enabled by Advanced Modeling and Simulation at the Extreme Scale,* Workshop report from the Grand Challenges Series of Workshops, Washington, D.C. (May 11-12, 2009).
13. *Opportunities in Biology at the Extreme Scale of Computing,* Workshop report from the Grand Challenges Series of Workshops, Chicago, IL (August 17-19, 2009).
14. *Scientific Grand Challenges in National Security: The Role of Computing at the Extreme Scale,* NNSA workshop report from the Grand Challenges Series of workshops, Washington, D.C. (October 6-8, 2009).
15. *Architectures and Technology for Extreme Scale Computing* Workshop report from the Grand Challenge Series of Workshops, San Diego, CA (December 8-10, 2009).
16. *Cross-cutting Technologies for Computing at the Exascale,* Workshop report from Grand Challenge Series of Workshops, Washington, D.C. (February 2-4, 2010).

17. J.A. Ang, P.J. Henning, T.T. Hoang, R. Neely, *Advanced Simulation and Computing: Computing Strategy* (2013).

18. *Preliminary Conceptual Design for an Exascale Computing Initiative,* Meeting of Advanced Scientific Advisory Committee (November 21, 2014) (http://science.energy.gov/ascr/ascac/meetings/november-2014).

Appendix D
Workforce and Site-Specific Information

NNSA has enhanced this year's workforce appendix by including a brief primer on the eight nuclear security enterprise sites. NNSA has three national security laboratories (LLNL, LANL, and SNL), four nuclear weapons production facilities (NSC, Pantex, SRS, and Y-12), and the test site (Nevada National Security Site). These sites, spread across the Nation, possess the expert workforce and advanced capabilities that provide the Nation's nuclear deterrent. Specific information is included in this appendix to familiarize stakeholders and the public with each site's mission, mission capabilities, FY 2016 budget request, physical infrastructure,[1] and workforce.



The Secretary of Energy formed the National Laboratory Operations Board (LOB) in 2013, as an agency priority goal, to restructure the relationships and interactions between the Department, the DOE national laboratories, and sites to ensure the continued status as world-class research institutions best able to achieve DOE's mission, maximize the impact of Federal R&D investment, accelerate the transfer of technology into the private and Government sectors, and better respond to opportunities and challenges. In support of this goal, DOE has established the National Laboratory Policy Council to address high-level policy challenges and develop initiatives to build and focus the laboratory system on

[1] *Detailed information about NNSA's approach to planning and management of physical infrastructure can be found in Chapter 4, "Revitalize Physical Infrastructure."*

critical economic, research, and national security priorities. In addition, the National Laboratory Operations Board (LOB) has been created to address operational and administrative issues.

A Working Group of the LOB was developed to assess how the infrastructure is meeting the mission related needs of the DOE/NNSA complex. One of the highest priorities identified by the LOB was the need to revitalize general purpose infrastructure. An integrated plan to conduct a site-wide assessment of general purpose infrastructure across all DOE national security laboratories and NNSA nuclear weapons production facilities was conducted; for the first time, common standards and an enterprise-wide approach was used. The assessments provided a detailed, uniform analysis of facilities and other infrastructure and provided information for decisions on future investments. This assessment included qualitative ratings of asset conditions as adequate, substandard, or inadequate. The LOB assessments provide a holistic view of the DOE infrastructure, in addition to the traditional metric of Deferred (DM)/Replacement Value (RPV), by going beyond physical condition and considering the suitability of the facility for its current mission. The findings from these assessments are included for each site in Appendix D.

With respect to the workforce, NNSA and its M&O partners developed a new methodology for analyzing the FY 2016 SSMP data collection that, as in previous years, is based on the Common Occupational Classification System (COCS). This new methodology has the following advantages:

- It reflects a common understanding of the data across the eight NNSA sites.
- It provides a much simpler process that is supported across the eight sites.
- It leverages established procedures and functions.
- It more closely aligns with the way historical data have routinely been collected by the sites.
- It allows accurate, consistent, and timely response to congressional legislation.

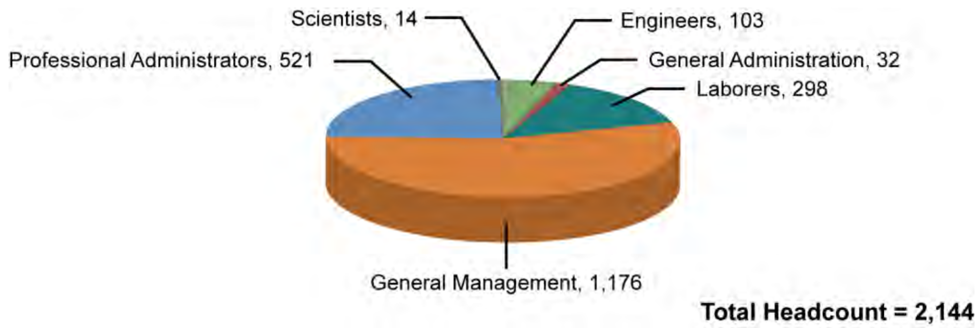
With the exception of SRS and the Nevada National Security Site,[2] the data represent NNSA's total site headcount information (as opposed to calculated full-time equivalent [FTE]) information for permanent career employees[3] to better reflect the total site effort for the assigned mission scope.

[2] The data in this SSMP do not include about 5,000 staff who support the DOE Environmental Management part of the Savannah River Site or about 290 Centerra-Nevada service contractors who provide security at the Nevada National Security Site.

[3] For consistency across the M&O sites, headcount numbers only include permanent career employees and do not include students, post-doctoral scholars, or temporary or contract employees.

D.1 National Nuclear Security Administration

D.1.1 Federal Workforce



Notes:

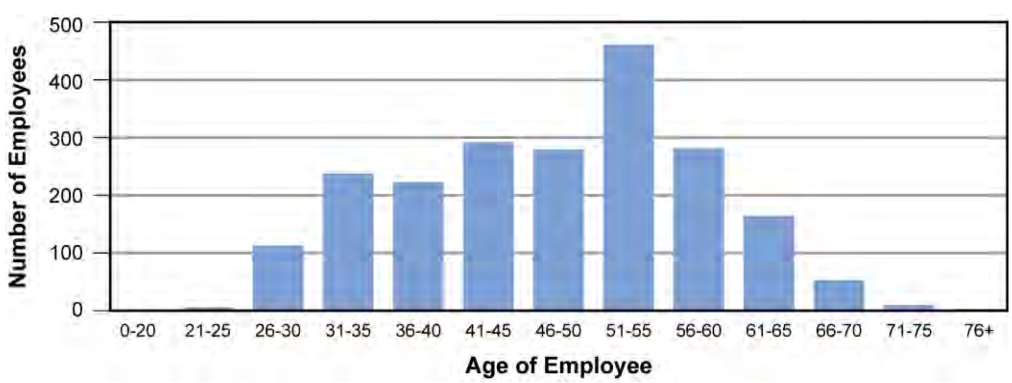
Includes all NNSA (Federal Salaries and Expenses [formerly known as the Office of the Administrator] and STA) employees, except Naval Reactors.

The National Defense Authorization Act (NDAA) for FY 2015 capped the total number of Federal employees under Federal Salaries and Expenses at 1,690 FTEs by October 2015. The total headcount of 2,144 includes 1,587 under Federal Salaries and Expenses and 557 in STA.

NNSA is pursuing a moderate recruitment effort focused on its most urgent needs, which include entry-level and some student hiring. Rather than creating a "one size fits all" program for entry-level and student hiring, line managers are being empowered with a robust set of choices.

Recent workforce planning activities recommended that NNSA's out-year growth should focus on acquisitions occupations, where benchmarks demonstrate a need and oversight, as well as planning for Defense Programs.

Figure D–1. Federal total headcount



Notes:

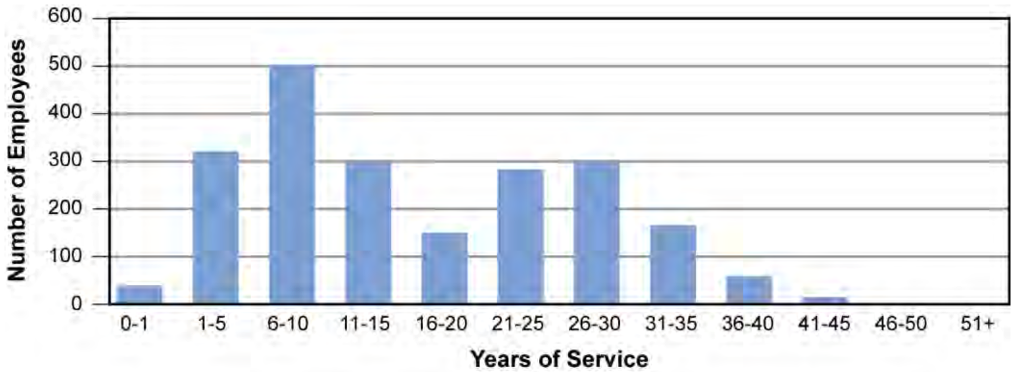
The ages of NNSA employees is skewed toward the high end, especially considering that the average retirement age is about 54 years.

The data set includes approximately 319 nuclear materials couriers who are, on average, younger than the rest of the workforce.

Ninety-two percent of this courier workforce is 26 to 45 years old, causing the data to be skewed to the left.

Challenges associated with an aging workforce have been identified and are addressed in the same manner as for years of service challenges.

Figure D–2. Federal employees by age



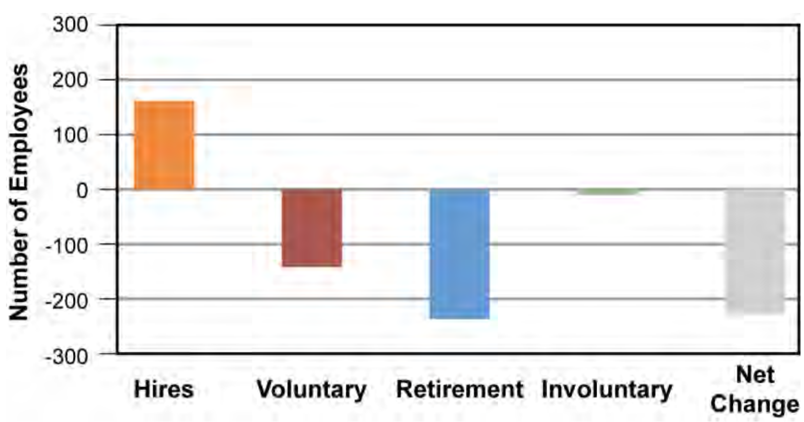
Notes:

The NNSA Federal workforce has a bimodal distribution, with large numbers of employees in the youngest and oldest age ranges and fewer in the mid-range. This presents some risk because of an "experience gap" in the valley between the two peaks. On the left side of the bimodal distribution, 802 experienced employees have 6 to 15 years of service, which represents an opportunity to manage the risk through knowledge transfer and mentoring.

NNSA will use knowledge-capture techniques and processes to record, understand, and transfer the invaluable experience and knowledge of its aging workforce.

NNSA recognizes the need for effective leadership, performance measures, and management consistency as well as an increased focus on training at the entry, middle, and executive levels and an increased flexibility and adaptability among its current staff.

Figure D–3. Federal employees by years of service



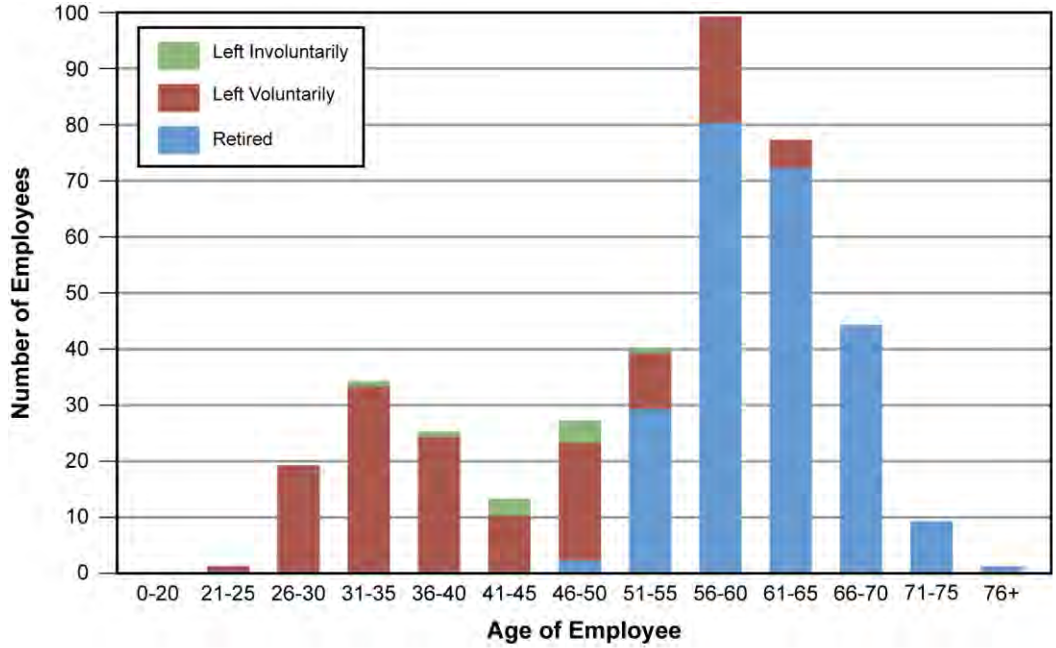
Notes:

NNSA, like many other Federal agencies, has experienced staff reductions caused by budget shortfalls over the past two years. NNSA severely constrained and froze hiring to cope with funding uncertainties (sequestration and continuing resolutions in FY 2013 and FY 2014) and to address skills mix issues.

The NDAA for FY 2015 capped the total number of Federal employees under Federal Salaries and Expenses at 1,690 FTEs by October 2015, excluding STA and the Office of Naval Reactors.

The NDAA 1,690-FTE cap represents a 12.3 percent reduction from the previous FY 2010 target of 1,926. This downward trend in the cap is constraining the workforce and yet offers an opportunity to reshape the Federal workforce's oversight and program management roles. (The Federal staff as of October 2014 totaled 1,587 FTEs under Federal Salaries and Expenses, which is below the 1.690 cap for October 2015.)

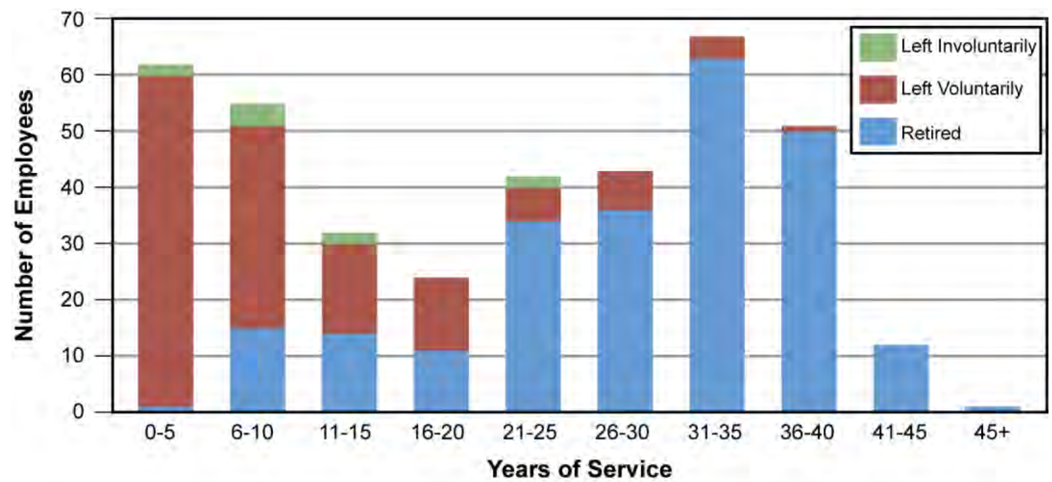
Figure D–4. Change in last two fiscal years for Federal employees (end of FY 2012 to end of FY 2014)



Notes:

To address the challenges presented by the retirement of highly experienced personnel, NNSA will use knowledge-capture processes and techniques to interview, record, and transfer the invaluable experience and knowledge of the late-career workforce.

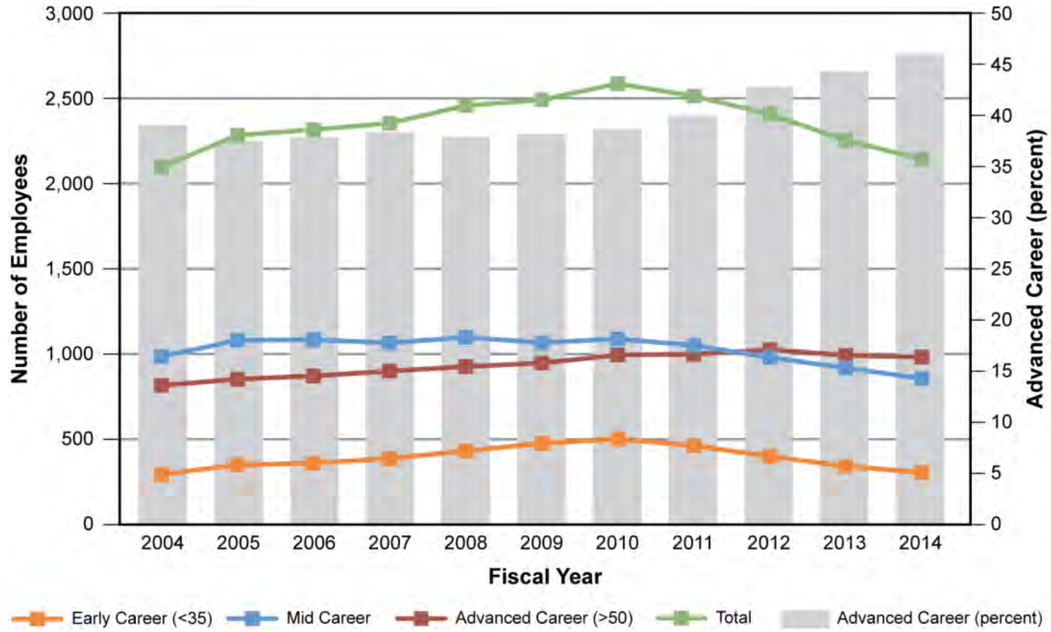
Figure D–5. Age of Federal employees who left service (end of FY 2012 to end of FY 2014)



Notes:

The loss of employees with less than 10 years of experience, coupled with the loss of employees with 20+ years of service from retirement, must be addressed to maintain a viable workforce.

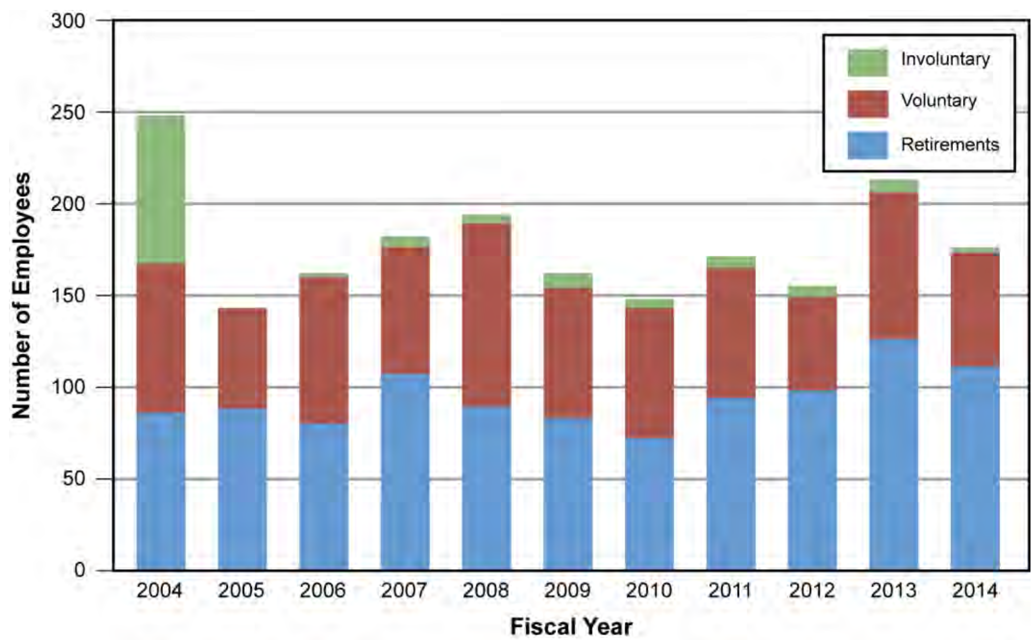
Figure D–6. Years of service of Federal employees who left service (end of FY 2012 to end of FY 2014)



Notes:

Less than 50 percent of the total Federal employee population is in the advanced-career stage. Only 14 percent is in the early-career stage. In FY 2010 a hiring spike caused an upward trend in these statistics, but the overall trend has since been downward.

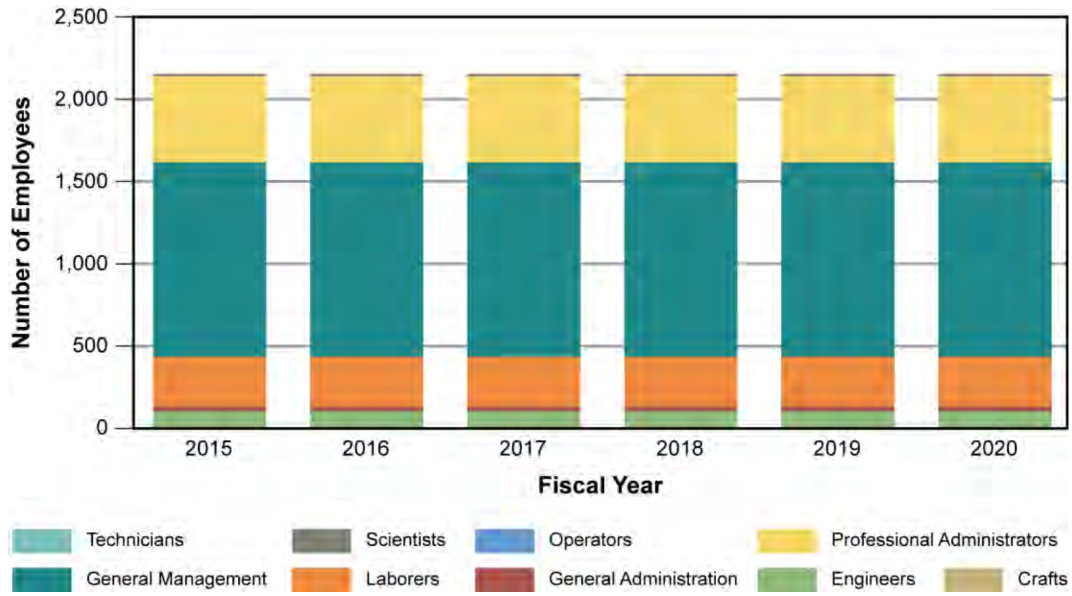
Figure D–7. Federal employees trends by career stage



Notes:

The rate of retirement has increased in the last two years and should remain slightly higher in the coming years, thereby creating a unique opportunity to reshape the workforce.

Figure D–8. Federal employment separation trends



Notes:

The staff in Federal Salaries and Expenses as of October 2014 totaled 1,587, which was below the authorized level of 1,690, thereby creating an opportunity to hire 103 new staff.

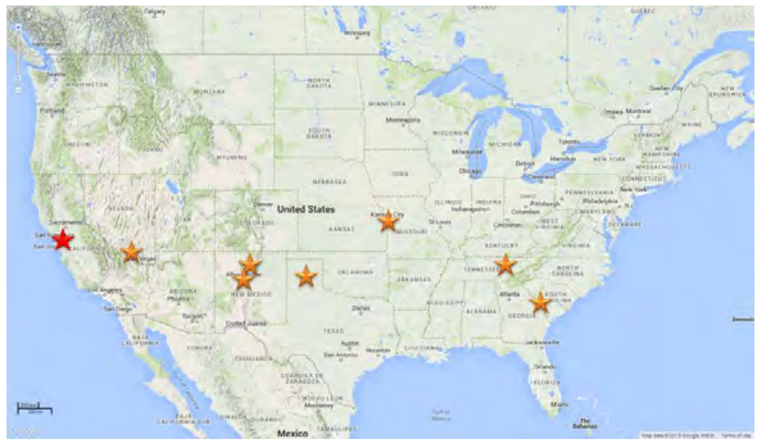
Figure D–9. Total projected Federal workforce needs by COCS over FYNSP

D.2 National Security Laboratories

D.2.1 Lawrence Livermore National Laboratory

D.2.1.1 Mission

Lawrence Livermore National Laboratory (LLNL) is located in Livermore, California, where it was founded by the University of California in 1952. DOE sponsors LLNL as a Federally Funded Research and Development Center (FFRDC) to provide special long-term research and development needs for the nuclear stockpile and a broad range of other national security capabilities integral to the mission and operation of the Department. LLNL is managed by Lawrence Livermore National Security, LLC.



LLNL is committed to strengthening the Nation's security through development and application of world-class science and technology to:

- enhance the Nation's defense;
- reduce the global threat from terrorism and weapons of mass destruction; and
- respond with vision, quality, integrity, and technical excellence to scientific issues of national importance.

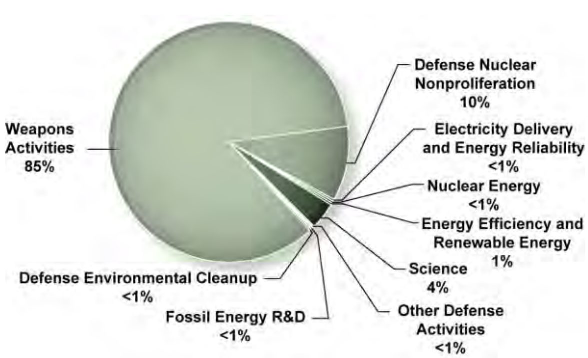
While LLNL's defining responsibility is ensuring the safety, security, and effectiveness of the Nation's nuclear deterrent, its science and engineering capabilities are being applied to achieve breakthroughs against a broad range of threats to national security and global stability in the areas of counterterrorism and nonproliferation, defense and intelligence, energy and environmental security.

Locations: Main site, Livermore, California (Site 200); Experimental Test Site, Tracy, California (Site 300)

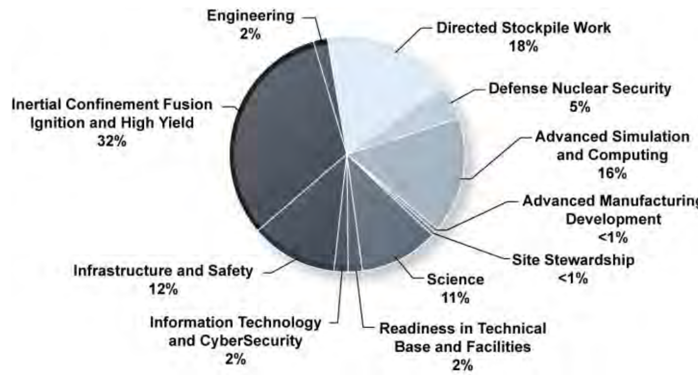
- Total employees: 5,290
- Type: Multi-program national security laboratory
- Web site: www.llnl.gov
- Contract Operator: Lawrence Livermore National Security, LLC
- Responsible Field Office: Livermore Field Office

D.2.1.2 Funding

FY 2016 Site Funding by Source
(Total LLNL FY 2016 Request $1,184.2 M)



FY 2016 FYNSP for Weapons Activities
($1,008.6 M)



D.2.1.3 Mission Capabilities

LLNL is an NNSA Center of Excellence for Nuclear Design and Engineering with core competencies in high explosives (HE) R&D, high energy density (HED) physics, and high performance computing (HPC). NNSA has recently announced LLNL as the lead laboratory for the W80-4 (formerly the cruise missile warhead) and W78-1 LEPs.

LLNL has unique capabilities that relate to design and development of stockpile systems, including:

- design, certification, testing, and surveillance of the nuclear stockpile;
- reliability assessments and certification of stockpile weapons;
- plutonium R&D;
- tritium operations and R&D;
- HE R&D;
- HED physics;
- HPC;
- destructive and nondestructive surveillance evaluations on pits to evaluate their reliability;
- advanced materials;
- nuclear counterterrorism; and
- nuclear nonproliferation.

LLNL has several NNSA flagship facilities such as NIF, CFF, the Superblock, the Livermore Computing Center, and HEAF.

These experimental and computational capabilities enable scientific and engineering staff to conduct research, design, and development of nuclear weapons; provide safety, security, and reliability assessments and certification of stockpile weapons; develop and evaluate analytical and simulation tools; design and test advanced technology concepts and prototypes including 3D advanced manufacturing capabilities; and conduct R&D in the areas of plutonium, tritium, HE, and environmental and hydrodynamic testing. The capabilities also support work in homeland security, energy, and environmental bioscience, and biotechnology areas.

D.2.1.4 Revitalizing Physical Infrastructure

LLNL is located about 50 miles east of San Francisco at the outskirts of the City of Livermore in Alameda County. It has been in operation since 1952 on the 1-square-mile site at Livermore (Site 200), with the addition in 1955 of the 7,000-acre remote test site (Site 300), located 17 miles east of Livermore.

LLNL's current infrastructure consists of 490 buildings and trailers, with an additional 146 other structures and facilities. The structures combined at both sites occupy approximately 6.96 million gross square feet (gsf). The infrastructure portfolio includes 29 mission-critical facilities and key NNSA flagship programmatic research facilities such as NIF, HEAF, the High Performance Computing Center, and CFF.

NNSA Real Property

LLNL Ten-Year Site Plan FY 2014

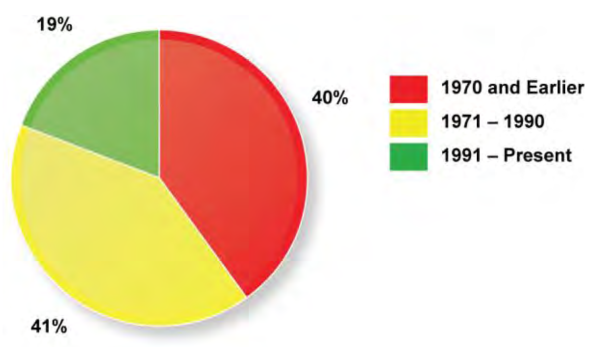
- 7,727 acres (owned)
- 490 Buildings/trailers
  - 6,363,217 gsf active and operational
  - 566,869 gsf nonoperational
  - 29,932 gsf leased
- Replacement plant value: $6,836,994,531
- Deferred maintenance: $484,529,077

Many of LLNL's permanent facilities are reaching their end of life and therefore require refurbishment, modernization, or replacement. Targeted infrastructure reinvestment is being made to meet mission deliverables, sustain mission-supportive RDT&E excellence, and support LLNL's special multidisciplinary capabilities.

LLNL has been able to sustain nearly 100 percent availability of its mission-critical and mission-dependent facilities that are managed under the RTBF Program. Future funding projections will balance modernization and reinvestment in this aging infrastructure.

With future investments, LLNL will continue to focus on real property sustainment, major system replacement, and modernization and consolidation with associated demolition of antiquated and unused facilities. With a balanced investment portfolio, the deferred maintenance backlog will continue to decrease and will therefore enhance LLNL's ability to accomplish its mission.

Age of General Purpose Infrastructure



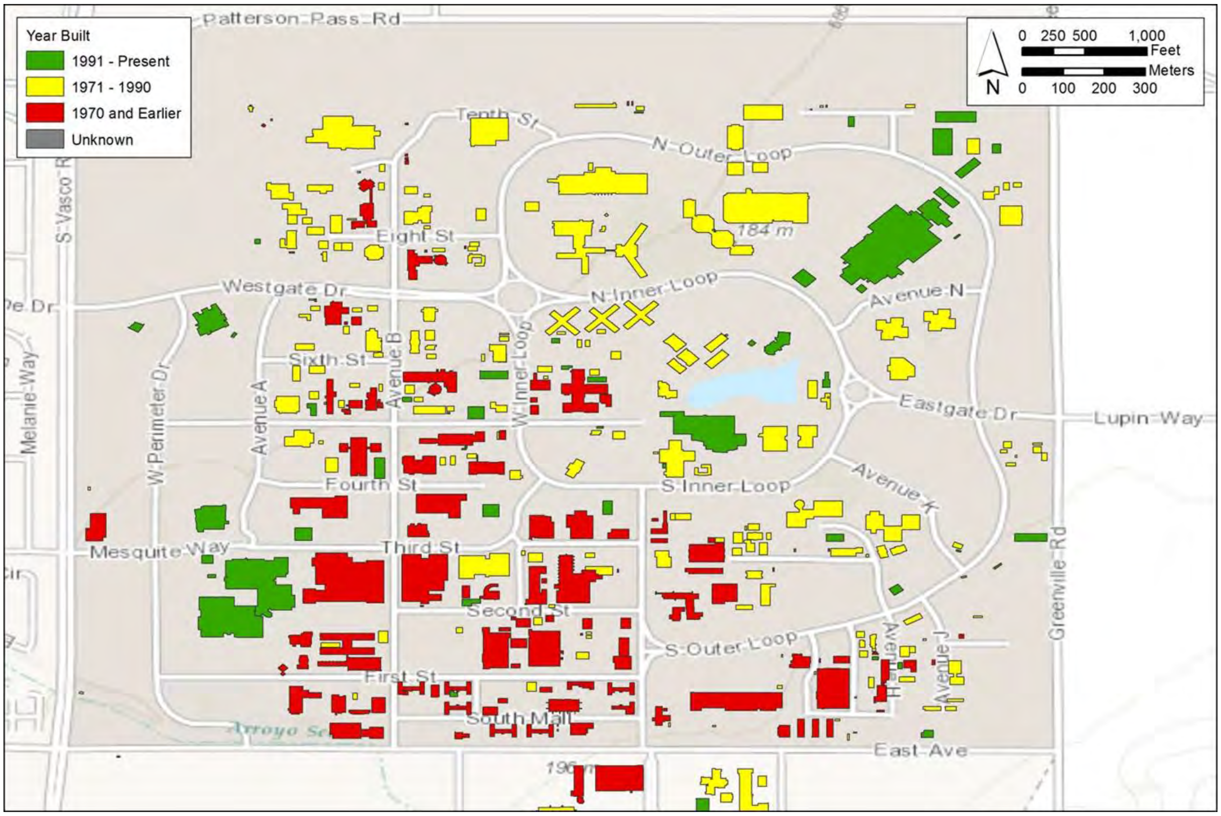
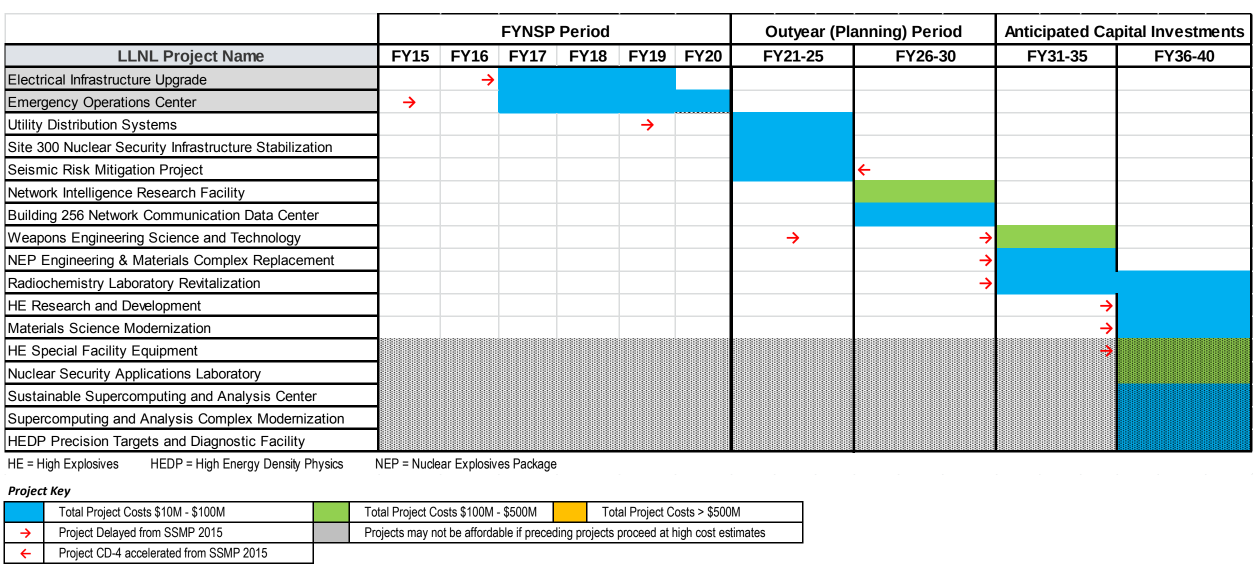


Figure D–10. LLNL age of facility assets in Site 200, Livermore, California

Facility Conditions and Deferred Maintenance

LLNL has a strategy to manage its deferred maintenance through effective facility management practices, including an aggressive internal reinvestment program. A key element of this strategy is an annual prioritization process to focus limited funding on the most important maintenance replacements. The deferred maintenance, as reported in the *LLNL Ten-Year Site Plan FY 2014 – FY 2023*, is currently $484,529,077.



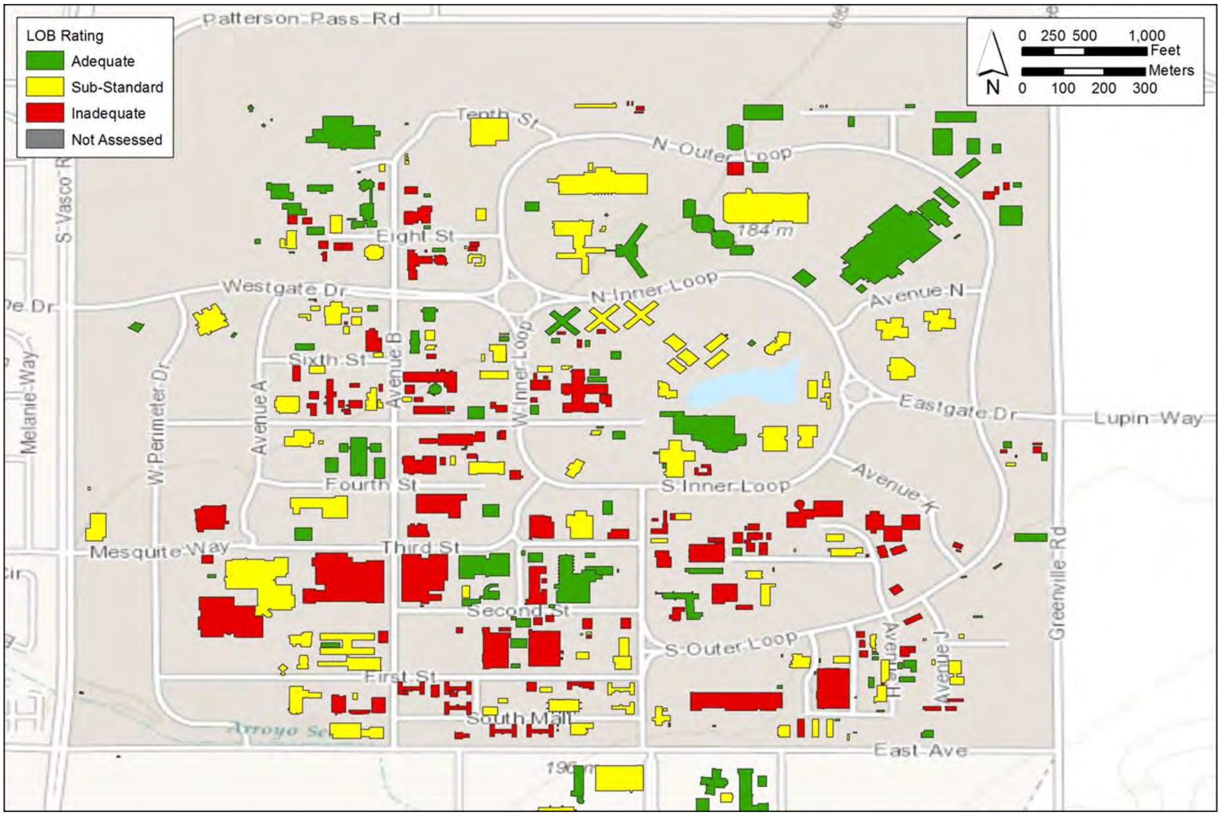
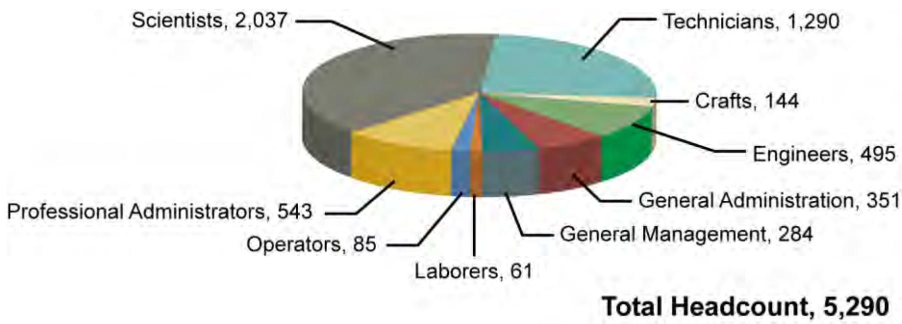


Figure D–11. Laboratory Operating Board rating for LLNL facility assets in Site 200, Livermore, California

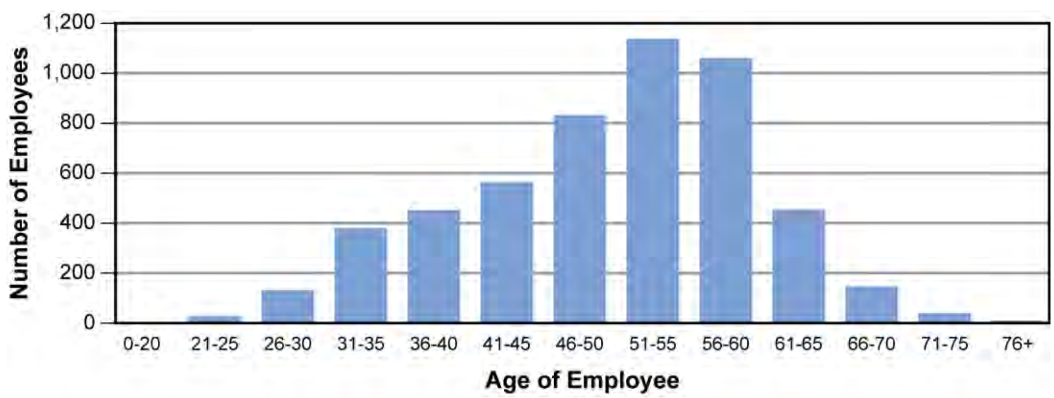
D.2.1.5 Lawrence Livermore National Laboratory Workforce



Notes:

The LLNL population has a large fraction of scientists and engineers engaged in RDT&E.

Figure D–12. LLNL total headcount



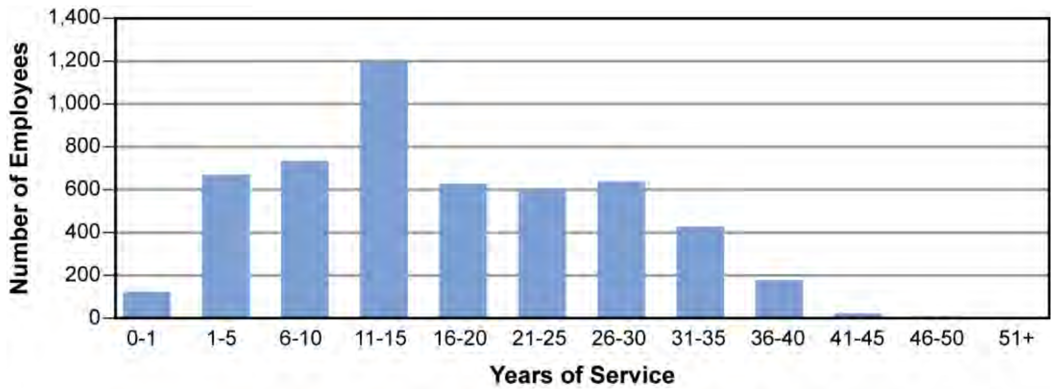
Notes:

The LLNL workforce overall average age is 50.5 years old with a median age of 52 years old.

About 60 percent of the population is over 50 years old.

Given the aging demographics at LLNL, succession planning is critical for knowledge preservation.

Figure D–13. LLNL employees by age



Notes:

The laboratory average for years of service is 17.4.

About 36 percent of the population has over 21 years of service.

Figure D–14. LLNL employees by years of service

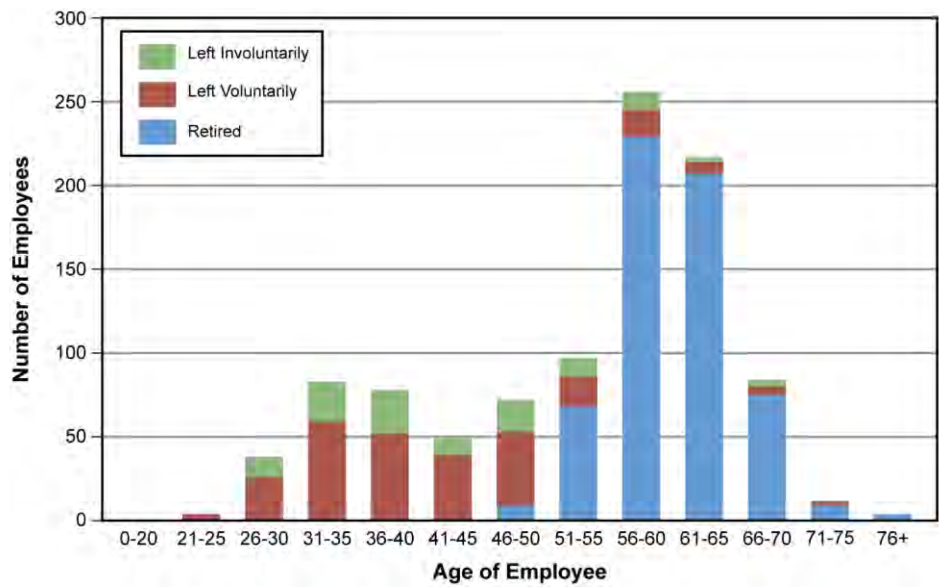
Notes:

Three-quarters of the net workforce reduction resulted from retirements.

The remaining workforce reduction was caused by other factors, including a Security Organization restructuring and a self-select voluntary separation plan.

There was a spike in early retirements in FY 2013. Replacements were not hired because of the decline in the budget.

Figure D–15. Change in last two fiscal years at LLNL (end of FY 2012 to end of FY 2014)

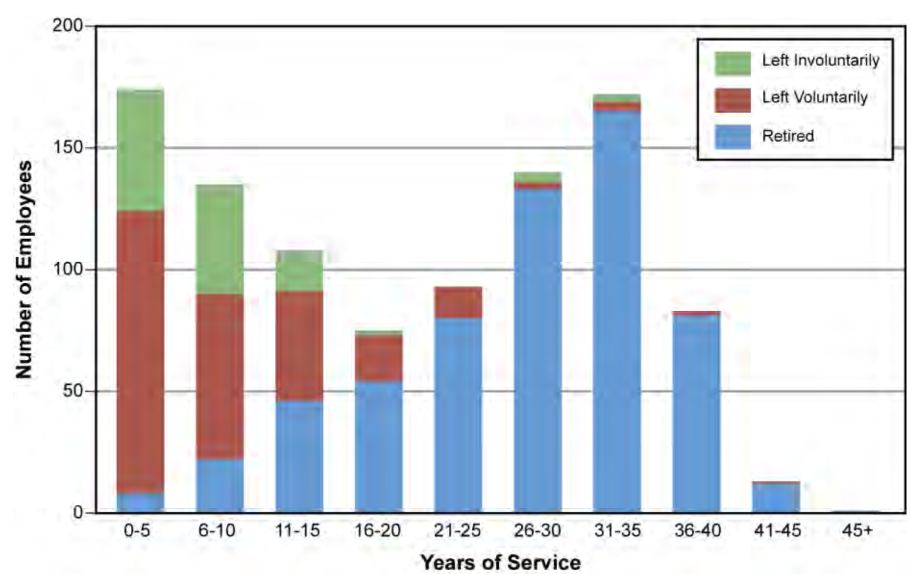


Notes:

A large fraction of the staff between 30 and 50 years of age retired early during the voluntary phase of the workforce reduction plan.

A high percentage of younger, early-career staff also voluntarily left service during this period.

Figure D–16. Age of LLNL employees who left service (end of FY 2012 to end of FY 2014)

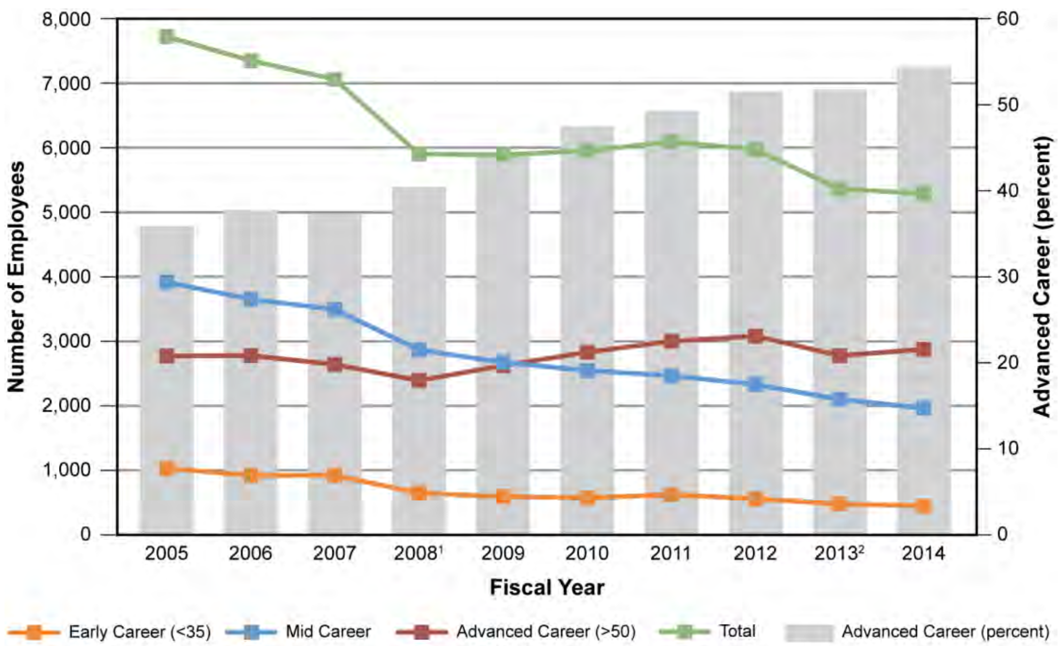


Notes:

A large fraction of the late-career employees left LLNL.

A high percentage of early career staff also voluntarily left service during this period.

Figure D–17. Years of service of LLNL employees who left service (end of FY 2012 to end of FY 2014)



[1] A decrease of 16.4% due to contract transition to LLNS from UC and implementation of an Involuntary Separation Plan.
[2] A decrease of 10.2% due to a restructuring in the Security Organization and the SSVSP.

Notes:

LLNL scientific and technical population decreased by more than 30 percent in the last decade.

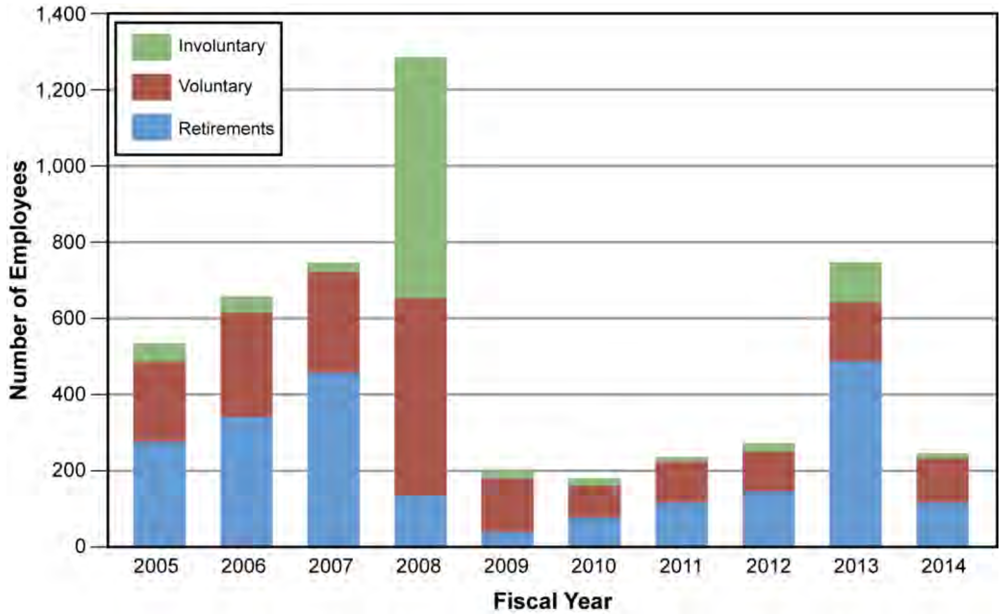
The biggest change in the population was during FY 2008, when LLNL went through a contract transition to Lawrence Livermore National Security, LLC from the University of California. This resulted in a 16.4 percent workforce reduction.

In FY 2013 LLNL experienced another significant decrease of 10.2 percent caused by a restructuring in the Security Organization and the self-select voluntary separation plan (SSVSP).

The LLNL aging population is also a concern; 55 percent are over 50 years old.

The LLNL strategy for knowledge preservation and succession planning is critical.

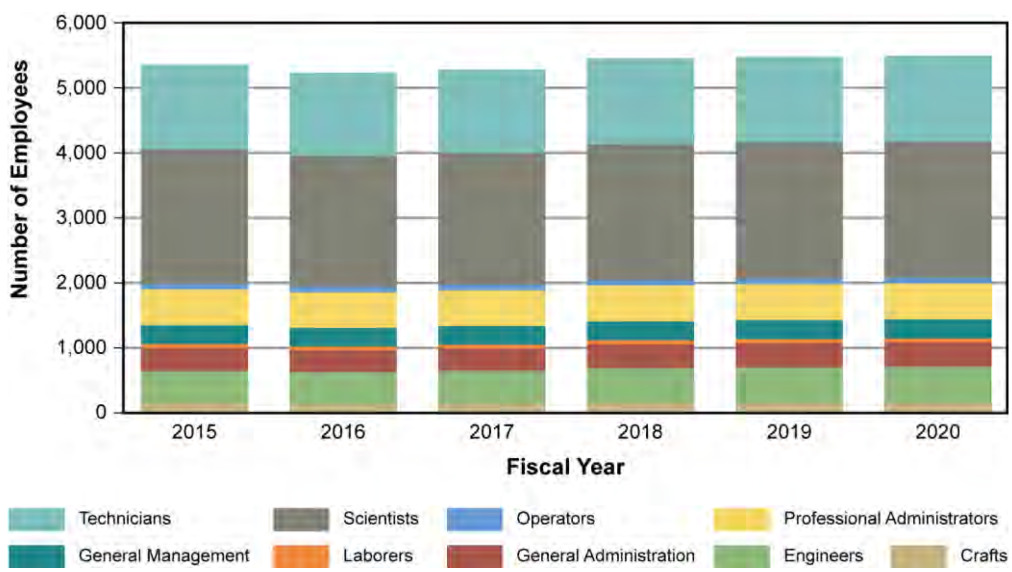
Figure D–18. LLNL trends by career stage



Notes:

The separations in FY 2008 were caused by the contract transition from the University of California to Lawrence Livermore National Security, LLC and the associated Involuntary Separation Program. The increase in FY 2013 was caused by the Security Restructuring and the self-select voluntary separation plan.

Figure D–19. LLNL employment separation trends



Notes:

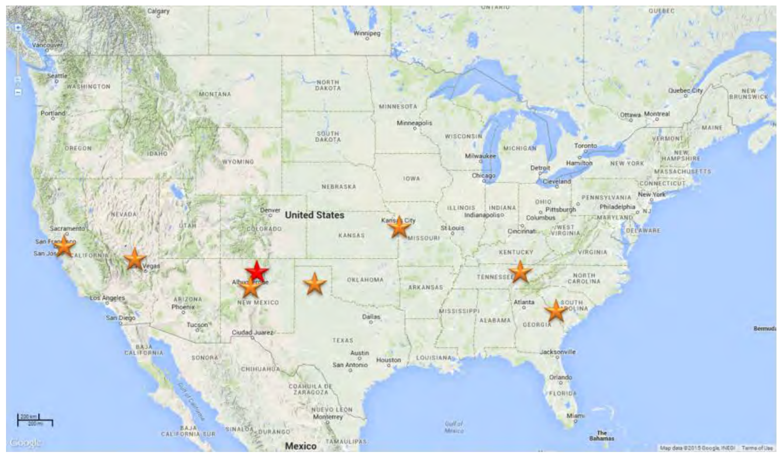
The LLNL workforce is projected to grow slightly over the FYNSP period to meet the laboratory missions and anticipated scope increase associated with the W80-4 LEP nuclear design and certification activities.

Figure D–20. Total projected LLNL workforce needs by COCS over FYNSP

D.2.2 Los Alamos National Laboratory

D.2.2.1 Mission

Los Alamos National Laboratory (LANL), founded in 1943 during World War II as Project Y, served as a secret facility to perform scientific research necessary to develop the first nuclear weapon. The site was chosen because the area was remote and provided controlled access and safety for testing purposes. The Manhattan Project's research and development efforts, which were previously spread throughout the Nation, became centralized at LANL. In 1945, the world's first nuclear device was detonated 200 miles south of LANL.



LANL conducts research, design, and development of nuclear weapons; designs and tests advanced technology concepts; provides safety, security, and reliability assessments and certification of stockpile weapons; maintains production capabilities for plutonium components (*i.e.*, pits) for delivery to the stockpile; manufactures nuclear weapon detonators for the stockpile; conducts plutonium, tritium, surrogate material, HE R&D, hydrodynamic experiments, and environmental testing; and stores Category I/II[1] quantities of SNM. LANL also conducts destructive and nondestructive surveillance evaluations on pits to assess their reliability.

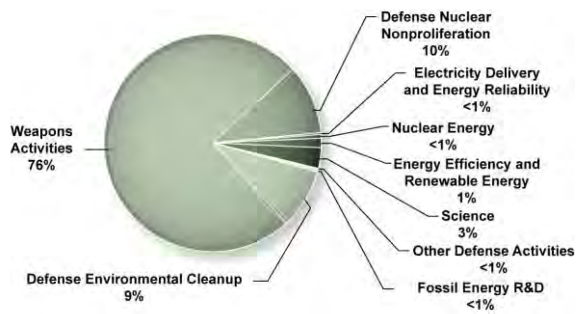
In addition to nuclear weapons stewardship, LANL's mission includes nuclear nonproliferation and counterterrorism, particle accelerator development, health physics, fusion power research, and supercomputing capabilities. Notably, in the field of health research, LANL recently made breakthroughs on a potential HIV/AIDS vaccine and cancer detection and treatment technologies.

- Location: Los Alamos, New Mexico
- Type: Multi-program national security laboratory
- Total employees: 6,739
- Web site: www.lanl.gov
- Contract Operator: Los Alamos National Security, LLC
- Responsible Field Office: Los Alamos Field Office

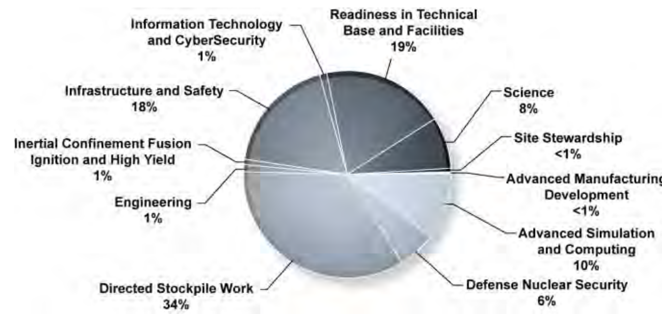
[1] *DOE Order 474.2, Nuclear Material Control and Accountability, Attachment 2, Page 3 provides the Graded Safeguards Table that must be used when determining the categorization and attractiveness level of accountable nuclear material. DOE provides additional information at https://www.directives.doe.gov/directives-documents/400-series/0474.2-BOrder-AdmChg2.*

D.2.2.2 Funding

FY 2016 Site Funding by Source
(Total LANL FY 2016 Request = $2,141.0 M)



FY 2016 FYNSP for Weapons Activities
($1,616.9 M)



D.2.2.3 Mission Capabilities

Following the end of World War II, LANL expanded operations while continuing to provide significant contributions to the Nation's science and defense programs. A unique array of facilities and infrastructure was built during the Cold War to accommodate weapons science R&D. Many of those unique facilities are now obsolete and are planned for either upgrade, refurbishment, or replacement to sustain LANL's core capabilities which include:

- design, certification, testing, experiments, surveillance, and the RDT&E base;
- plutonium;
- tritium;
- HE;
- non-nuclear components;
- accountability, storage, protection, handling, and disposition of SNM;
- enabling infrastructure; and
- counterterrorism and counterproliferation.

D.2.2.4 Revitalizing Physical Infrastructure

LANL is engaged in revitalizing key infrastructure to continue to fulfill its diverse, complex, and evolving national security missions. Highlights of LANL's revitalization of its physical infrastructure include the following:

- **Plutonium Strategy.** LANL developed a plutonium strategy that has been approved by NNSA and endorsed by the Nuclear Weapons Council. This strategy was developed following deferral of the CMRR-NF project in FY 2012. LANL is currently pursuing an infrastructure approach that transfers capabilities from the CMR Building and will reduce operational risks in PF-4. The strategy to terminate operations in the CMR Building

NNSA Real Property
LANL Ten-Year Site Plan FY 2014
(End of FY 2012 FIMS Reporting)

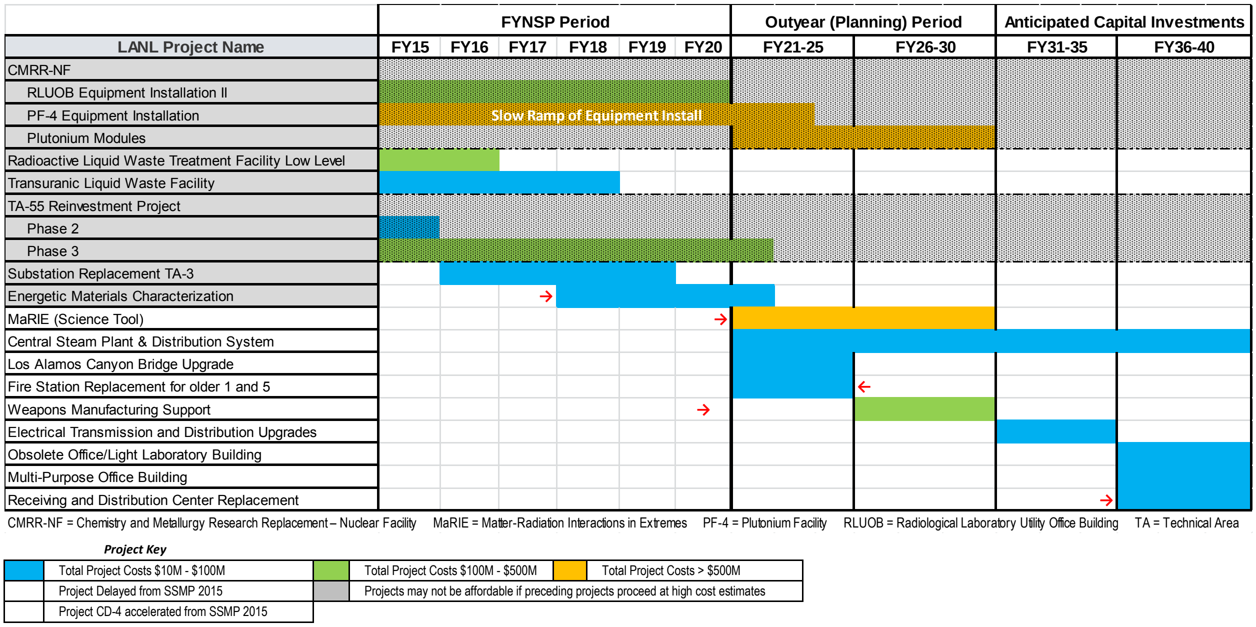
- 28,116 Acres (leased/owned)[1]
- 1,063 Buildings/trailers
  - 7,925,911 gsf active and operational[2]
  - 303,748 gsf nonoperational[2]
  - 471,622 gsf leased
- Replacement plant value: $14,058,722,390[3]
- Deferred maintenance: $1,190,514,100[2]

1. Per FY 2012 FIMS Snapshot
2. DOE-owned real property (buildings, trailers, other structures)
3. DOE-owned real property and leased facilities

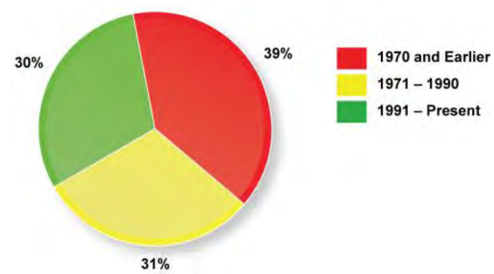
includes (1) maximizing the use of RLUOB by installing additional equipment and (2) repurposing underused laboratory space in PF-4. A future step may include constructing modular additions to the TA-55 facility network. LANL has initiated steps 1 and 2, and has been directed by NNSA to initiate DOE Acquisition Decision Milestone, CD-0, Approve Mission Need.

- **TA-55 Reinvestment Project II.** This project will revitalize aging mechanical, safety, facility controls, and other systems.
- **Transuranic Waste Facility**. The Transuranic Waste Facility project will provide a replacement facility to stage, characterize, and certify newly generated transuranic waste as a result of the closure of TA-54, Area G.
- **Radioactive Liquid Waste Treatment Facility Project**. This project will replace radioactive liquid waste treatment capabilities at TA-50. The final design for this low-level-waste capability was completed, and the project is in construction.
- **Electrical Infrastructure Upgrades**. This project will replace the TA-3 substation and expand electrical distribution systems for mission loads at TA-3 and the Metropolis Center. CD-1 was attained; the CD-2/3 package for the project is in preparation for capital funding in FY 2016.
- **Energetic Materials Characterization Facility**. The Energetic Materials Characterization Facility (EMCF) provides reliable and efficient infrastructure to conduct energetic material research, development, and analysis that is critical to current and future needs in stockpile surveillance, surety, safety, the LEPs and other, broader national security needs. The Energetic Materials Characterization Facility will result in an enduring, modern capability able to address a broad range of questions, needs and applications including analysis of unique HE-driven reactions. Additionally, the Energetic Materials Characterization Facility will result in decreased deferred maintenance and cost savings related to consolidation and higher-efficiency facilities.

LANL will continue to take substantial steps to streamline its operations, modernize its infrastructure, and fulfill its vision of being the premier national security laboratory. In addition, further revitalization is being planned for LANL’s other technical areas to support the increasing core capability workload. Preconceptual planning is being conducted for a signature science facility, Matter-Radiation Interactions in Extremes (MaRIE).



Age of Assets and General Purpose Infrastructure



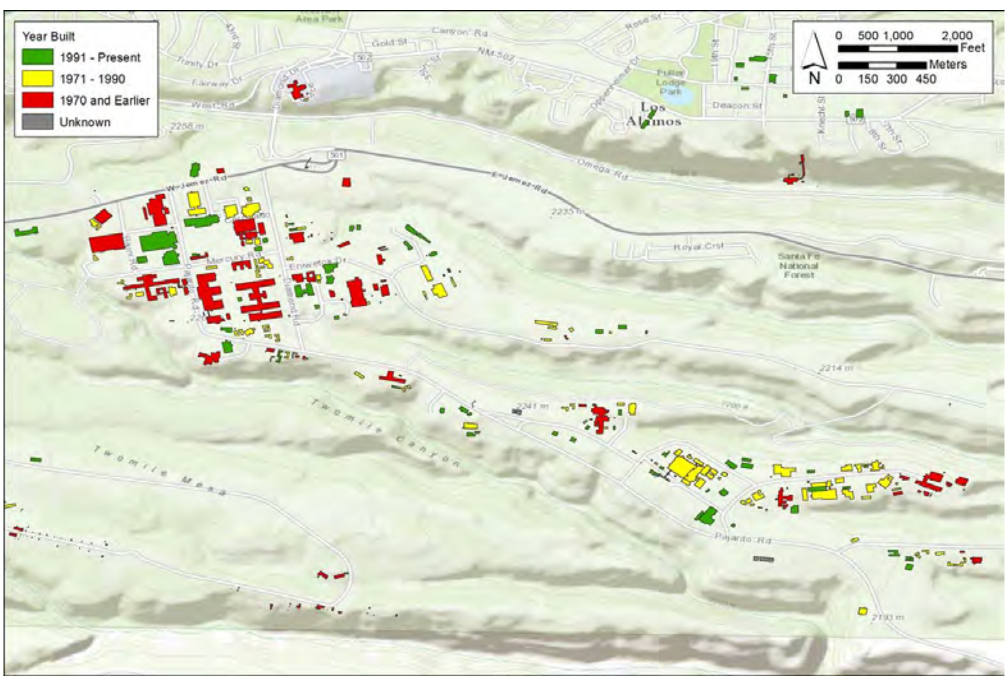


Figure D–21. LANL age of facility assets in TA-3, Los Alamos, New Mexico

Condition of Assets and Deferred Maintenance

LANL is currently conducting mission work in facilities that were constructed in virtually every decade, including the Manhattan Project and the Cold War eras. Overall, LANL's facilities are rated as "adequate," based on the ratio of the site's deferred maintenance backlog to the replacement plant value. Facilities that support mainly Defense Programs missions are in better condition, with an overall rating of "good." Targeted reinvestment in Defense Programs assets through the RTBF Program over the last decade has helped maintain these structures to ensure they are fully capable of supporting the current mission needs. However, consolidation planning, footprint reduction, and recapitalization programs should be accelerated to outpace facility aging and degradation in the face of infrastructure budget reductions.

As with all the older sites, aged facilities and funding constraints have resulted in a substantial backlog of maintenance. The estimate for deferred maintenance, as reported in the LANL Ten-Year Site Plan FY 2014 – FY 2023, is currently $1,190,514,100. Roughly 72 percent of the deferred maintenance captured in the FIMS is within facilities and utility systems that will endure into the foreseeable future for LANL missions—36 percent in facilities and 36 percent in utility systems. It is important for the site to prioritize and perform corrective maintenance based on the needs of the programs. Urgent maintenance tied to safety and security does not get deferred. However, 28 percent of the deferred maintenance is within facilities that are awaiting funds for demolition or facilities that are not intended for continued use.

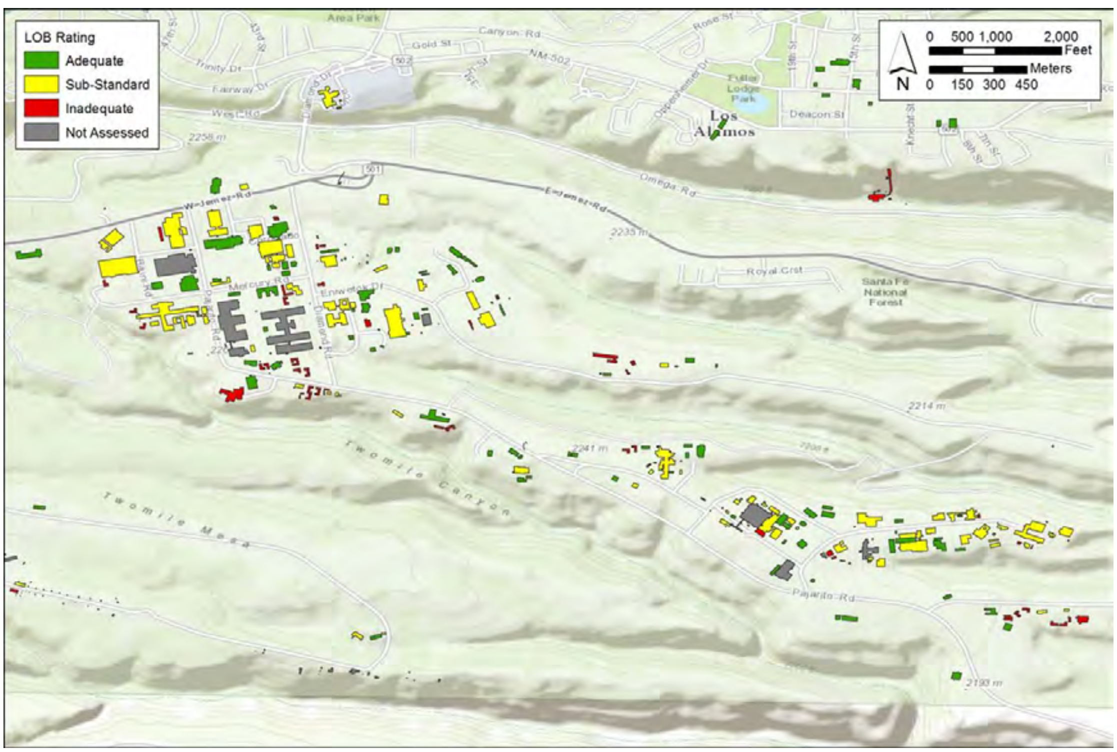
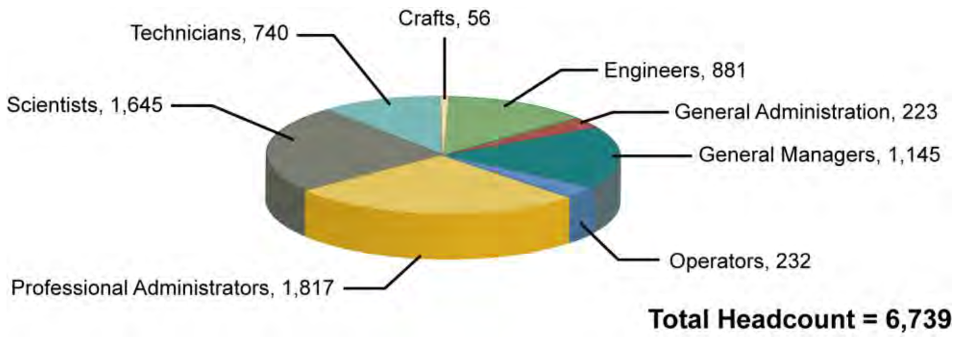


Figure D–22. Laboratory Operating Board rating for LANL facility assets in TA-3, Los Alamos, New Mexico

D.2.2.5 Los Alamos National Laboratory Workforce

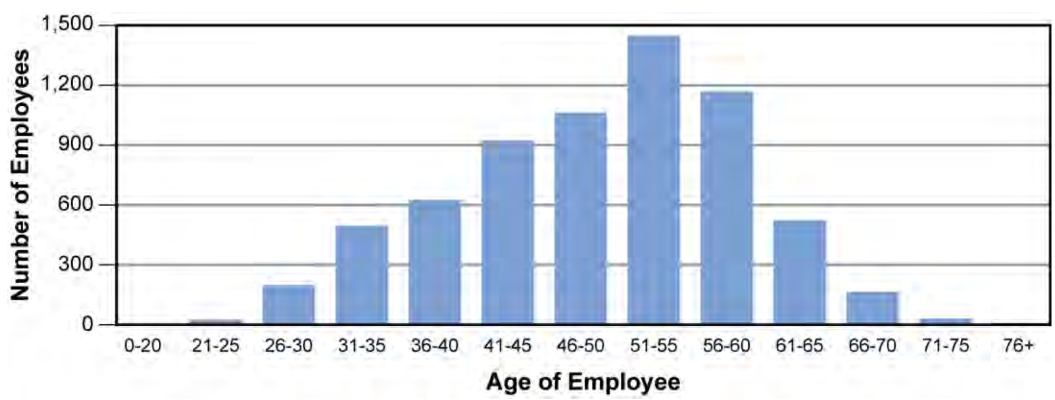


Notes:

The LANL total site headcount is spread across five main directorates, including the Weapons Program; Global Security; Science Technology and Engineering; Operations; and Capital Projects.

The Weapons Program, Global Security, and Science Technology and Engineering directorates benefit from significant leveraging of scientific capabilities and expertise. Ultimately, this leveraging provides synergy among capabilities and results in a greater work capacity with fewer people.

Figure D–23. LANL total headcount

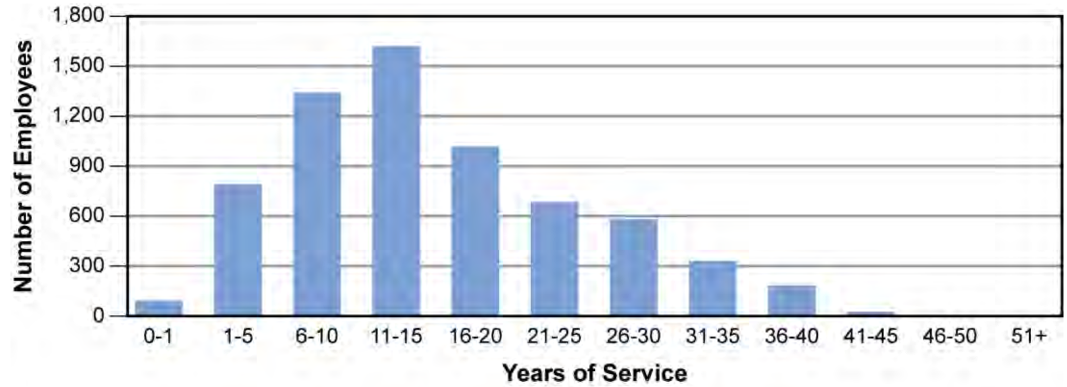


Notes:

"Retirement-eligible," for an employee with a pension, is defined as an employee at least 50 years of age who has at least 5 years of LANL service. For those without a pension, it is defined as 59.5 years of age.

The current age distribution indicates that LANL should pursue normal replacement hiring for the next several years with an increase in five to ten years to replace the largest current distribution of employees who will become retirement-eligible in the next five to seven years.

Figure D–24. LANL employees by age

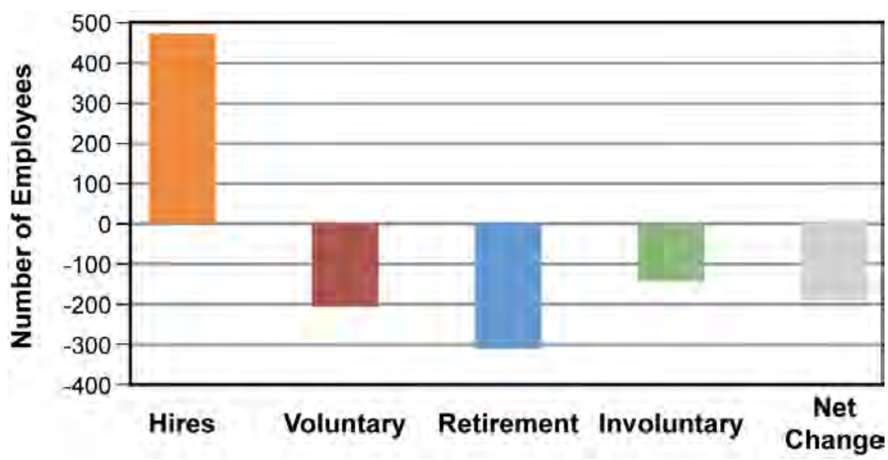


Notes:

This distribution reflects a portion of the outcome of the 2012 Voluntary Separation Program.

The primary focus is to retain the employees with 10 to 15 years of service to provide a sufficient future population for mentoring and critical skills development.

Figure D–25. LANL employees by years of service



Notes:

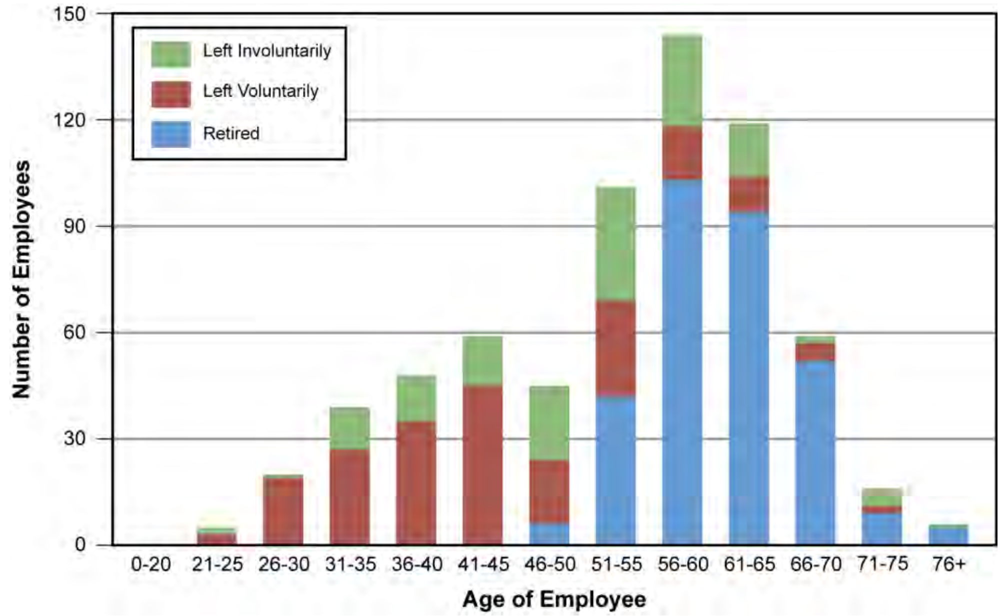
An additional eight individuals left career positions to take temporary positions elsewhere at LANL. Those individuals do not appear here as terminated, but also do not appear in the 2014 headcount because they no longer qualify.

The overall decrease results from restaffing in critical skills areas after completion of the 2012 Voluntary Separation Program.

A key goal for retention is preventing voluntary separations from exceeding retirements. This goal, if successful, would retain more early and mid-career employees for the future.

A primary challenge to acquiring and retaining younger employees is the perceived lack of appeal of Northern New Mexico as a vibrant place to live.

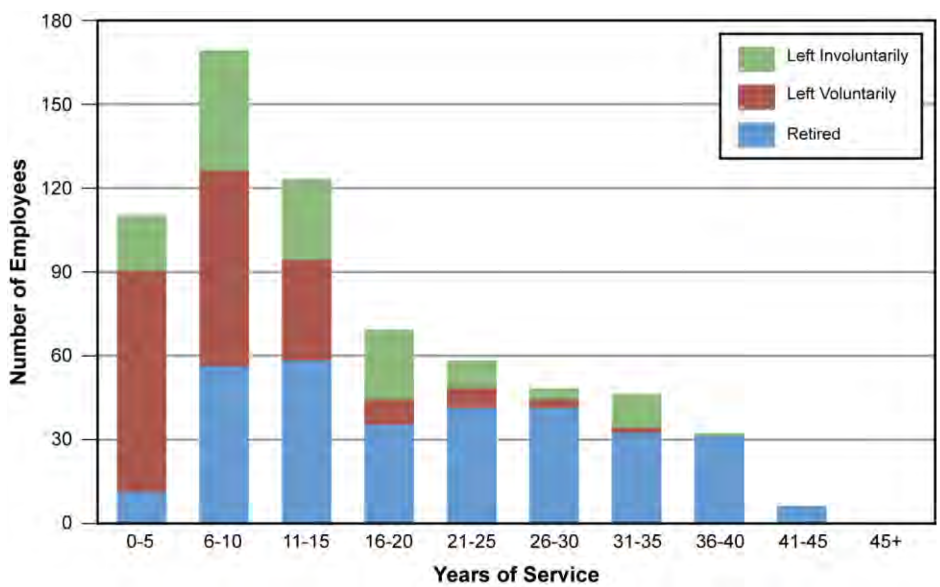
Figure D–26. Change in last two fiscal years at LANL (end of FY 2012 to end of FY 2014)



Notes:

Involuntary separations and retirements reflect a portion of the 2012 Voluntary Separation Program outcome.

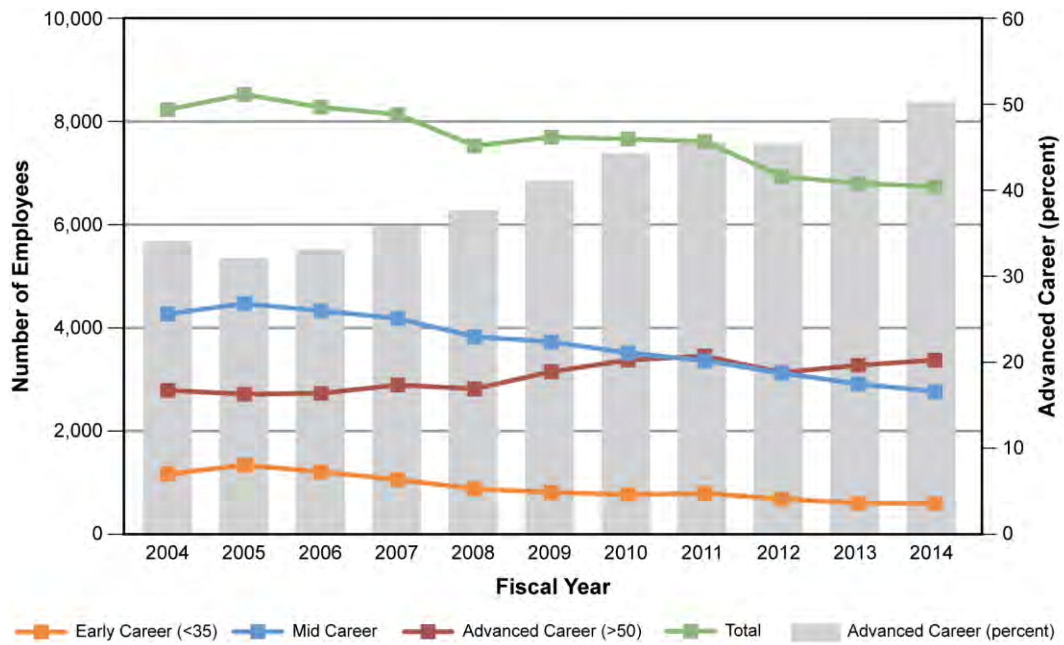
Figure D–27. Age of LANL employees who left service (end of FY 2012 to end of FY 2014)



Notes:

Data support the concern that greater numbers of newer employees are voluntarily separating. Contributing factors include concerns about longevity in observance of and reaction to the 2012 Voluntary Separation Program, as well as national trends in the restructuring and reduction of benefits that may discourage younger employees from remaining with one employer for an entire career.

Figure D–28. Years of service of LANL employees who left service (end of FY 2012 to end of FY 2014)



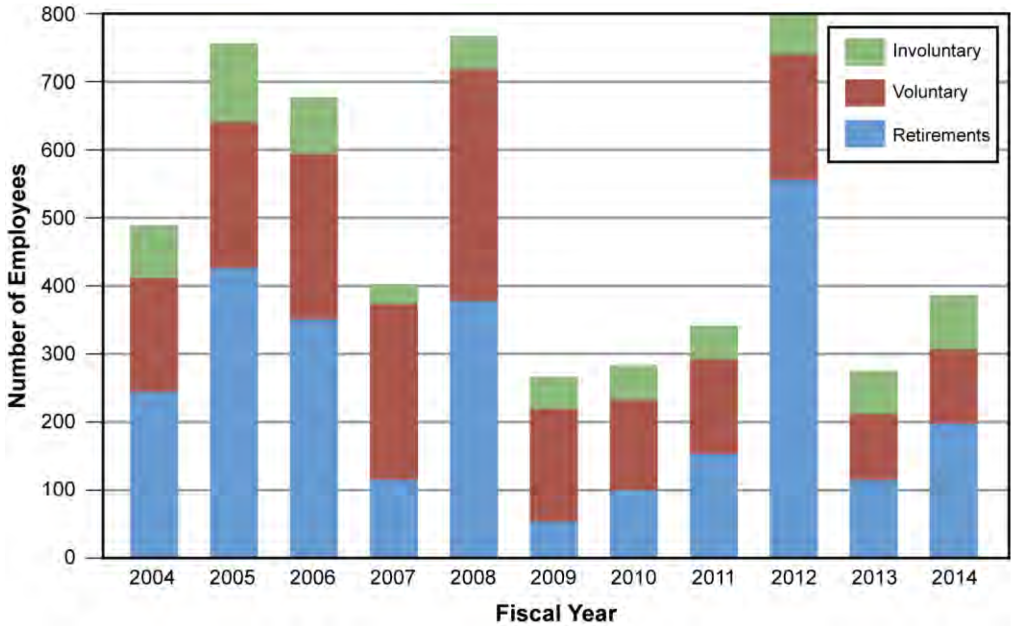
Notes:

Two events are reflected by the inflection points in the data—one in 2008 and the other in 2012. In both cases, these points represent a voluntary termination incentive plan designed to reduce the headcount to meet reduced budget allocations.

The continued downward pressure in the budget makes it more difficult to hire a diverse group of early-career employees to provide continuity as the advanced career employees retire.

In addition, the data show mid-career numbers are continuing to fall and the early-career numbers are barely being maintained. Since the contract change in 2006, mid-career numbers had the most significant downward shift. Some of the shift relates to the ability to retain mid-career employees who have concerns about contract uncertainty.

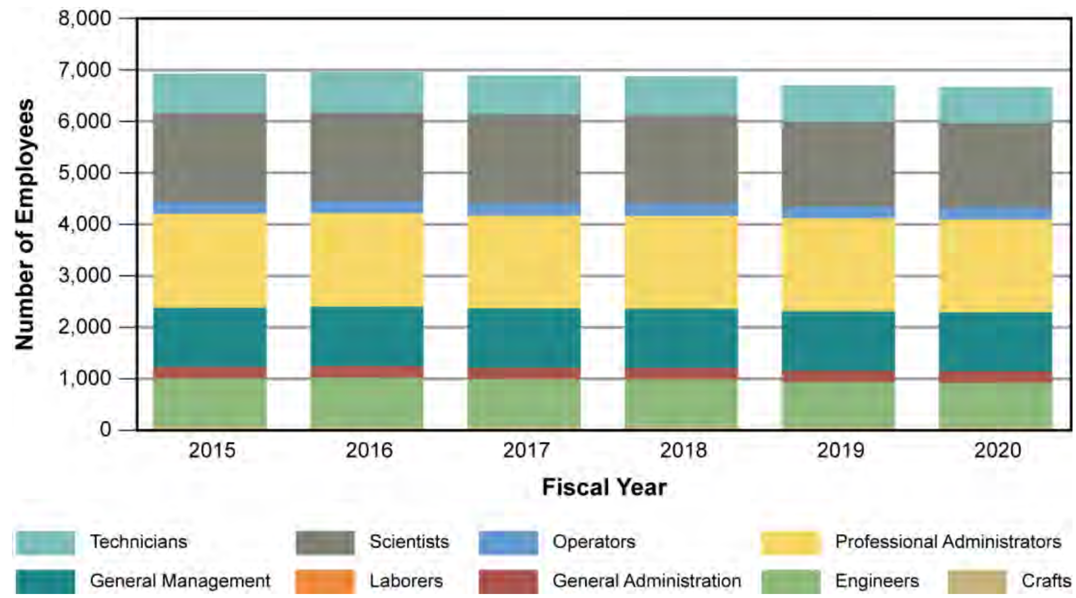
Figure D–29. LANL trends by career stage



Notes:

The uncertainty leading up to June 2006, when Los Alamos National Security, LLC assumed responsibility for the LANL contract, drove the retirement rates to a level higher than normal. Two separation incentives—one in 2008 and one in 2012—mainly attracted retirement-eligible staff.

Figure D–30. LANL employment separation trends



Notes:

LANL plans for and manages workforce types and numbers based on actual, current-year funding, projected funding and scope through the FYNSP, and its workforce demographics and skill analyses to ensure continuity of essential skills for stockpile stewardship.

The following are two funding scenarios:

- If actual funding is below projection, LANL may have to take short-term action—at a cost—to achieve affordability, such as the FY 2012 Voluntary Separation Program.
- If actual funding is higher than projected, LANL must have action plans to ensure the workforce and/or staff augmentation contracts will be sufficient to meet the scope associated with the increased funding.

In cases where actual funding received was significantly lower, LANL has historically implemented the following strategies to minimize involuntary workforce reductions:

- Determining whether the funding shortage can be resolved through efficiencies.
- Conducting internal reviews of avoidable costs and deferred procurements during the period of lower-than-expected funding.

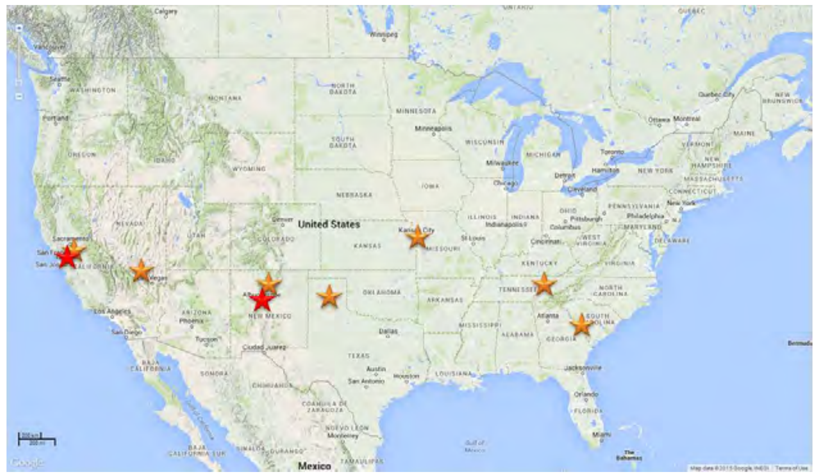
In the 2012 time frame, after experiencing a significant funding shortfall, LANL formally instituted the Laboratory Integrated Stewardship Council to evaluate staffing and procurement proposals. In summary, to avoid the impacts when actual funding falls below projections, LANL executes an internal system to first mitigate the reduction before reducing the headcount.

Figure D–31. Total projected LANL workforce needs by COCS over FYNSP

D.2.3 Sandia National Laboratories

D.2.3.1 Mission

Sandia National Laboratory (SNL) began in 1945 as Z Division, the ordnance design, testing, and assembly arm of Project Y (which after World War II became Los Alamos Scientific Laboratory). Z Division was renamed Sandia Laboratory in 1948 and, in 1949, Sandia Corporation was established as an AT&T subsidiary to manage the laboratory through a no-fee contract. In 1956, a second site was opened in California's Livermore Valley. In 1979, Congress designated Sandia Laboratory as a DOE national laboratory. SNL has been operated by Lockheed Martin (or its predecessor) since 1993. As a national security laboratory and a Federally Funded Research and Development Center (FFRDC), SNL accomplishes tasks integral to the mission and operation of its sponsoring agencies by:



- anticipating and resolving emerging national security challenges,
- innovating and discovering new technologies to strengthen the Nation's technological superiority,
- creating value through products and services that solve national security challenges, and
- informing the national debate where technology policy is critical to preserving national security

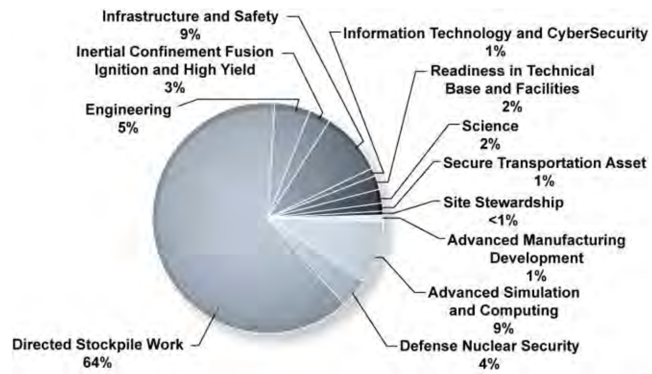
SNL's mission includes the design, development, qualification, testing, certification, and systems integration of all components required to safe, arm, fuze, and fire a weapon to military specifications. SNL's mission also includes production agency responsibilities for weapon components including NGs and trusted radiation-hardened integrated circuits. SNL's relationship as an FFRDC, with DOE as the sponsoring agency, creates an environment that supports its fields of expertise and enables it to maintain objectivity and independence and to be familiar with the broader missions of all its sponsors. SNL provides solutions to existing problems and emerging threats, drawing from its deep science and engineering experience to anticipate, innovate, create, and inform policy debate for decision makers.

- Locations: Albuquerque, NM; Livermore, California; Tonopah Test Range, Nevada; Kauai, Hawaii
- Total employees: 10,009
- Type: Multi-program national security laboratory
- Web site: www.sandia.gov
- Contract Operator: Lockheed Martin Corporation
- Responsible Field Office: Sandia Field Office

D.2.3.2 Funding

FY 2016 Site Funding by Source
(Total SNL FY 2016 Request = $1,885.0 M)

FY 2016 FYNSP for Weapons Activities
($1,591.6 M)



D.2.3.3 Mission Capabilities

As a multidisciplinary national security laboratory and FFRDC, SNL accomplishes tasks that are integral to national security. Its eight key missions are as follows:

- Maintain a safe, secure stockpile and effective nuclear deterrent now and into the future.
- Reduce global nuclear dangers.
- Provide nuclear assessments and warning.
- Enable the United States to defend and dominate in cyberspace.
- Maintain U.S. defense technological superiority through synergistic defense products.
- Reduce global chemical and biological dangers.
- Ensure a secure and sustainable energy future.
- Maintain U.S. defense technological superiority through leveraged defense.

Within the context of its nuclear weapon mission, SNL is uniquely responsible for the systems engineering and integration of stockpile weapons and for design, development, certification, sustainment, and retirement of the non-nuclear components. Core capabilities include the following.

- **Stockpile Management.** Design and produce non-nuclear components; conduct surety assessments and surveillance evaluations; maintain the stockpile through alterations, modifications, and LEPs; qualify and certify non-nuclear components and systems; and disassemble, characterize, and dispose of specific weapon components.
- **Stockpile Stewardship.** These RDT&E efforts include: (1) analyzing options to extend the life of stockpile weapons; (2) conducting radiation effects tests in support of system certification; (3) characterizing weapons-related materials and developing and validating models for material properties; and (4) developing and using experimental facilities, diagnostics, analytic models, and computational tools to provide an improved predictive understanding of the effects of aging, changes in manufacturing processes and technologies, material substitution, and extreme environments on the performance of weapons and weapon subsystems without underground nuclear testing.

Complementing and underpinning these core capabilities are the following additional competencies:

- High-reliability engineering
- Sensors and sensing systems
- Cyber technology
- Reverse engineering
- Microscale and nanoscale electronics and systems
- Natural and engineered materials
- Pathfinder technologies
- Safety, risk, and vulnerability analysis
- HE and energetic materials research and development

In addition to its direct mission work for NNSA, SNL has the largest Strategic Partnership Program budget in the nuclear security enterprise, at around $1 billion annually. SNL leverages its capabilities and resources across programs to optimize the deployment of resources in order to maintain a stable workforce.

D.2.3.4 Revitalizing Physical Infrastructure

SNL's vision for general purpose infrastructure is to provide a smaller, safer, more secure, and less expensive infrastructure that leverages the scientific and technical capabilities of the workforce and meets national security requirements. SNL analyzes trade-offs to ensure each new investment:

- represents optimal use of land and capital,
- improves synergy of campus and community,
- provides capacity and agility to meet SNL's missions and support strategic planning,
- maximizes efficiency and effectiveness and minimizes long-term operations and maintenance,
- contributes to a strong and vital intellectual and research community,
- enhances the quality of the environment and the quality of life for those employed at SNL, and
- preserves and enhances the legacy of landscape and architecture.

Mission-essential facilities include laboratories, an array of specialized test facilities, and manufacturing space for microelectronics, neutron generators, and power sources. Several mission-dependent laboratory and office buildings

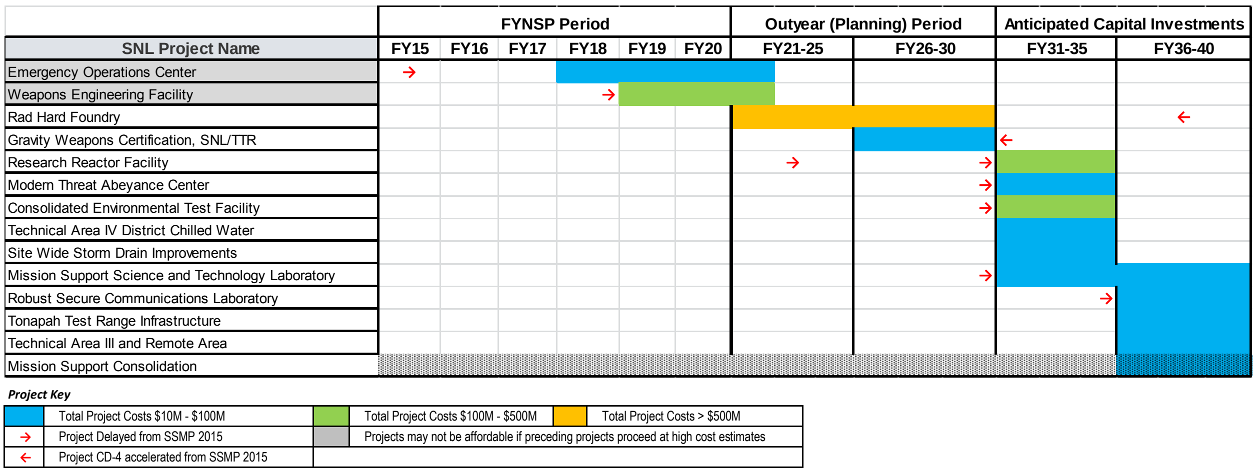
NNSA Real Property

SNL Ten-Year Site Plan FY 2014

- Albuquerque, New Mexico
  - 13,758 Acres
  - 552 Buildings/trailers
  - 242 Other structures and facilities
  - 5,756,928 gsf
  - Replacement Plant Value: $3,992,949,007
  - Deferred Maintenance: $345,947,735
- Livermore, California
  - 410 Acres
  - 67 Buildings/trailers
  - 39 Other structures and facilities
  - 885,994 gsf
  - Replacement plant value: $920,882,282
  - Deferred maintenance: $107,504,851
- Tonapah Test Range (TTR), Nevada
  - 179,200 Acres
  - 60 Buildings/trailers
  - 82 Other structures and facilities
  - 120,925 gsf
  - Replacement plant value: $328,296,717
  - Deferred maintenance: $51,967,183
- Kauai Test Facility (KTF) and Maui, Hawaii
  - 133 Acres
  - 56 Buildings/trailers
  - 53 Other structures and facilities
  - 61,778 gsf
  - Replacement plant value: $99,080,117
  - Deferred maintenance: $21,926,505
- Leases
  - 19 Buildings/trailers
  - 1 Other structure and facility
  - 394,316 gsf
  - Replacement plant value: $90,892,875
- SNL Total
  - 193,501 Acres
  - 754 Buildings/trailers
  - 417 Other structures and facilities
  - 7,217,928 gsf
  - Replacement plant value: $5,432,100,999
  - Deferred maintenance: $527,346,274

house programmatic assets for non-nuclear design, engineering, R&D, systems engineering, and other functions. Scientific facilities include reactors, pulsed-power devices, material characterization, and computational modeling and simulation capabilities housed in specialized facilities that, taken as a whole, support investigation into and certification of weapons without underground nuclear testing.

SNL continues to experience growth in its nuclear weapon and other mission areas. Recent acceleration of the B61-12 and W88 Alt 370 LEPs, coupled with strong growth in workload projections for SNL's Defense Systems and Assessments programs,[1] has placed considerable pressure on already constricted available office and laboratory space. SNL is working closely with NNSA and DOE as they develop policy and guidance to implement the Office of Management and Budget's "Freeze the Footprint" directive. The manner in which this directive is implemented can have a significant impact on SNL's ability and plans to ensure future building investments, specifically through construction of new space, renovation of existing space, and decontamination and demolition.



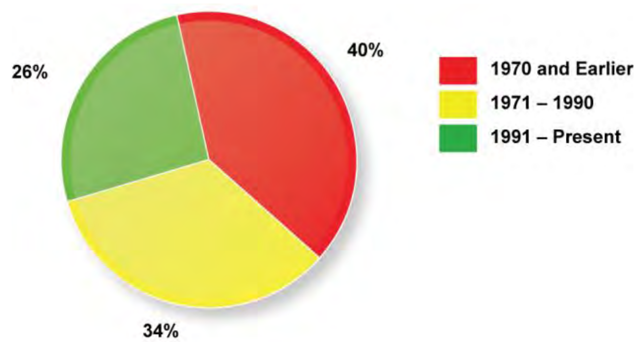
During the next ten years, SNL's highest priorities for new or revitalized facilities to support its NNSA mission requirements are as follows:

- Plan, design, and construct the Weapons Engineering Facility to colocate core nuclear weapons organizations in modern facilities and dispose of a building that is at the end of its service life.
- Complete the SNL Silicon Fabrication Revitalization initiative to replace and modernize facilities and capital equipment in the MESA Complex that directly support LEPs and alterations.
- Plan, design, and construct the Emergency Operations and Response Center in a modern facility that houses emergency operations and supports both local and national response teams.
- Plan, design, and construct the Rad Hard Foundry facility to replace the current facility, which is operating with aging, outdated infrastructure and production equipment nearing obsolescence. A replacement facility is needed by 2027 to ensure an uninterrupted ability to manufacture radiation-hardened silicon circuits to meet LEP and stockpile requirements.

[1] *The seven main programs in this area involve integrated military systems, proliferation assessments, defensive information technologies, remote sensing and verification, science and technology products for DOD, sensing solutions for space missions, and surveillance and reconnaissance related to nonproliferation.*

Several other projects are proposed over the next 25 years. These include modernizing and replacing RDT&E facilities and sustaining core capabilities in support of the nuclear weapons mission, as well as other infrastructure projects that underpin core mission areas and capabilities.

Age of Assets and General Purpose Infrastructure



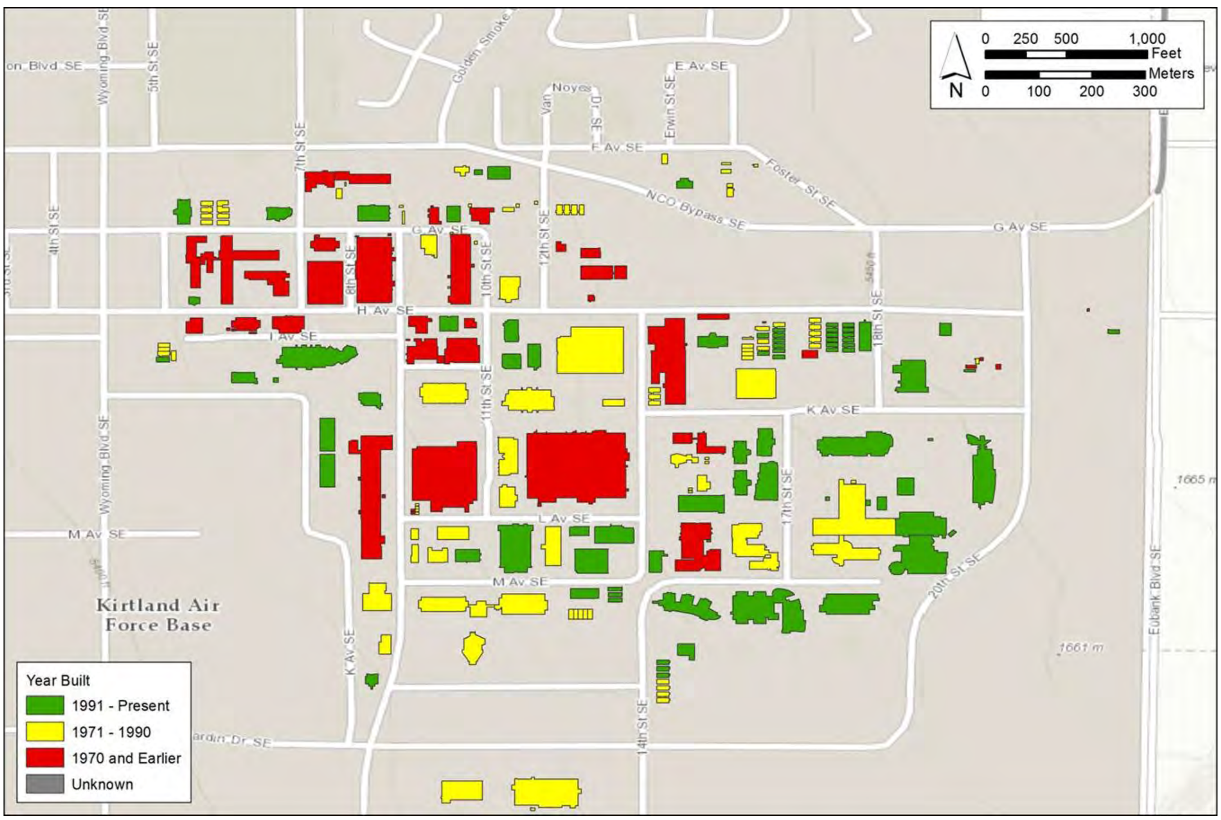


Figure D–32. SNL age of facility assets in TA-1, Albuquerque, New Mexico

Condition of Assets and Deferred Maintenance

SNL's Facilities Management and Operations Center manages the physical infrastructure by identifying key facilities and infrastructure and focusing resources on the most critical systems and equipment. The maintenance management program establishes activities, processes, and associated performance measures to ensure DOE/NNSA property is in a "fit-for-mission-use" condition that promotes operational safety, worker health, environmental compliance, property preservation, facility performance, and overall cost-effectiveness. SNL's methodology for conducting a condition assessment survey has undergone a major restructure in the last two years to ensure better alignment with requirements in DOE Order 430.1B and a more accurate representation of the condition of assets.

Using these strategies, SNL has, to date, kept mission-dependent and mission-support facilities operating reliably. However, in the current budget-constrained environment, some assets are not being maintained at optimal levels, and preventive maintenance and predictive maintenance have been reduced. As a result, the risk that failures in the infrastructure will affect operational reliability is growing over time.

The total deferred maintenance estimate, as reported in the SNL Ten-Year Site Plan FY 2014 – FY 2023, is $527,346,274.

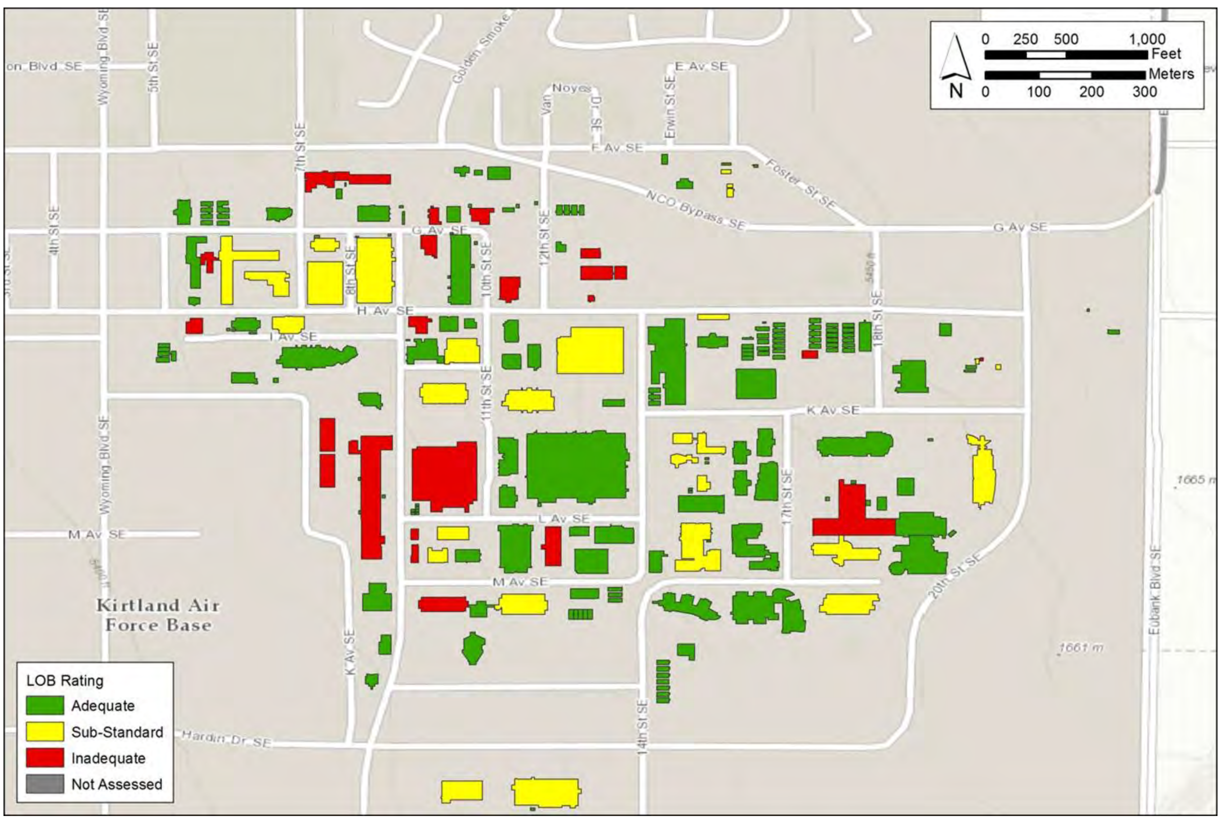
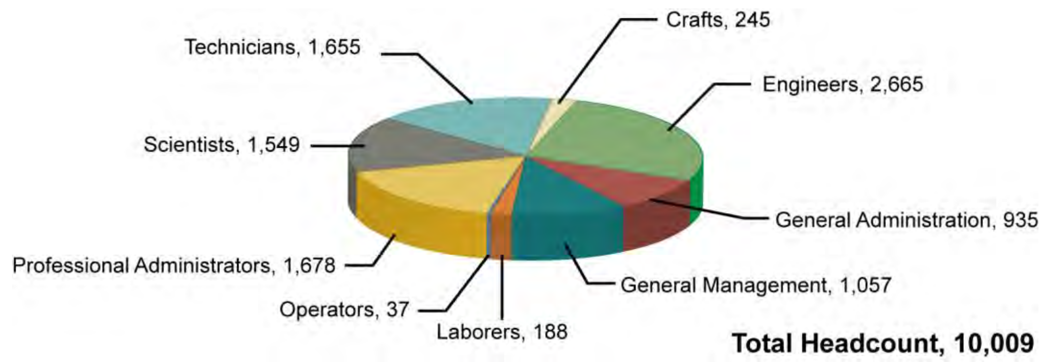


Figure D–33. Laboratory Operating Board rating for SNL facility assets in TA-1, Albuquerque, New Mexico

D.2.3.5 Sandia National Laboratories Workforce

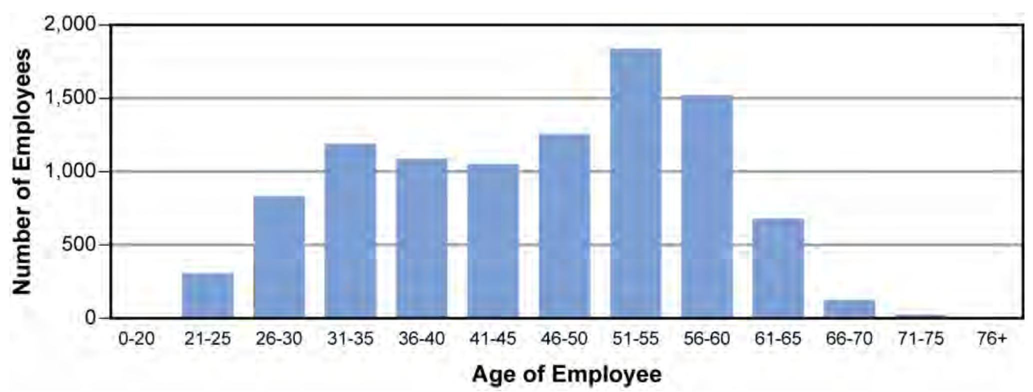


Notes:

Approximately 60 percent of SNL's headcount is aligned with technical duties and responsibilities ranging from R&D to applied engineering to operations.

SNL uses a systems integration approach to workforce assignments. Team members are matrixed to support key mission areas, including the Work for Others Program.

Figure D–34. SNL total headcount



Notes:

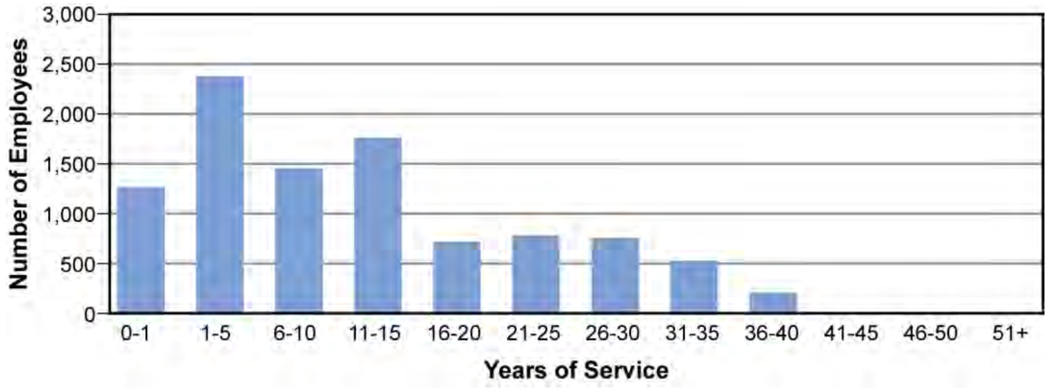
The average age of the employee population is 46.4 years. A large proportion of the population is aged 56 and above (23.8 percent). Approximately 11 percent of the population is aged 30 or less. The remaining 64 percent is between the ages of 31 and 55.

About one-fifth (21.2 percent) of SNL's employees are retirement eligible, with 23 percent of engineers and 18 percent of scientists eligible to retire.

A trend toward hiring more experienced professionals to meet skill gaps over the past several years has lessened the bimodal distribution of the employees by age. While the bimodal distribution is not extreme, there are categories in which this is more pronounced, *i.e.,* engineers and, to a lesser extent, scientists and professional administrators. SNL is taking this into account as it plans for mentoring and knowledge transfer through a Knowledge Development Program.

The FY 2015 and FY 2016 hiring projections reflect a continuing mix of hires between experienced and new college graduates to meet skill gaps. SNL is experiencing some problems in attracting and hiring personnel in the STEM fields because of increased competition from the private sector. SNL is monitoring this issue and adjusting its recruiting strategies accordingly.

Figure D–35. SNL employees by age

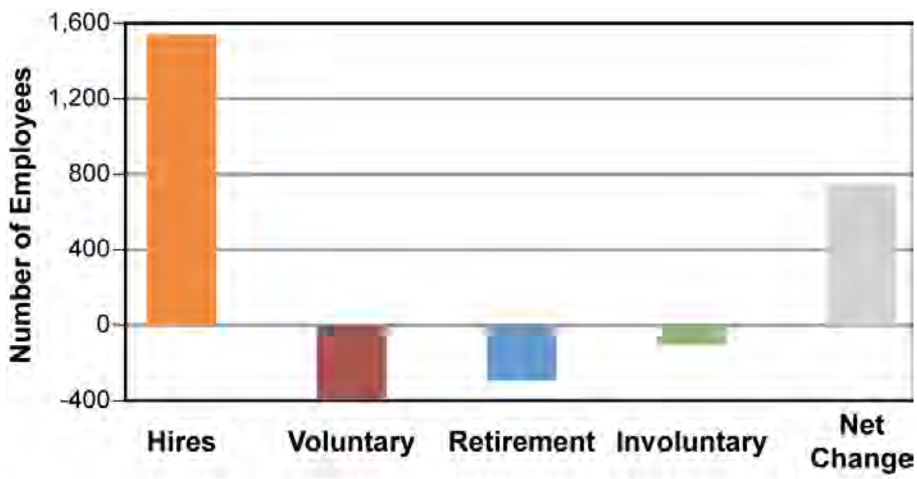


Notes:

Approximately 70 percent of personnel have 15 or less years of service. Approximately 36 percent have less than five years of service. These numbers reflect the hiring of more than 4,250 new regular employees over the past five years (FY 2010 through FY 2014).

The mix of both experienced and new college graduates assures that the necessary skills and capabilities are present to support SNL's mission work. Strong hiring over the past five years ensures that a substantial percentage of employees are in earlier phases of their careers to replace those in later career phases. However, this will require an increased focus on knowledge transfer and training programs.

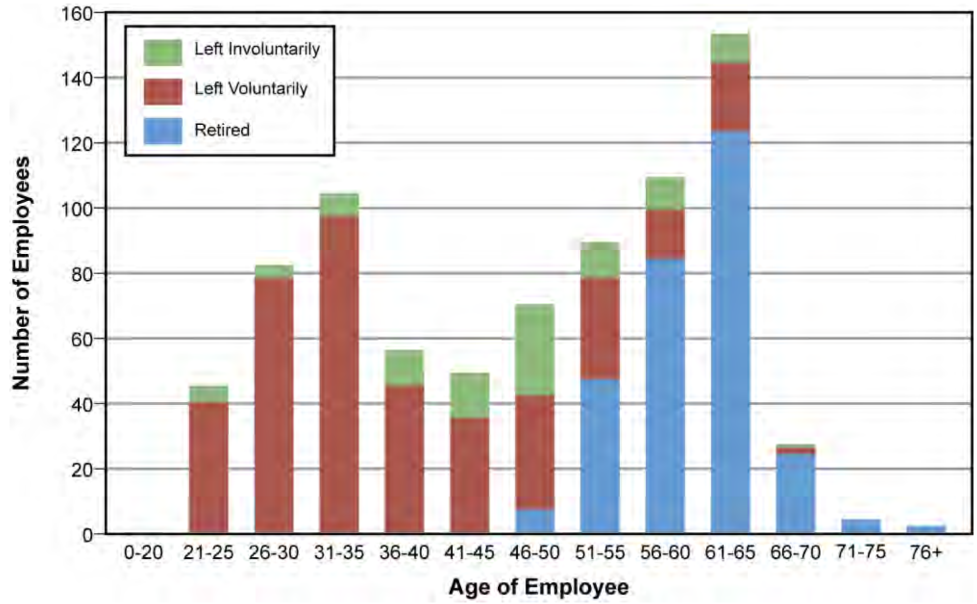
Figure D–36. SNL employees by years of service



Notes:

A net change of 753 staff reflects strong hiring efforts over the past two years. Most of this growth is attributable to growing mission scope related to stockpile modernization through LEP activities.

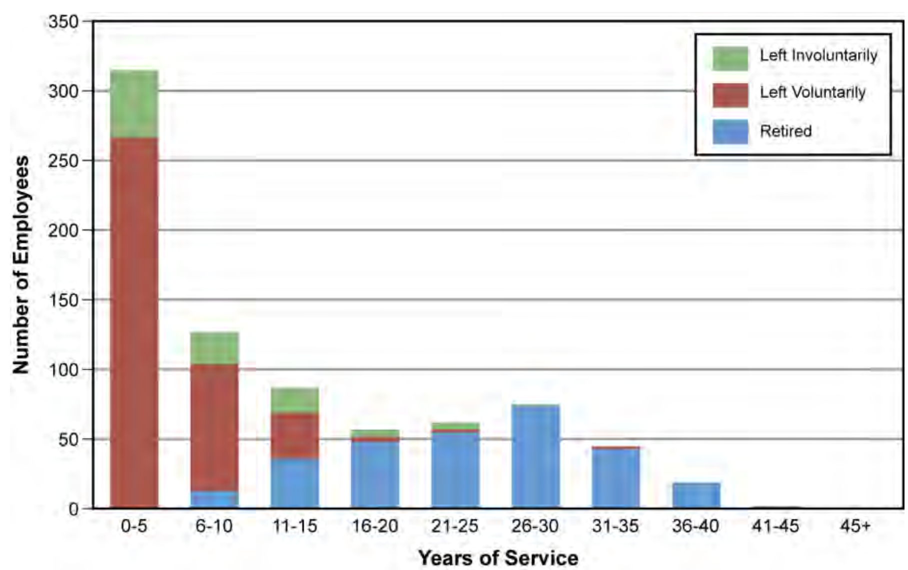
Figure D–37. Change in last two fiscal years at SNL (end of FY 2012 to end of FY 2014)



Notes:

Voluntary separations as a percentage of total separated employees are trending higher and are clustered in the younger age groups. Early separations, ages 21 to 35, are approximately 2.3 percent.

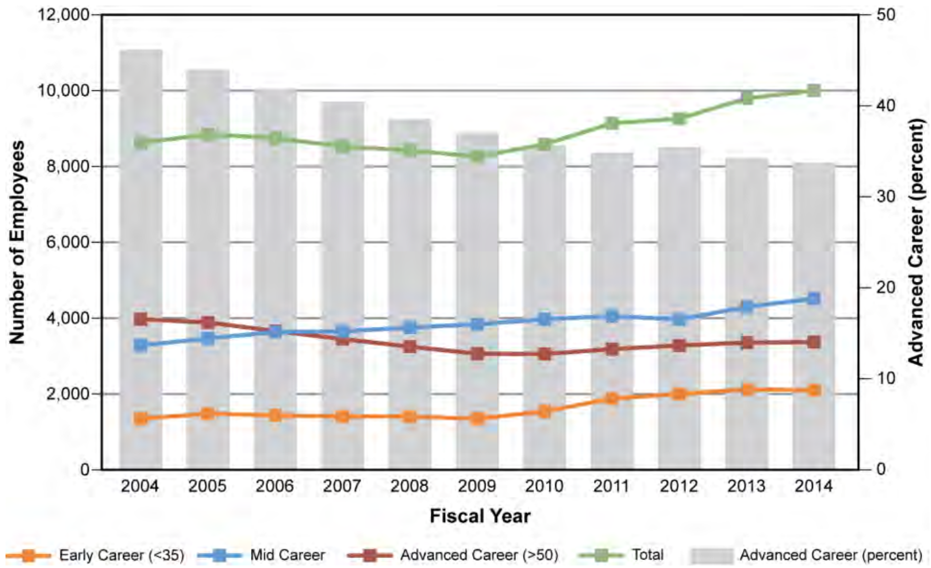
Figure D–38. Age of SNL employees who left service (end of FY 2012 to end of FY 2014)



Notes:

Of the voluntary separations, 67 percent of personnel had less than 5 years of service, and 98 percent were employees who had less than 15 years of experience. This turnover may reflect the external demand for skills and highly competitive value propositions in other companies.

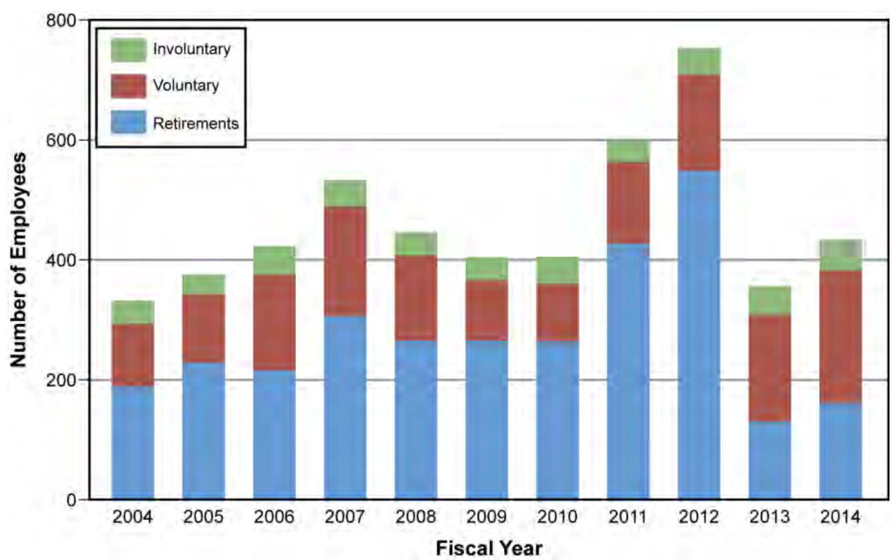
Figure D–39. Years of service of SNL employees who left service (end of FY 2012 to end of FY 2014)



Notes:

The shift in workforce composition reflects SNL's workforce strategy of maintaining a mix of approximately 60 percent mid-to-late career and 40 percent early-career employees to support mission needs.

Figure D–40. SNL trends by career stage

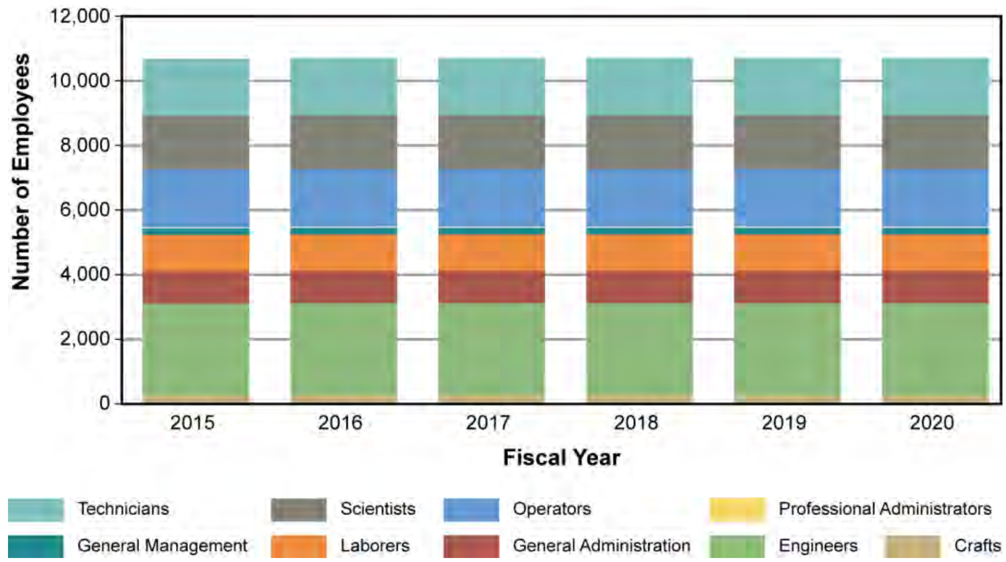


Notes:

Over the past ten years, voluntary separations have totaled 1,598; the highest number occurred in FY 2014. As a percentage of population at the beginning of FY 2012, the voluntary separation rate ran from 1.2 percent to 2.3 percent over the two-year period.

Retirements were higher in FY 2011 and FY 2012 because of changes made in retiree medical care benefits, which encouraged some employees to leave early and thereby reduced retirements in FY 2013 and FY 2014. Retirements are expected to increase in FY 2015 and beyond.

Figure D–41. SNL employment separation trends



Notes:

SNL's total workforce is held constant from FY 2017 to the end of the FYNSP. With SNL's current understanding of out-year scope and resulting workload, as well as the assumption that budgets will remain flat, SNL will monitor workload fluctuations and manage the workforce as required through leveraging across programs, cross-training within programs, and strategic hiring. Beyond the FYNSP, SNL's best estimate of workload suggests a continued flat trend for the workforce.

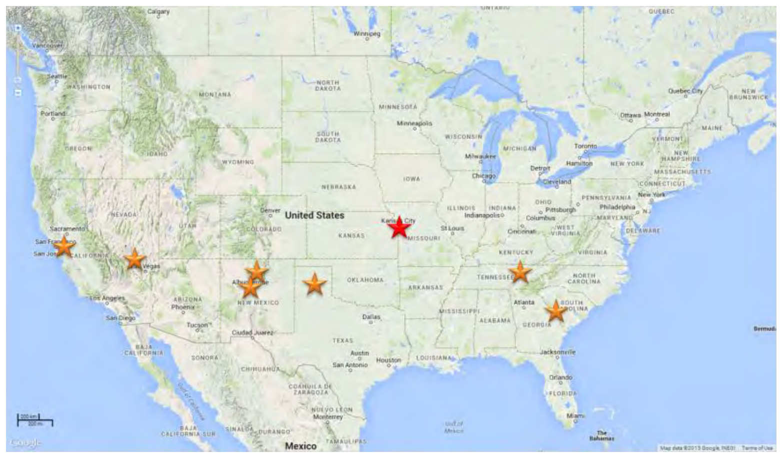
Figure D–42. Total projected SNL workforce needs by COCS over FYNSP

D.3 Nuclear Weapons Production Facilities

D.3.1 National Security Campus at Kansas City

D.3.1.1 Mission

The original site for the Kansas City Plant was built in 1942 to assemble World War II airplane engines. In 1949, the Atomic Energy Commission assumed responsibility for the facility and directed the mission of the plant to manufacture non-nuclear weapon system components. In 2013 to 2014, the Kansas City Plant relocated its operations to a new leased site, where its mission continues to be manufacturing a wide array of sophisticated, non-nuclear mechanical, electronic, and engineered material components to ensure the safety and security of the Nation's weapon systems. This new site, the National Security Campus (NSC), houses approximately 2,600 employees and is one of the first LEED[1] Gold-certified manufacturing campuses in the country.

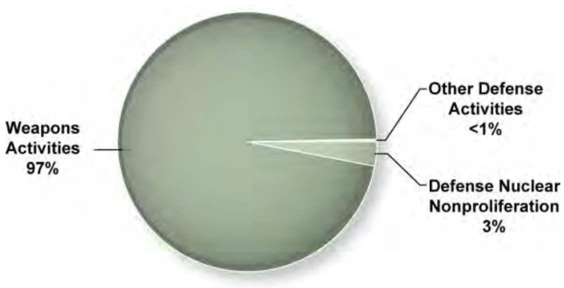


- Locations: Kansas City, Missouri; Albuquerque, New Mexico
- Total employees: 2,587
- Type: Multi-program nuclear weapons production facility
- Web site: www.kcp.com
- Contract Operator: Honeywell Federal Manufacturing &Technologies
- Responsible Field Office: Kansas City Field Office

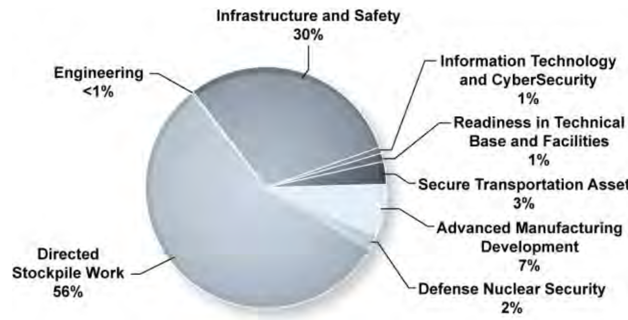
[1] *LEED [Leadership in Energy and Environmental Design] is a set of ratings developed by the U.S. Green Building Council for the design, construction, operation, and maintenance of "green" buildings.*

D.3.1.2 Funding

FY 2016 Site Funding by Source
(Total NSC FY 2016 Request = $624.4 M)



FY 2016 FYNSP for Weapons Activities
($603.0 M)



D.3.1.3 Mission Capabilities

NSC is responsible for approximately 40 technologies and over 1,000 unique product families, including AF&F devices, safing devices, microcircuits, machined parts, polymers, plastics, and other engineered materials. NSC's capabilities support stockpile management and research, development, testing, and evaluation (RDT&E) activities ranging from heavy industrial machinery to sophisticated electronic devices and associated support equipment and tooling. NSC supports the Directed Stockpile Work Program by delivering products and services for both fielded weapons systems and those being modernized *via* LEPs, alterations, and modifications. The work scope for legacy systems includes management, production, processing, and delivery of hardware for LLC exchanges and flight test systems, surveillance testing of components and materials, and maintenance and repair of weapons systems. NSC also supports advanced science initiatives through the activities of the Advanced Manufacturing Development and Engineering Programs. NSC's core capabilities include:

- calibration and metrology;
- analytical science and failure analysis services;
- support of significant finding investigations;
- development and qualification of manufacturing processes;
- production builds;
- procurement of war reserve production material;
- fabrication and qualification of tools, fixtures, gauges, and test equipment;
- enhanced aging studies of components and materials;
- development of new and improved surveillance testing capabilities; and
- annual state-of-health and post-mortem testing of components and materials.

D.3.1.4 Revitalizing Physical Infrastructure

For more than 60 years, the Kansas City Plant provided the nuclear security enterprise with unique non-nuclear component production, testing, and facilities infrastructure support. The costs to maintain and reconfigure that site in a responsive manner became excessive relative to the costs of the primary production mission. A smaller, more-flexible site was required to reduce maintenance costs, security, and other support areas. In response to this need, the non-nuclear production operations were recently relocated to a new, smaller, leased site in Kansas City, now known as the NSC, as part of the Kansas City Responsive Infrastructure Manufacturing and Sourcing (KCRIMS) project. The new site reduced the operating footprint from 3.1 million square feet to 1.5 million square feet, is LEED Gold-certified, and is saving NNSA approximately $100 million in operating costs annually.

NNSA Real Property

Kansas City Plant

FY 2014 – FY 2023 Ten-Year Site Plan

- Bannister Federal Complex (historical)
  - 136.1 Acres (permitted/owned)
  - 38 Buildings owned
    - 2,925,366 gsf active and operational
    - 150 gsf nonoperational
    - 231,233 gsf General Services Administration (GSA)-assigned and 186 gsf leased
  - Replacement plant value: $1,484,667,811 (owned)
  - Deferred maintenance: $225,009,560 (no longer required)
- National Security Campus (current)
  - Acres: N/A
  - 5 Buildings GSA Assigned
  - 1,509,950 gsf GSA Assigned

As part of the KCRIMS project, maintenance and repair activities at the old site were restricted to only those necessary for environmental, safety, and production during the relocation period. This approach is consistent with the Defense Programs strategy to reduce investment in facilities planned for disposition. It is envisioned that the DOE's authority for transfer of property pursuant to the National Defense Authorization Act of 2013, Section 3143, will be used to transfer the real property of the old site to a nonfederal entity for redevelopment. As a result, approximately $225 million in deferred maintenance will no longer be required.

NSC does not have any projects on the Integrated Project List (IPL) at this time.

The new NSC site consists of five leased buildings. Building 1 provides office and administrative space, Building 2 is the production factory; Building 3 is the special products production space; Building 4 is the National Secure Manufacturing Center facility that supports a host of Work for Others Program activities for other Government agencies; and Building 5 is the Central Utilities Plant for the campus.

The new NSC was designed with unallocated 'white' space that could be configured to support new and emerging programs and missions. Based on future weapons activity and weapons manufacturing requirements, product development, mission assignments, and production strategy, a general plant project will prepare white space for this capability and capacity expansion. The execution of this effort will occur in both embedded white space (within current factory environments) and adjacent white space (unfinished areas adjacent to current factory areas) that are more flexible and can be configured to the required size, shape, and environmental specifications.

Operations in Albuquerque include refurbishment and fabrication for the Office of Secure Transportation, the Office of Emergency Response, and engineering, technical support, information technology, training, field support, and small-scale production services for Defense Programs, the national security laboratories, and other Government agencies. These operations were recently relocated from Kirtland Air Force Base permitted property (NC-135 site) to three privately held, leased properties (Air Park, Alamo, and Craddock). The disposition of the NC-135 site will be completed by the end of FY 2015 with site closure and return to Kirtland Air Force Base.

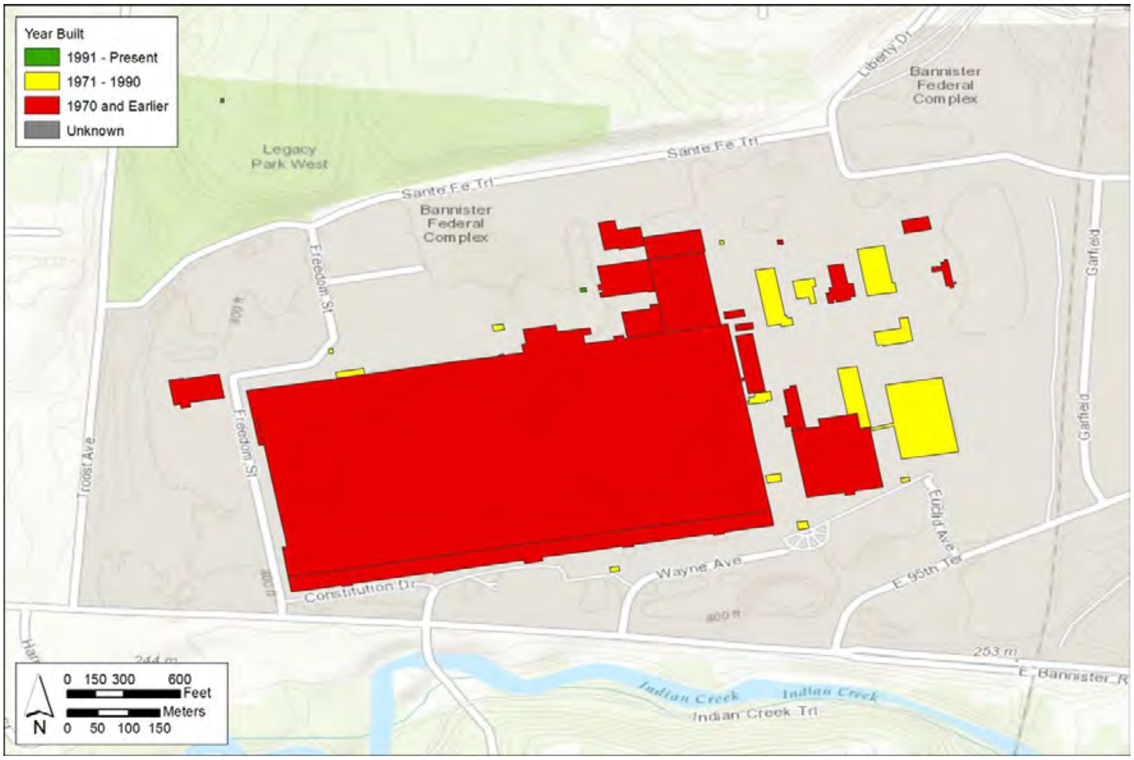


Figure D–43. NSC age of facility assets in Bannister Road Facility, Kansas City, Missouri (historical)

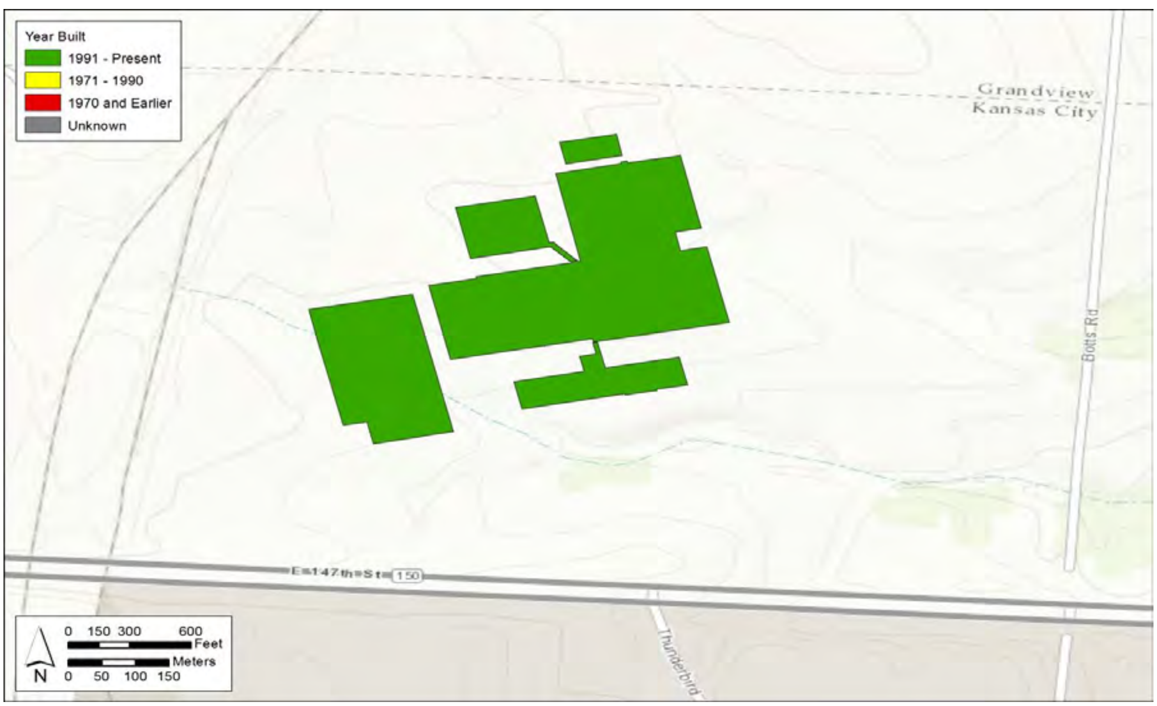


Figure D–44. NSC age of facility assets in Botts Road Facility, Kansas City, Missouri (current)

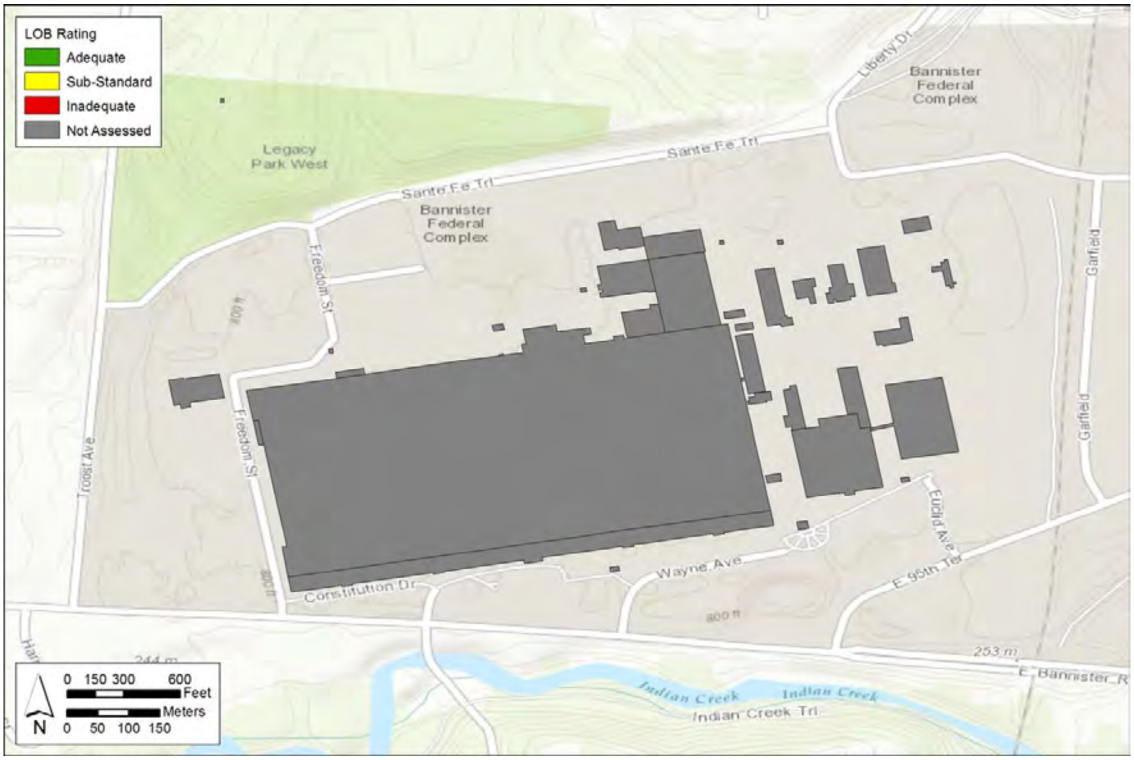


Figure D–45. Laboratory Operating Board rating for NSC facility assets in Bannister Road, Kansas City, Missouri (historical)

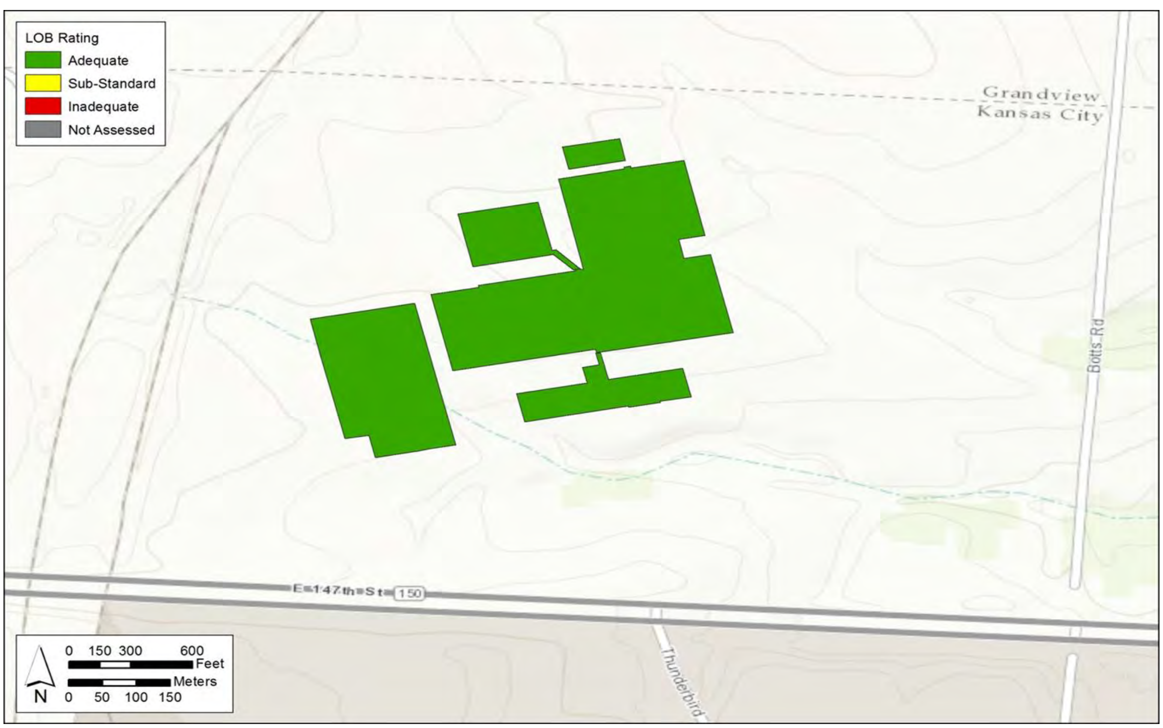
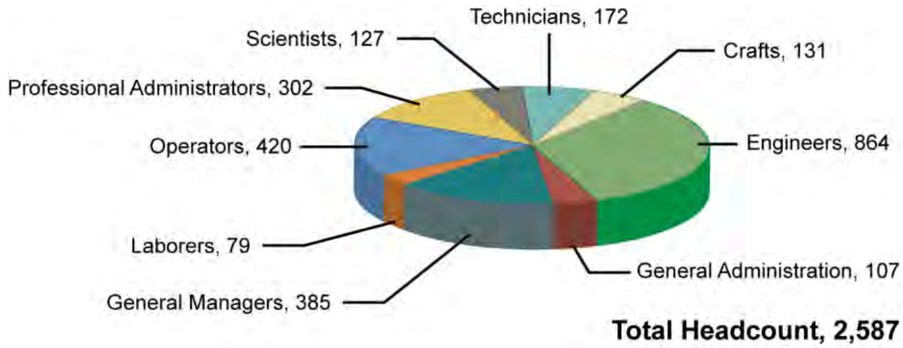


Figure D–46. Laboratory Operating Board rating for NSC facility assets in Botts Road, Kansas City, Missouri (current)

D.3.1.5 National Security Campus (Kansas City) Workforce

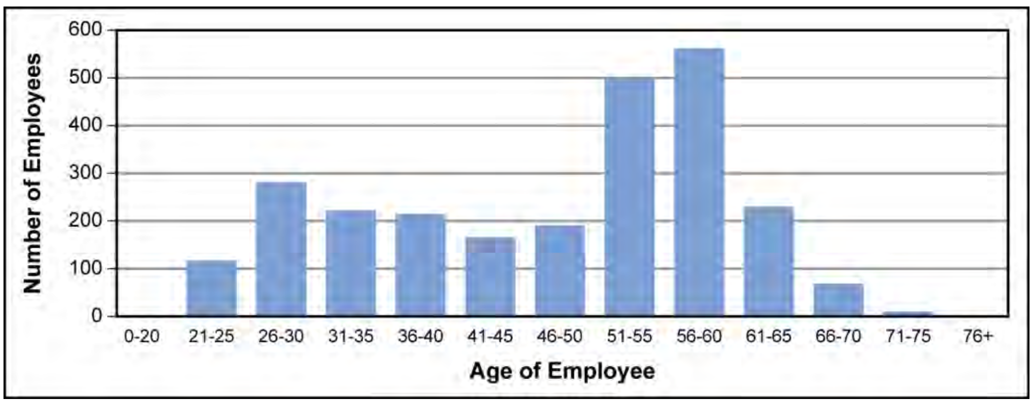


Notes:

The NSC closed out fiscal year 2014 with a total headcount of 2,587.

About 40 percent of the staff hold technical positions that directly support the non-nuclear manufacturing mission and about 20 percent of the staff provide the manufacturing labor.

Figure D–47. NCS total headcount



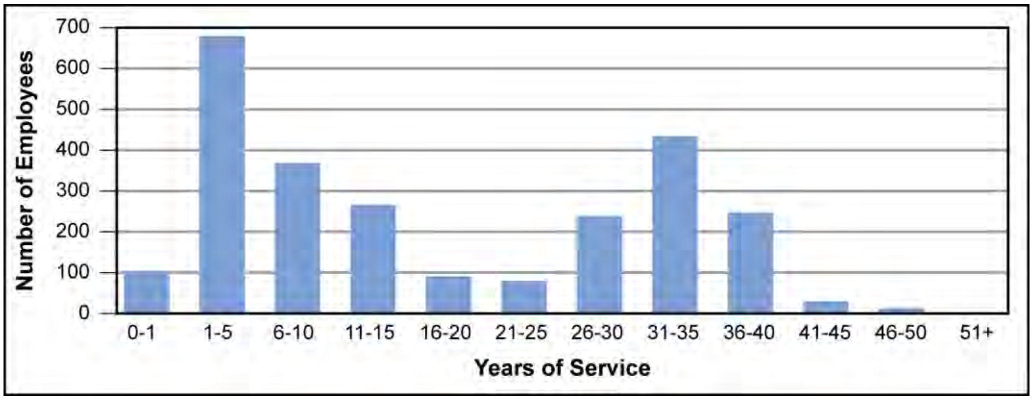
Notes:

The distribution of the staff by age is bimodal, with most of the workforce being in their 50s and the next highest group being in their late 20s. This is reflective of recent hiring to support emerging programs such as the B61-12 LEP and W88 Alt 370 and to replace ongoing attrition of certain key skills and positions.

Twenty-seven percent of the engineering staff are in their 20s, and 41 percent are age 50 or older. For the production operators, over 67 percent are age 50 or older, while only 9 percent are in their 20s.

The average age of the workforce is 47.8 years of age and over 43 percent of the workforce is eligible to retire under the current benefits system.

Figure D–48. NSC employees by age



Notes:

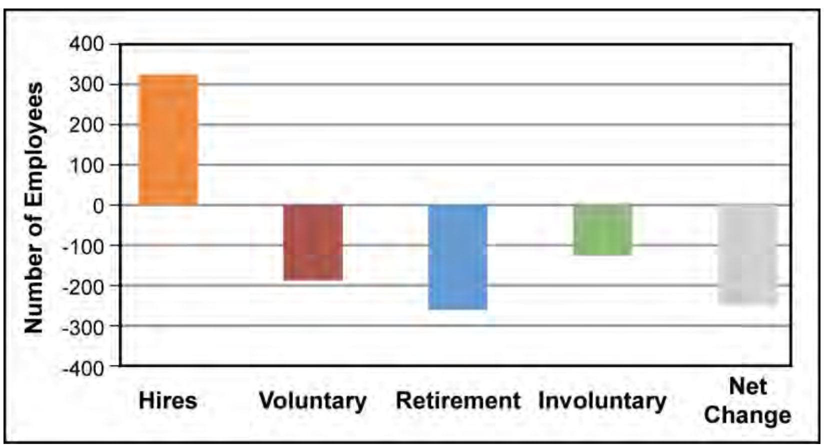
The distribution of employees by years of service is also bimodal, which is again reflective of recent hiring to support emerging programs.

Over 30 percent of the employees have 5 years or less experience; nearly 38 percent of the employees have more than 25 years of service.

Among engineers, 45 percent have 5 years or less experience, while nearly 30 percent have more than 25 years of service.

For the production operators, over 51 percent have more than 25 years of experience with Honeywell, while only 9 percent have 5 years or less.

Figure D–49. NSC employees by years of service



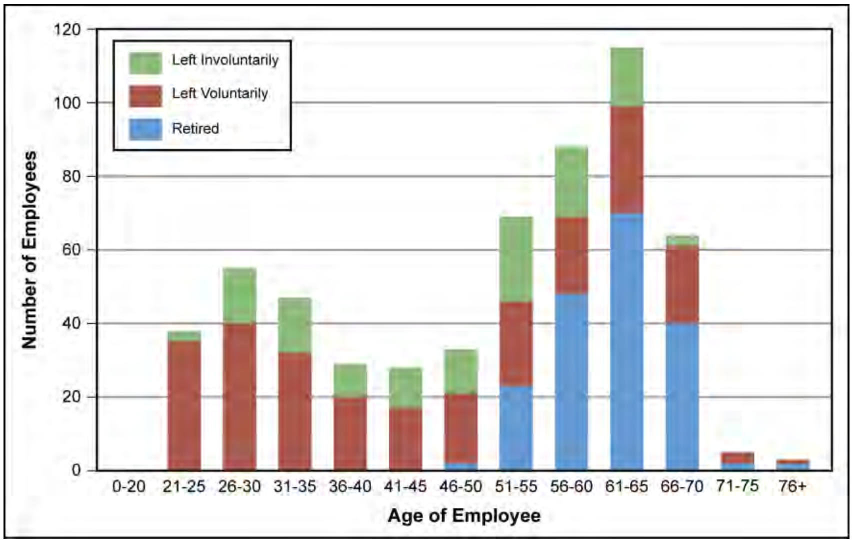
Notes:

NSC had a net decrease of 249 employees since the last SSMP reporting period (FY 2013 and FY 2014). The 325 newly hired employees were offset by 187 voluntary separations, 126 involuntary separations, and 261 retirements.

Much of this attrition was planned for and controlled as part of the Kansas City Responsive Infrastructure Manufacturing and Sourcing (KCRIMS) project, which relocated operations from a Government-owned facility to a leased commercial facility.

Reductions in the labor and crafts categories accounted for 26 percent of the involuntary separations and 23 percent of all separations over the reporting period.

Figure D–50. Change in last two fiscal years at NSC (end of FY 2012 to end of FY 2014)



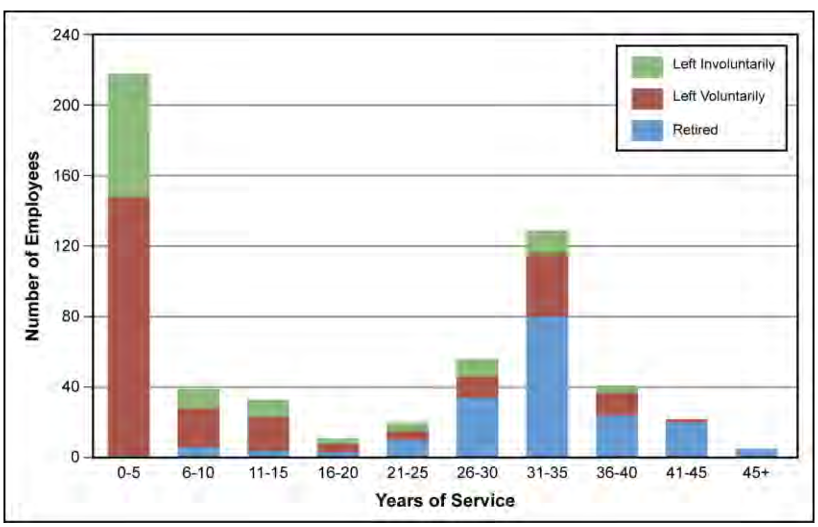
Notes:

A total of 574 employees left NSC during FYs 2013 and 2014, either by voluntary separation, involuntary separation, or through retirement. Most separating employees older than 50 years were retiring, accounting for more than 32 percent of all separations for the reporting period.

In that same age group (greater than 50 years old), nearly 78 percent of the voluntary separations were part of the voluntary component of the staff reduction program.

A troubling trend is that separations of staff less than 40 years of age account for over 28 percent of all separations and nearly half of all voluntary separations.

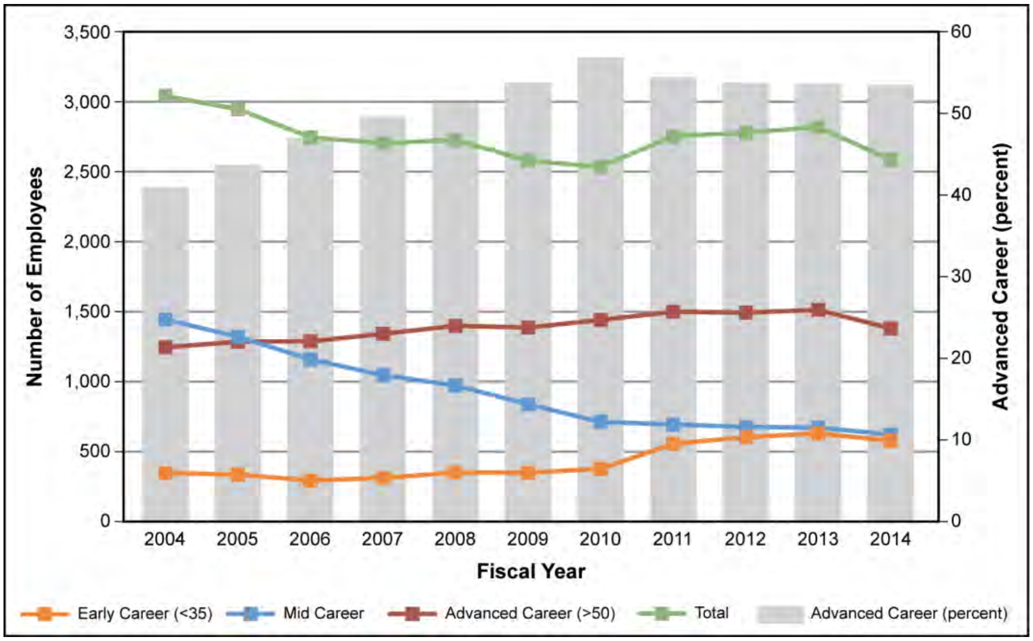
Figure D–51. Age of NSC employees who left service (end of FY 2012 to end of FY 2014)



Notes:

574 employees left service during the reporting period of FY 2013 through FY 2014; 38 percent of those who left having 5 years or less service, and 34 percent who left having more than 30 years of experience, with 65 percent of those leaving through retirement.

Figure D–52. Years of service of NSC employees who left service (end of FY 2012 to end of FY 2014)

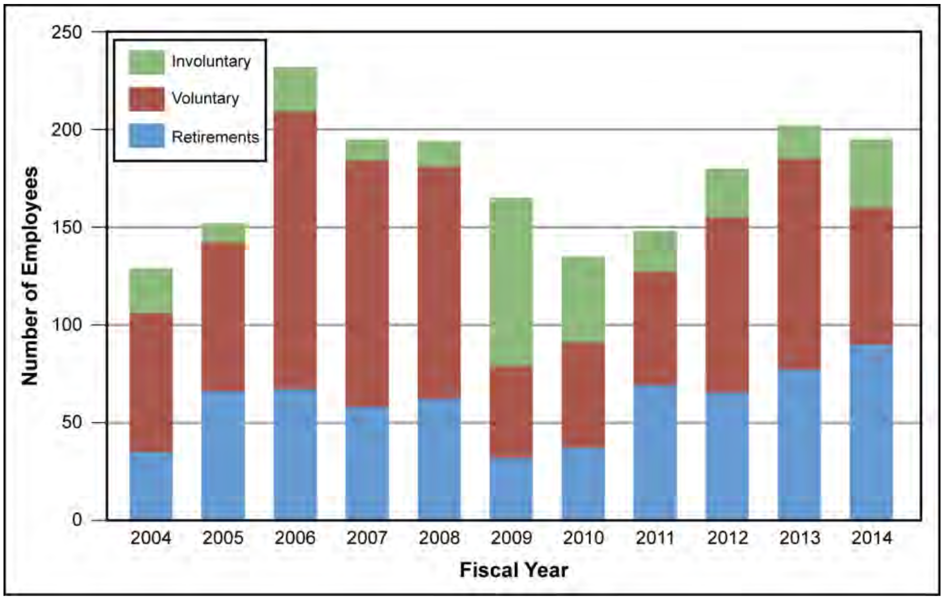


Notes:

Mid-career employees (those between 35 and 50 years of age) have steadily decreased over the analysis period as they have left for other career opportunities or progressed to the advanced-career (more than 50 years of age) group. The number of employees in the advanced-career group is beginning to decline as retirements increase and fewer mid-career employees advance in age to take their place.

The crafts and laborers workforce is trending downward as fewer of these employees are required for facility maintenance in the leased National Security Campus facility. The engineering headcount is trending upward as NSC prepares to support the emerging weapons modernization through LEPs.

Figure D–53. NSC trends by career stage

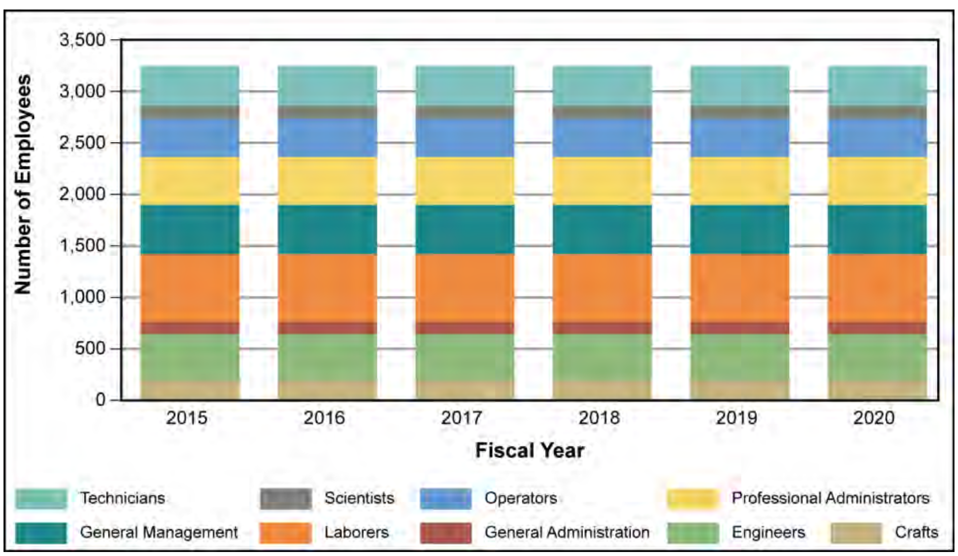


Notes:

Employee separations have trended up over the last three fiscal years, largely driven by both the KCRIMS plan for increased efficiencies and the resulting requirement for fewer workers for facility maintenance.

For instance, there was an increase in the retirement rate in FY 2006, with nearly 45 percent of the retirements by bargaining unit employees, even though only 33 percent of all employees that year were represented by the union.

Figure D–54. NSC – employment separation trends



Notes:

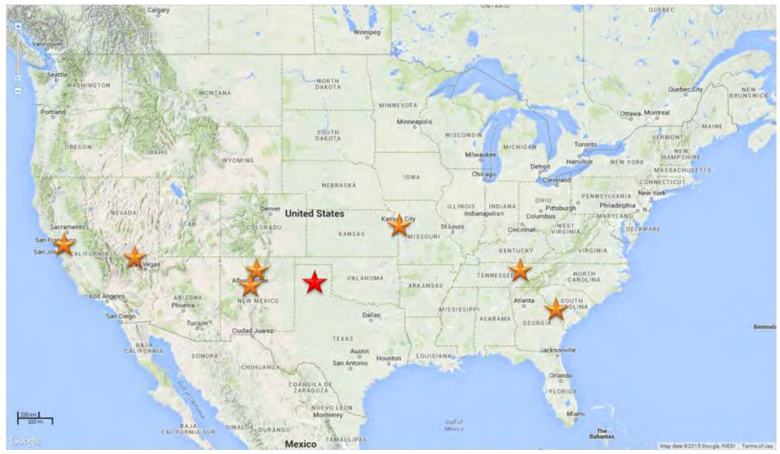
NSC projects its workforce needs will remain fairly steady over the FYNSP period. Slight increases in the number of engineers and operators will be required as development work begins on the W80-4 and IW-1. This is in addition to the B61 LEP, W88 Alt 370, and W87 AFA development and production work.

Figure D–55. Total projected NSC workforce needs by COCS over FYNSP

D.3.2 Pantex Plant

D.3.2.1 Mission

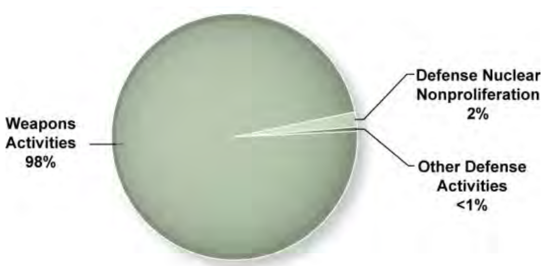
First authorized for construction in 1942, Pantex, located 17 miles northeast of Amarillo, Texas, was used to load artillery and bombs during World War II. In 1951, Pantex's mission shifted to support Cold War nuclear capabilities. Pantex's mission includes four core areas: national security, nuclear explosive operations, nuclear material operations, and HE operations. Pantex is NNSA's High Explosive Center of Excellence. It is the only NNSA site authorized to assemble or disassemble nuclear weapons and has cradle-to-grave responsibilities for HE production. As a collaborative partner with the national security laboratories, Pantex provides capabilities to transition HE R&D from bench scale to production scale. In addition, Pantex collaborates and provides capabilities to DOD, the United Kingdom, universities *(e.g.*, West Texas A&M and Texas Tech), and commercial vendors. Pantex also supports global nonproliferation activities.



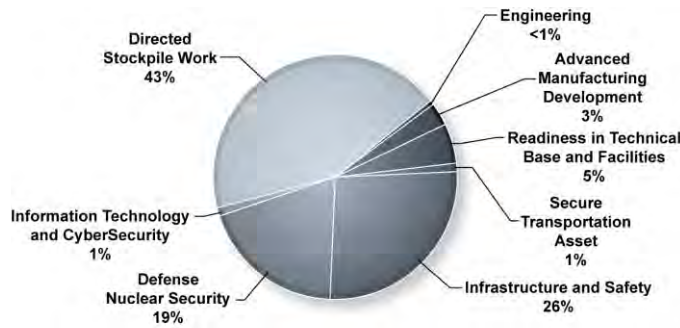
- Location: Amarillo, Texas
- Total employees: 3,111
- Type: Single-program nuclear weapons production facility
- Web site: www.pantex.com
- Contract Operator: Consolidated Nuclear Security (CNS), LLC
- Responsible Field Office: NNSA Production Office

D.3.2.2 Funding

FY 2016 Site Funding by Source
(Total Pantex FY 2016 Request = $626.1 M)



FY 2016 FYNSP for Weapons Activities
($616.2 M)



D.3.2.3 Mission Capabilities

Pantex's mission capabilities include manufacture of specialty explosives; fabrication and testing of HE components; assembly, disassembly, refurbishment, maintenance, and surveillance of weapons and weapon components; dismantlement of retired weapons; sanitization and disposal of components from dismantled weapons; interim staging and storage of nuclear components from dismantled weapons; pit requalification; pit surveillance; and pit packaging (including container surveillances and recertification).

Pantex's specific capabilities are:

- HE;
- weapon assembly, disassembly, inspection and rebuild;
- SNM accountability, interim storage, protection, handling, and disposition;
- surveillance of weapons components;
- surveillance and requalification capabilities for pits;
- assembly and post-mortem analysis of joint test assemblies;
- assembly, disassembly, and analysis of testbed units;
- radiography and nondestructive evaluation of weapon components; and
- electrical and mechanical tests of weapon components.

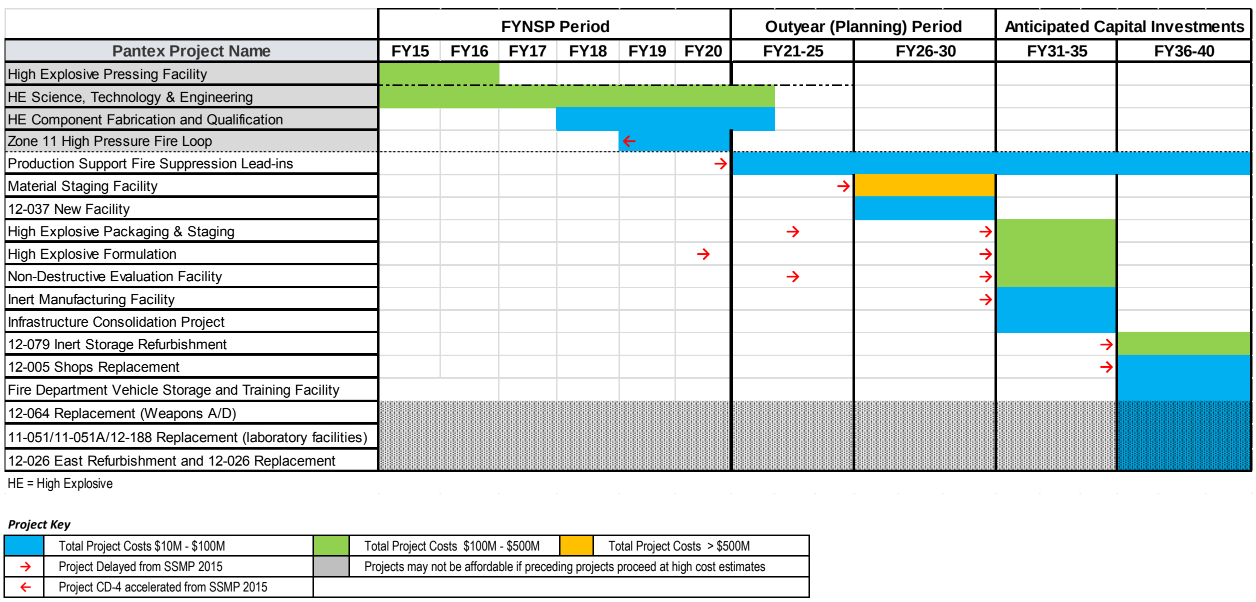
D.3.2.4 Revitalizing Physical Infrastructure

Pantex resides on 17,512 acres leased or owned by DOE. Pantex operations near its southern boundary required DOE to lease approximately 5,800 acres from Texas Tech between the plant and U.S. Highway 60, primarily as safety and security buffer areas. Pantex has 52 mission-critical facilities; 385 mission-dependent, non-critical facilities; and 180 non-mission-dependent facilities; 233 of the mission-dependent, non-critical facilities directly sustain capabilities and mission operations in mission-critical facilities.

NNSA Real Property

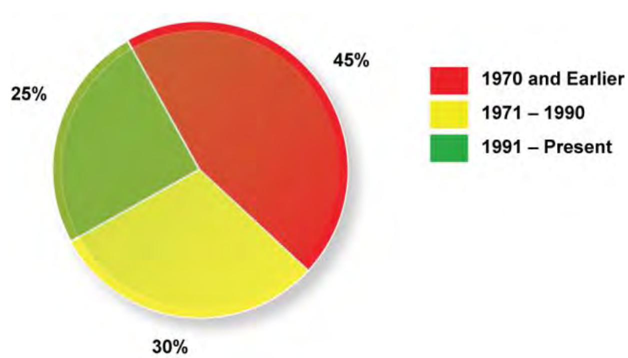
Pantex Plant Ten-Year Site Plan FY2014-FY 2023

- 17,512 Acres (leased/owned)
- Buildings/trailers
  - 3,000,023 gsf active and operational
  - 35,166 gsf nonoperational
  - 84,754 gsf leased
- Replacement plant value: $4.08 billion
- Deferred maintenance: $351 million



Age of Assets and General Purpose Infrastructure

The physical infrastructure, established during the Cold War, has exceeded its original design lifetimes. Infrastructure is being recapitalized to maintain functionality and efficiency and for right-sizing to provide capabilities to execute life-extension activities, dismantle surplus weapons, manage surplus fissile materials, manufacture explosive components, and conduct other nuclear-security-related activities.



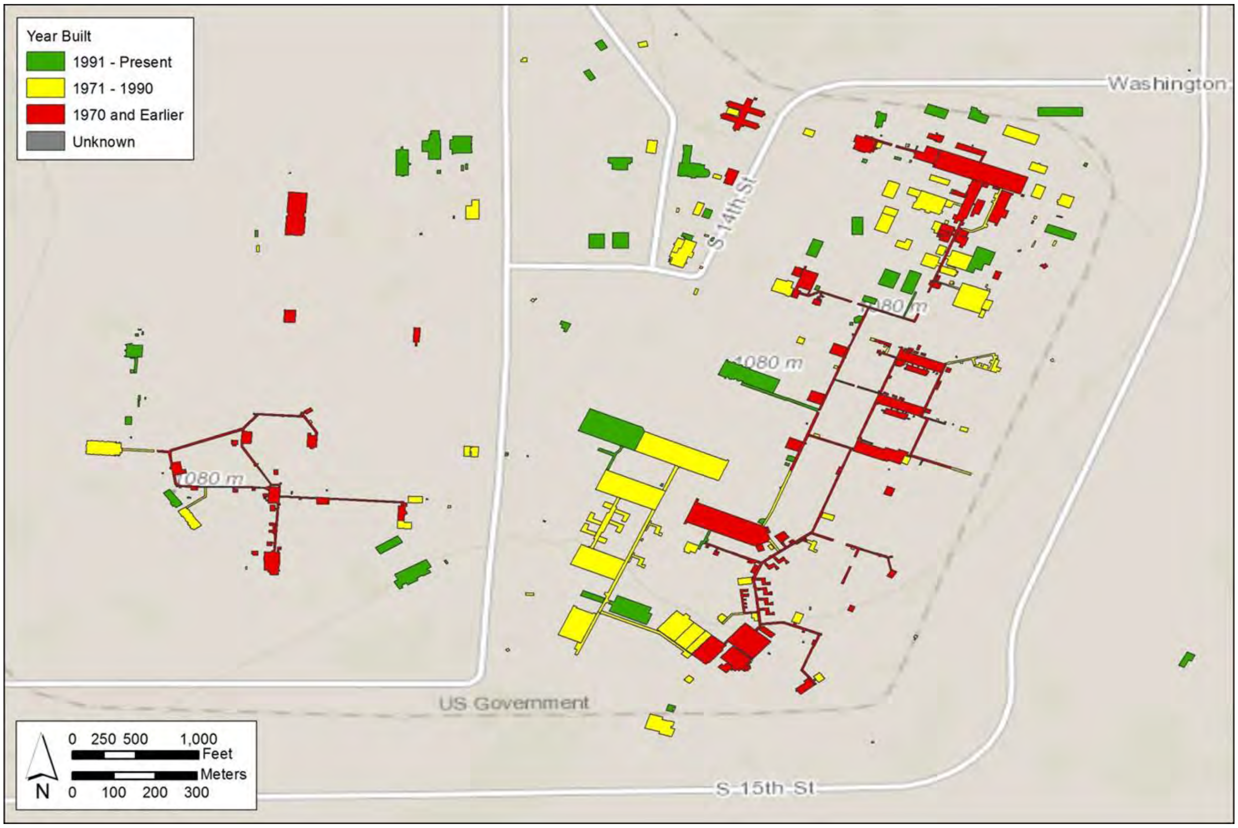


Figure D–56. Pantex age of facility assets in Amarillo, Texas

Condition of Assets and Deferred Maintenance

Systematic life-cycle replacements in the nuclear production bays and cells will reduce the risk to operability and ensure capacities exist to meet projected workload schedules. The initial focus will be on replacing the Flame Detection System, Radiation Alarm Monitoring System, and fire protection lead-ins. Because of obsolescence, failures of the Flame Detection System and Radiation Alarm Monitoring System continue to impact production. Eventually, failure to address these systems and equipment will render the production bays and cells inoperable. Advances in technology are accelerating the need to replace those systems. The lack of replacement parts and supported software is decreasing system maintainability and reliability.

Category I SNM storage and weapon staging are consolidated and adjoined with the weapon assembly area to achieve modern, efficient, secure, and effective operations at a lower cost. A new facility will provide the capability and capacity for safe and efficient staging of weapons and weapon components while enhancing the site's security posture at a reduced infrastructure cost. That facility will support the consolidation of Pantex and reduce the future recapitalization mortgage related to Zone 4 West and the associated PIDAS replacement. Environmental testing capabilities for SNM components (to be relocated from LANL as directed by the *Complex Transformation Supplemental Programmatic Environmental Impact Statement* Record of Decision) will support surveillance and LEP requirements. Comprehensive nondestructive diagnostics for evaluating weapons and weapon components, as well as reacceptance and refurbishment, are mature and responsive and therefore minimize overall costs while supporting the increased surveillance demands.

The deferred maintenance backlog as reported in the *Pantex Plant Ten-Year Site Plan FY 2014 – FY 2023* was $351 million.

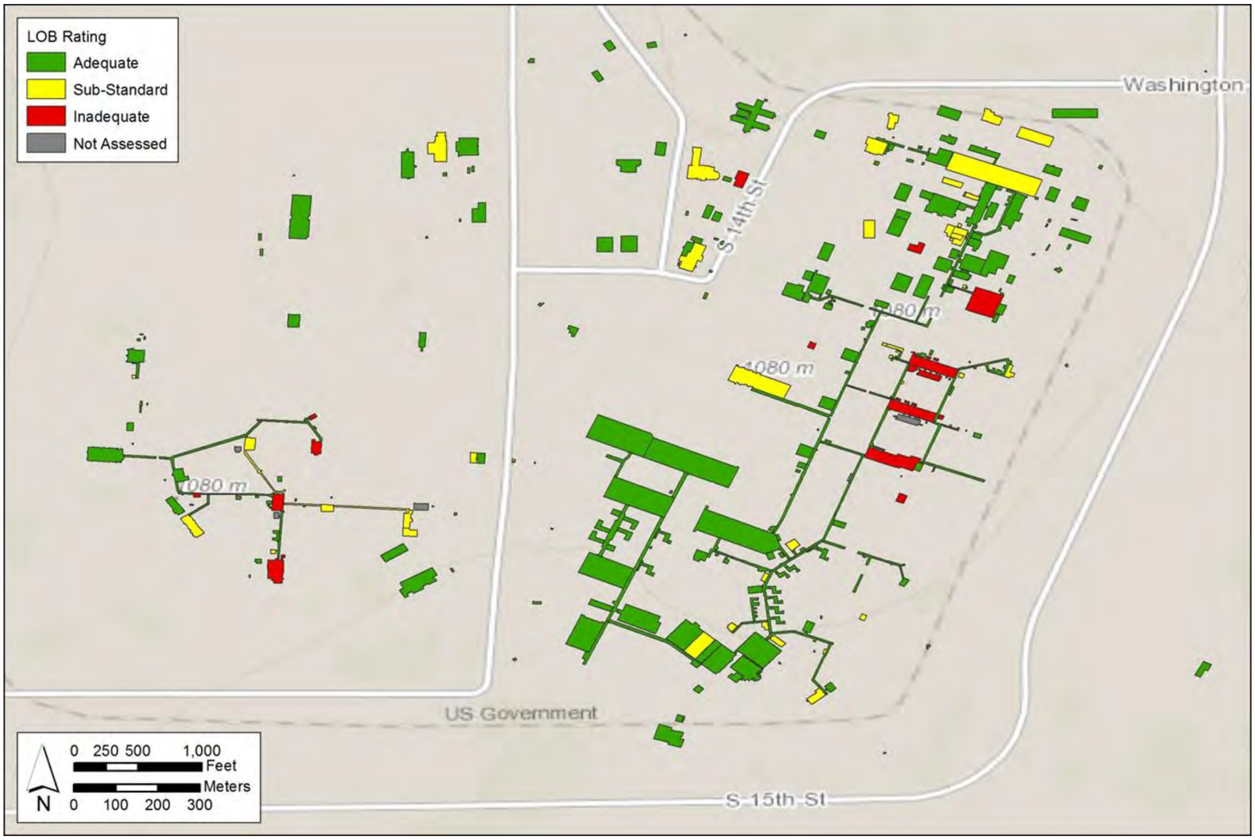


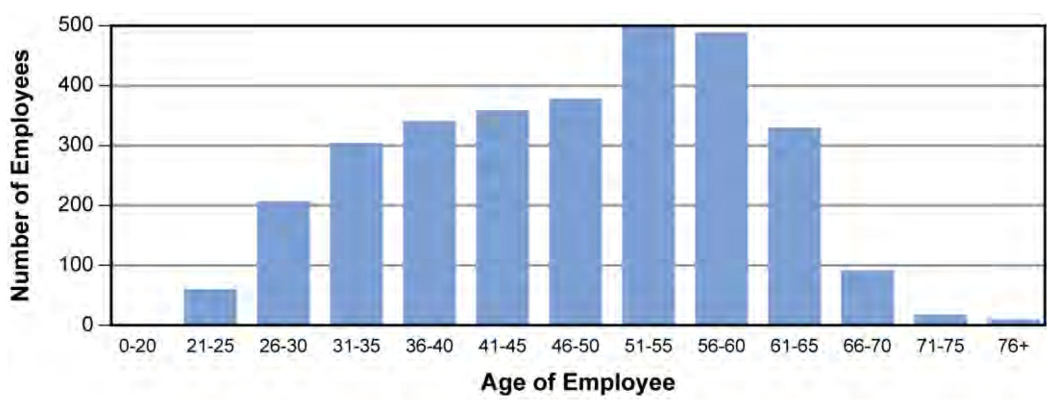
Figure D–57. Laboratory Operating Board rating for Pantex facility assets in Amarillo, Texas

D.3.2.5 Pantex Plant Workforce

Notes:

The site is supported by three primary funding areas: Directed Stockpile Work, RTBF, and Security.

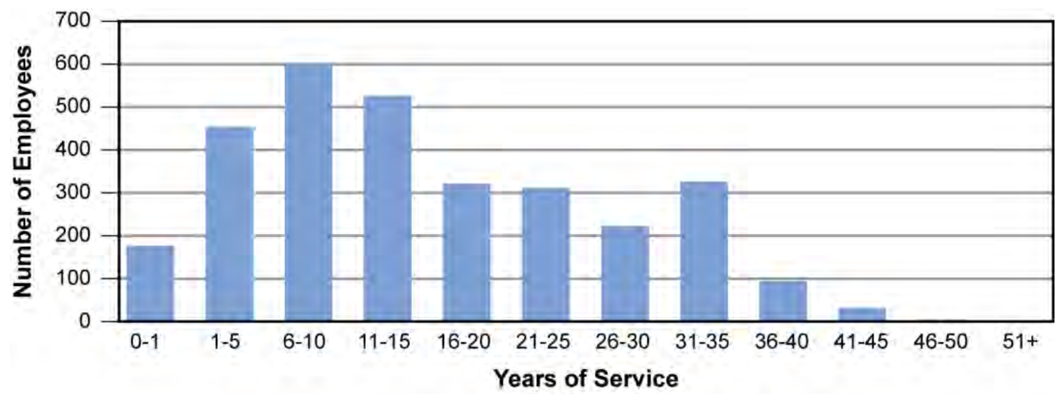
Figure D–58. Pantex total headcount



Notes:

As illustrated in the graph, a significant percentage of the population is eligible for retirement. There are no distinct gaps in age groups, which may correlate to experience and development of next-generation expertise.

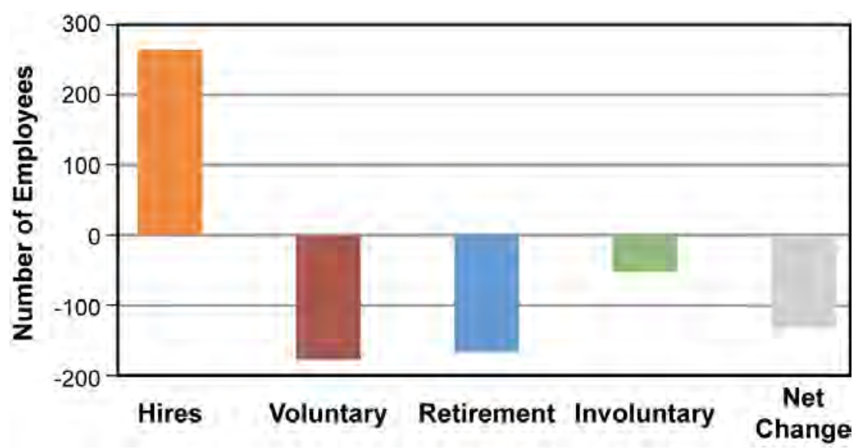
Figure D–59. Pantex employees by age



Notes:

Years of service range broadly a significant population of the site has between 1 and 15 years of service.

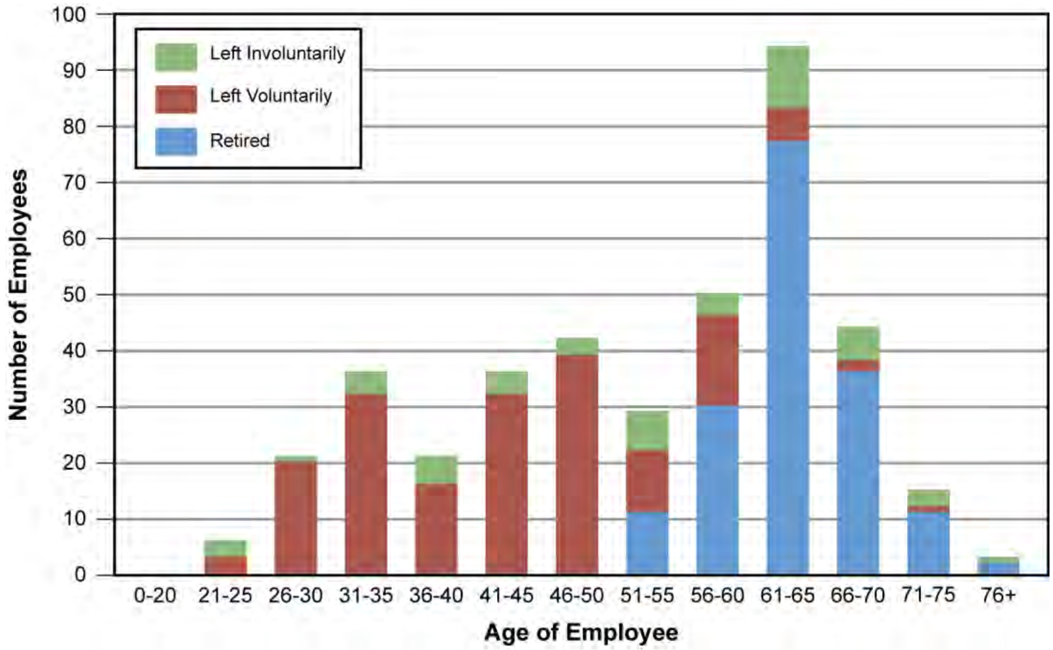
Figure D–60. Pantex employees by years of service



Notes:

The number of voluntary terminations increased slightly because of a voluntary separation package that was offered prior to the advent of the Consolidated Nuclear Security contract.

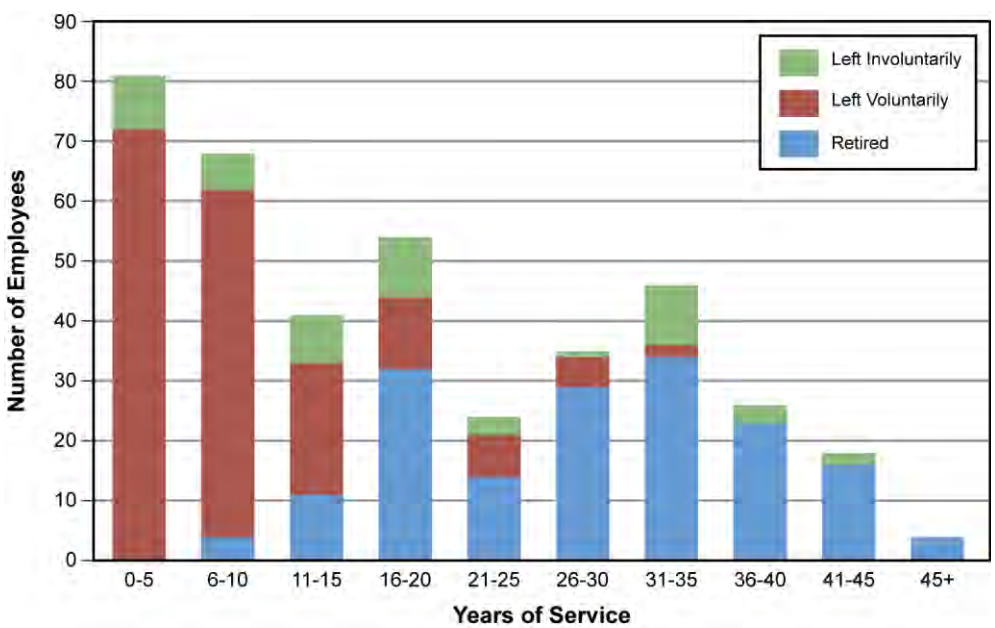
Figure D–61. Change in last two fiscal years at Pantex (end of FY 2012 to end of FY 2014)



Notes:

The distribution of employees leaving the site does not present any significant challenges or concerns.

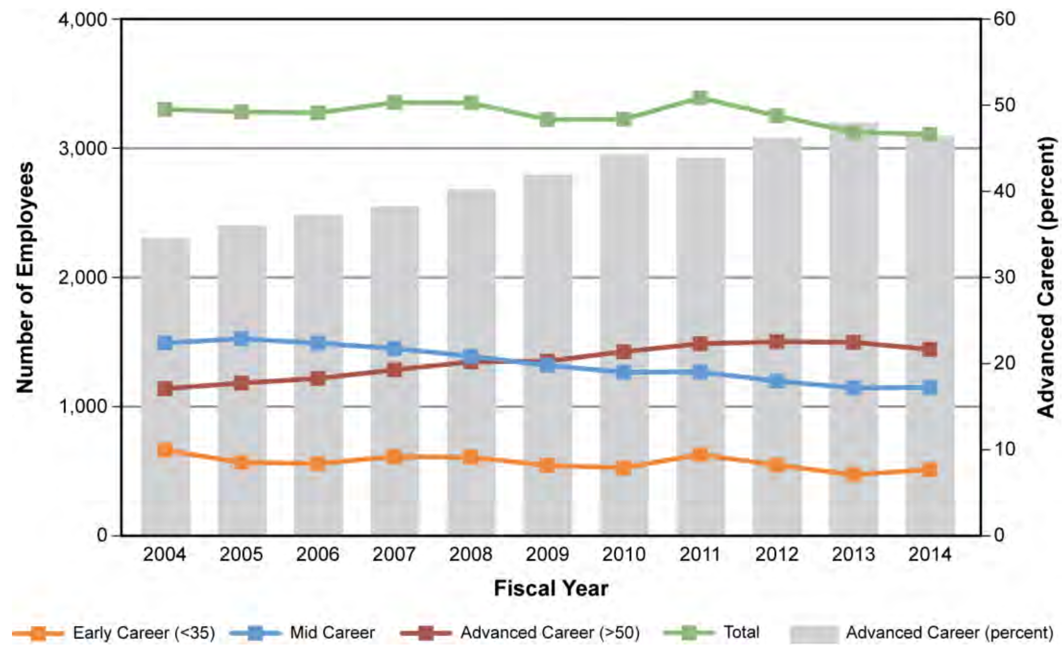
Figure D–62. Age of Pantex employees who left service (end of FY 2012 to end of FY 2014)



Notes:

Attrition rates are highest for new employees with zero to five years of service.

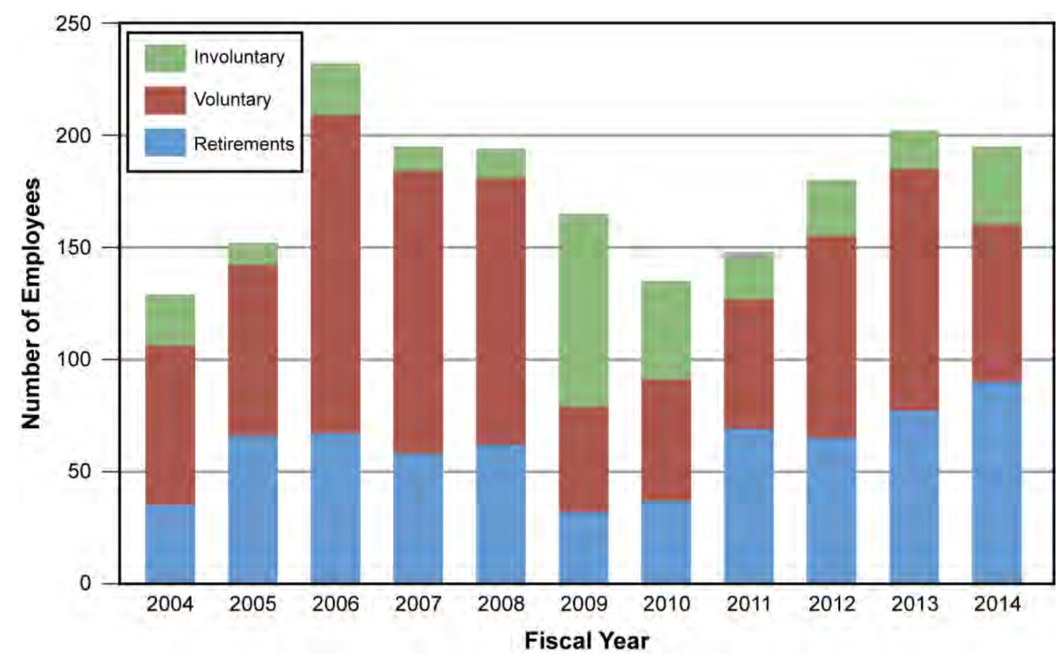
Figure D–63. Years of service of Pantex employees who left service (end of FY 2012 to end of FY 2014)



Notes:

The trend in the divergence of the early- and mid-career workforce from the advanced-career workforce is being monitored to ensure sufficient maturation of the workforce.

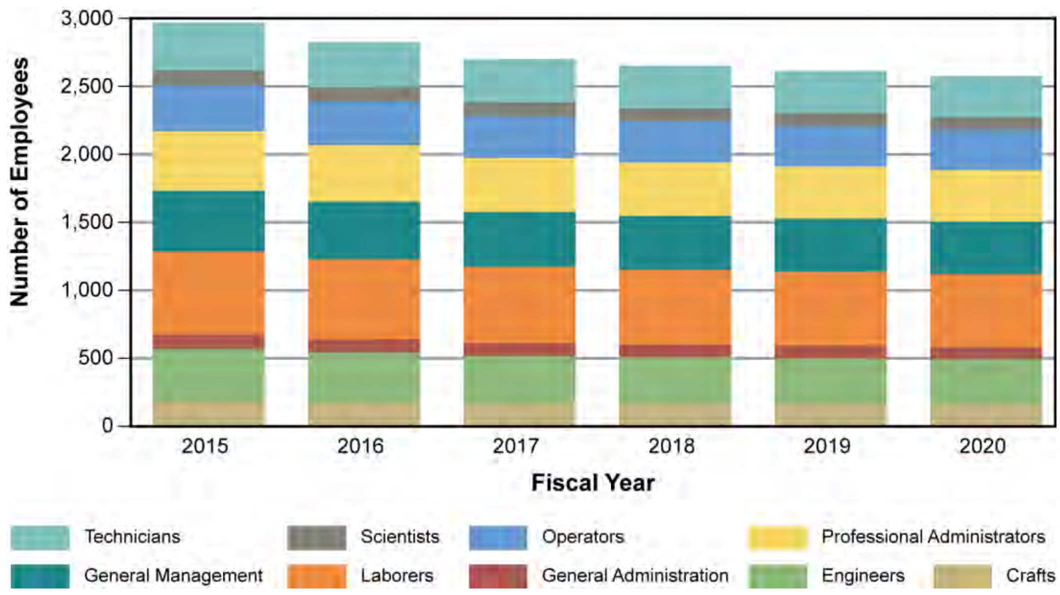
Figure D–64. Pantex trends by career stage



Notes:

Separation trends do not present specific concerns or challenges.

Figure D–65. Pantex employment separation trends



Notes:

With the new contract in place for the operations of Pantex and Y-12, cost efficiencies and workforce optimization will be realized through systems and operational integration and other planned cost savings initiatives. This is reflected in the workforce projections for both Pantex and Y-12.

The total estimated number of FTEs needed to support the work is 3,248. The current plant population is 3,111 with approximately 150 open requisitions, mostly for engineers, authorization-basis personnel, production technicians, and quality assurance technicians.

Technicians are being filled quickly from the local market. Engineers and authorization-basis positions are being recruited from job fairs and universities. Internal realignment is used in some cases to fill critical vacancies. Pantex attrition is 6.3 percent overall.

Crafts, technicians, and administrative positions have lower attrition at 5 percent, while engineers and authorization-basis positions have much-higher attrition at over 10 percent. This is an ongoing concern as oil, gas, and other technologies are all competing for the limited market of engineers. Desperate competitors often offer large bonuses to lure engineers away from Pantex.

Based on current hiring and termination statistics, Pantex anticipates gaps in engineering, authorization-basis, information technology, risk management, tooling, tester design, explosives technology, and fire protection positions in the next ten years.

Pantex is working closely with area universities to provide engineering curricula to help fill the pipeline for engineers for years to come.

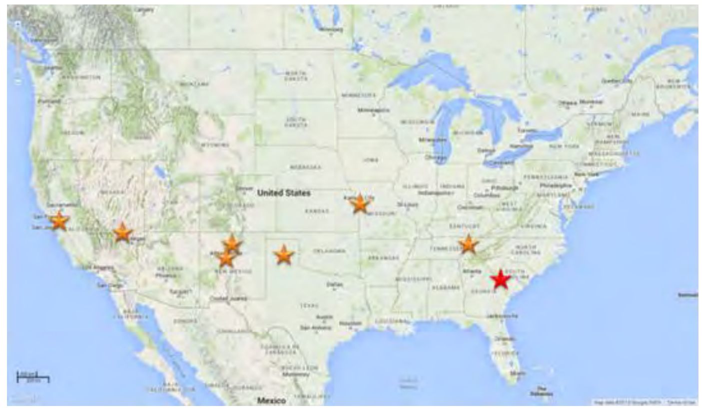
Pantex currently attracts engineers and IT professionals from Texas Tech; West Texas A&M; the University of Texas, El Paso; the University of Oklahoma, New Mexico Tech; the University of New Mexico; and other academic institutions in surrounding states. Fire-protection engineers are typically recruited from Oklahoma State University. HE technology professionals are typically recruited from New Mexico Tech.

Figure D–66. Total projected Pantex workforce needs by COCS over FYNSP

D.3.3 Savannah River Site

D.3.3.1 Mission

With land spanning Aiken, Allendale, and Barnwell Counties in South Carolina, work at SRS dates back to the 1950s and the Cold War. SRS, which has been operational since 1952, is the only domestic site producing tritium and GTS components for the Nation's nuclear stockpile. The Savannah River Tritium Enterprise (SRTE)[1] is the NNSA Center of Excellence Involving Large Quantities of Tritium. Its five tritium-related missions are of critical concern to NNSA for maintaining a safe, secure, and effective stockpile, as well as supporting nuclear nonproliferation, as described below.



- **Tritium Supply.** Recycle tritium from the reservoirs of existing warheads and extract the tritium from target rods irradiated in Tennessee Valley Authority reactors.
- **Stockpile Maintenance.** Replenish the tritium in GTSs to support the schedule for LLC exchanges.
- **Stockpile Evaluation.** Conduct surveillance of GTSs to support annual stockpile certification.
- **Helium-3 Recovery.** Recover, purify, and bottle helium-3, a decay product of tritium used in instrumentation for neutron detectors.
- **GTS/Tritium R&D.** In partnership with the national security laboratories, DOE's Savannah River National Laboratory (SRNL) scientists conduct R&D to support new GTS designs for alterations, modifications, and LEPs, and to enhance gas processing in the Tritium Plant. SRNL also participates in addressing emergent stockpile issues such as corrosion, contamination, and other unexpected phenomena that may affect weapon performance.

Tritium operations are supported by and tightly integrated with the colocated SRNL—a unique arrangement in the nuclear security enterprise that contributes to the United States' world leadership position in tritium science and technology. SRNL's tritium-related capabilities, knowledge, and expertise are also applied to support global nuclear nonproliferation stakeholders such as the DOE Office of Intelligence and Counterintelligence, DOD's Defense Threat Reduction Agency, the Department of Homeland Security, and the International Atomic Energy Agency.

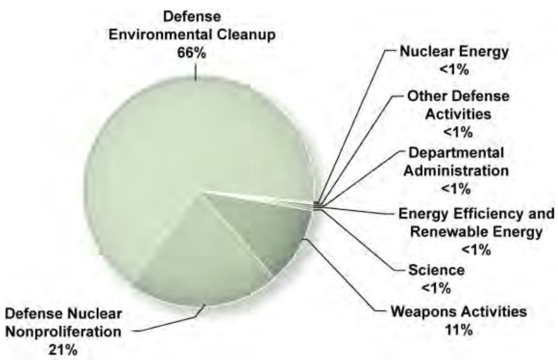
- Location: Aiken, South Carolina
- Total employees (tritium-related operations only): 426 direct plus support (see Section D.7.5 Workforce)
- Type: Multi-program site – DOE's Office of Environmental Management is the site landlord; NNSA is a tenant
- Web sites: www.srs.gov, www.savannahrivernuclearsolutions.com

[1] *"Savannah River Tritium Enterprise" is the collective term for the facilities, capabilities, people, and expertise at SRS related to tritium, and the SRTE "umbrella" extends beyond the Tritium area to include vital mission-support functions.*

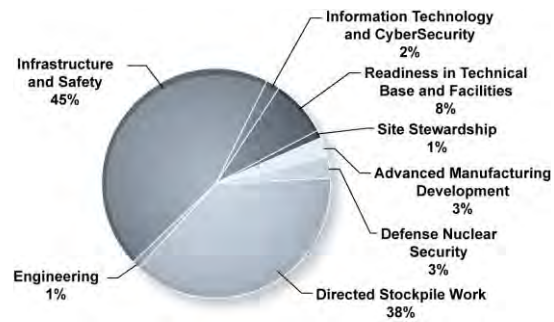
- Contract Operator: Savannah River Nuclear Solutions (SRNS), LLC
  (Fluor, Honeywell, Huntington Ingalls Industries)
- Responsible Field Office: Savannah River Field Office

D.3.3.2 Funding

FY 2016 Site Funding by Source
(Total SRS FY 2016 Request = $2,095.2 M)



FY 2016 FYNSP for Weapons Activities
($244.2 M)



D.3.3.3 Mission Capabilities

SRTE has unique capabilities that relate to LLCs and the broader national security mission of reducing global nuclear security threats for the United States and its allies. These capabilities include:

- producing and replenishing GTSs for stockpile weapons;
- environmental conditioning and surveillance testing;
- evaluation of GTS components and materials for integrity in tritium service;
- purifying and recycling tritium from War Reserve reservoirs;
- receiving, storing, and extracting tritium from target rods irradiated in nuclear reactors;
- recovering, purifying, and bottling helium-3, a decay product of tritium;
- R&D supporting new GTS designs (ensuring the capability to process them) and enhancement of tritium gas processes; and
- knowledge and expertise gained from GTS and tritium R&D that is leveraged to support global nuclear nonproliferation efforts.

Examples of the SRS Role in Ensuring a Safe, Secure, and Effective Deterrent

- *SRTE collects surveillance data to certify stockpile reliability by environmentally conditioning and testing tritium gas transfer systems to simulate forces that would be experienced during weapon deployment to verify operability.*
- *SRTE performs metallographic evaluations and burst tests to obtain data on reservoir integrity that lead to improved design options for alterations, modifications, and life extension programs.*
- *SRTE provides gas transfer systems to DOD for Joint Test Assembly flight tests.*

D.3.3.4 Revitalizing Physical Infrastructure

SRTE's enduring tritium-related missions are currently executed in a mix of Cold War-legacy and modern production facilities that are located within a 29-acre area (called the "H Area") of the 310-square-mile SRS. These include two legacy facilities, the H-Area Old Manufacturing facility and the Reservoir Reclamation Facility, and three modern production facilities, the HANM facility, the Materials Testing Facility, and the Tritium Extraction Facility. NNSA's strategy to revitalize SRTE infrastructure is to relocate and right-size the remaining operational functions from the two aged and inefficient facilities to the newer production facilities *via* the TRIM Program and to recapitalize and sustain the enduring facilities. The TRIM Program consists of one line-item project and a suite of capital equipment and general plant projects. Two additional line-item projects and steady annual funding for minor construction projects are needed to recapitalize and sustain the enduring production facilities. The three line-item projects shown below are from the Integrated Project List in Chapter 4.

Key points about the TRIM Program

- *Significantly reduces cost, footprint, energy usage, and deferred maintenance.*
- *TRIM savings will enable investments to address SRTE's primary mission risks:*
  - *The deteriorating infrastructure*
  - *An increasingly retirement-eligible workforce*
- *It is important to fully fund the TRIM Program through to completion in FY 2022:*
  - *Enables closure of costly legacy facilities and avoids the high cost to recapitalize them.*
  - *Available project funding has already been shifted to support the enduring facilities.*
- *The TRIM Program does not sustain any enduring facilities.*

	FYNSP Period						Outyear (Planning) Period		Anticipated Capital Investments	
SRS Project Name	FY15	FY16	FY17	FY18	FY19	FY20	FY21-25	FY26-30	FY31-35	FY36-40
Tritium Production Capability										
HANM Risk Reduction										
H-Area New Manufacturing Chiller EPA Compliance										

EPA = U.S. Environmental Protection Agency   HANM = H Area New Manufacturing (facility)

Project Key

(blue)	Total Project Costs $10M - $100M	(green)	Total Project Costs $100M - $500M	(orange)	Total Project Costs > $500M
→	Project Delayed from SSMP 2015	(gray)	Projects may not be affordable if preceding projects proceed at high cost estimates		
←	Project CD-4 accelerated from SSMP 2015				

Age of Assets and General Purpose Infrastructure

In addition to the above mission-critical facilities, SRTE has 47 mission-dependent assets and eight assets that are not mission dependent. These include five office buildings constructed from 1984 to 2013, two training facilities constructed in 2000 and 2013, five storage facilities constructed in 1970 to 2011, and eight service buildings built in 1969 to 2011. One office building is being repurposed as storage, and two warehouses will be repurposed as production facilities under the TRIM Program. Three facilities are designated as excess in the DOE FIMS.

SRTE has general-purpose equipment that performs key functions within mission-critical facilities. Specific examples requiring line item project support for sustainment (due to obsolescence issues) include refrigeration systems and safety-significant glove box oxygen monitors.

NNSA Real Property

Savannah River Field Office
FY 2014-2023 Ten-Year Site Plan

- 29 Acres (owned)
- 39 Buildings/trailers
  - 304,171 gsf active and operational
  - 83,588 gsf nonoperational
  - 0 gsf leased
- Replacement plant value: $1.9B
- Deferred maintenance: $97M

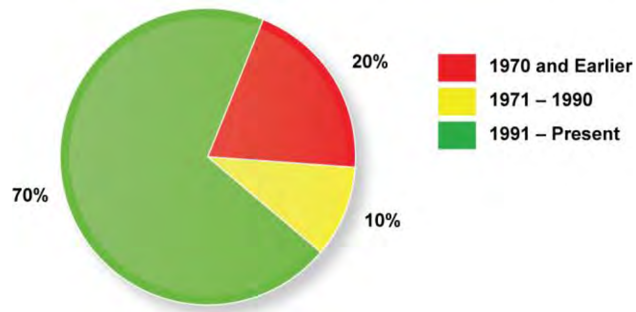


Figure D–67. SRS age of facility assets in H Area (Tritium), Aiken, South Carolina

Key to Understanding SRTE's Unique Facilities and Infrastructure

"Infrastructure" is commonly understood to mean buildings, utilities, etc., and SRTE has these. However, it is important to recognize that SRTE's buildings are fully integrated with the process equipment and active confinement and ventilation systems. There is, in essence, an "infrastructure within the infrastructure,"—i.e., glove boxes, monitoring systems, distributed control systems, etc. that must be sustained to ensure mission continuity. This extra complexity is also required to keep workers and the public safe from the inherently high hazards associated with processing tritium, i.e., radioactive hydrogen gas, which is extremely flammable and explosive and can be readily assimilated into the human body.

Conditions of Assets and Deferred Maintenance

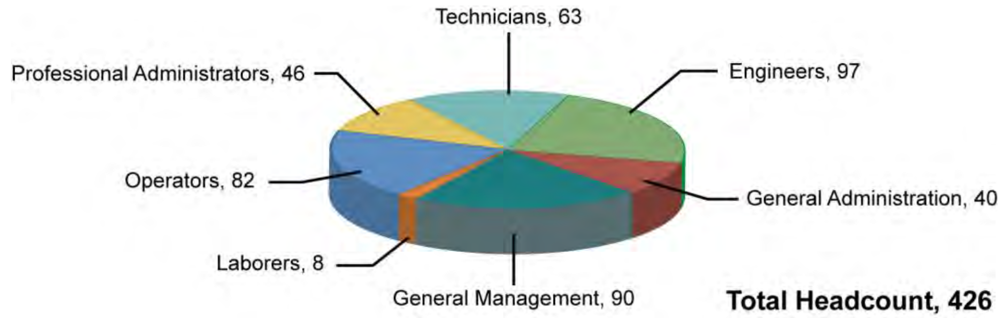
Deferred maintenance in the tritium facilities at SRS, as reported in the Savannah River Field Office FY 2014 – FY 2023 Ten Year Site Plan, in the tritium facilities at SRS is currently $97 million, $91.6 million of which is associated with mission-critical production facilities. This is significantly increasing mission risk due to the potential loss of facility availability and the cost of safely maintaining facilities that are outdated, costly to operate, and inefficient. Completion of the TRIM Program will be helpful in this respect by allowing SRS to vacate the two legacy facilities, which collectively have almost $40 million in deferred maintenance. The remainder of the deferred maintenance is in the three modern production facilities: $47.2 million in HANM, $3.4 million in the Materials Testing Facility, and $2.1 million in the Helium-3 Byproduct Recovery Facility.

Figure D–68. Laboratory Operating Board rating for SRS facility assets in H Area (Tritium), Aiken, South Carolina

Perspective

Because of tritium's radioactive decay rate, SRTE's core missions will endure as long as nuclear weapons are needed. SRTE is front line to the warfighter because on-time delivery of LLCs is required to maintain stockpile readiness. Therefore, maintaining SRTE's facilities and infrastructure in a continual state of readiness to execute missions is one of NNSA's highest priorities.

D.3.3.5 Savannah River Site Workforce



Notes:

SRS is managed by the DOE Office of Environmental Management and performs limited NNSA activities. The Defense Programs scope resides in SRTE, and this group is managed as a severable entity within the M&O contract. About 8 percent (426) of the 5,258 personnel that make up the total M&O workforce at SRS are dedicated to SRTE's defense missions; the other 92 percent (4,832) primarily support the Office of Environmental Management.

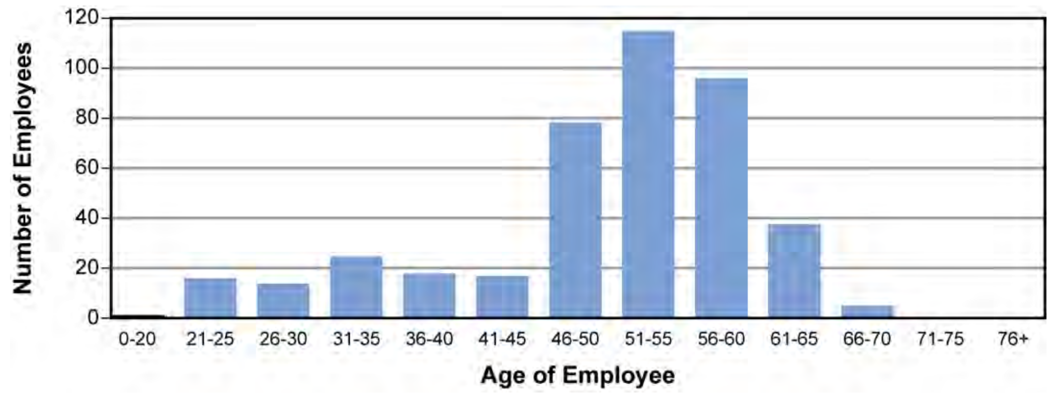
Beyond the SRTE Defense Programs mission, SRS provides significant support for many parts of NNSA and additional national security mission space. More than half of the SRNL budget supports this NNSA and national security scope.

SRTE's mission success highly depends on vital M&O support services that are acquired on an as-needed basis. For example, in FY 2014, 260 SRNL personnel supported tritium-related missions, of which 65 (25 percent) were full time and 195 (75 percent) were part time. Overall, in FY 2014, M&O support services consisted of the equivalent of 849 full-time heads in addition to the 426 tritium staff, making a total of 1,275. NNSA's SRTE also pays its share of an indirect allocation of M&O staff to maintain roads, steam, fire, water, medical, *etc*.

The majority of the workforce within SRTE has been relatively stable over the last three years. However, two pockets of instability exist: (1) as the workforce continues to age SRTE has experienced an uptick in retirement, and (2) the geographical area where the site is located is in the hub of the commercial nuclear power renaissance, posing considerable local competition for talent. Some employees have taken opportunities with other nuclear partners that offer higher levels of pay. While attrition has increased in the last few years, attrition rates remain relatively low compared to commercial standards.

SRTE is still staffed appropriately at this point to support all mission needs. Its focus will be on how to attract and retain a workforce in advance of the continued escalation in retirements of a very experienced workforce.

Figure D–69. SRS total headcount



Notes:

The SRTE group will be facing an uptick in retirements over the next ten years.

SRTE employees average 50.2 years of age, and approximately 50 percent of the population are between the ages of 51 to 60.

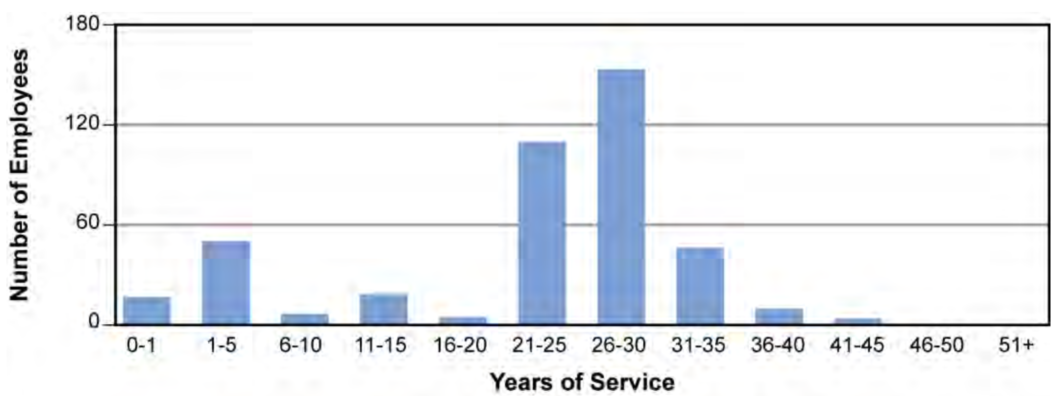
Based on age demographics and retirement eligibility, SRTE must have plans in place to address workforce replacements as its experienced employees retire or leave the workforce.

Approximately 50 percent of the SRTE workforce will be fully retirement eligible by the year 2018.

SRS has seen a significant increase in younger employees; the number of employees in the 20 to 30-year-old age group doubled between 2010 and 2014, primarily as a result of pipeline funding from the Component Manufacturing Development.

SRTE has increased college recruiting and has built relationships with local universities and technical schools.

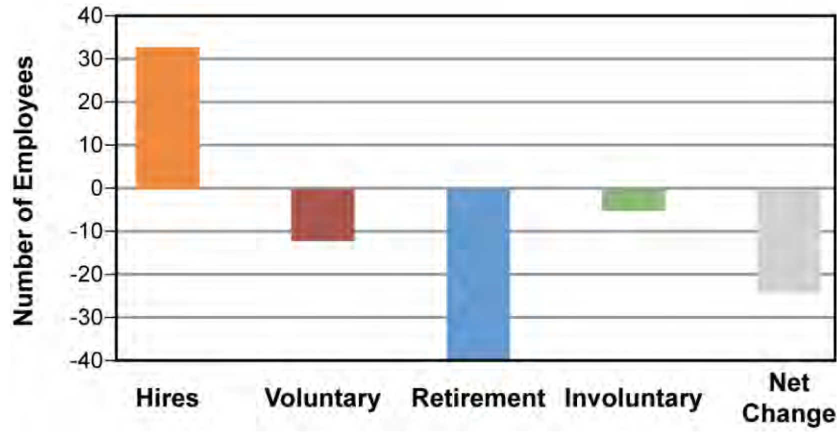
Figure D–70. SRS employees by age



Notes:

SRTE is an organization with an extremely experienced workforce. Currently almost 63 percent of its workforce has 21 to 30 years of experience.

Figure D–71. SRS employees by years of service

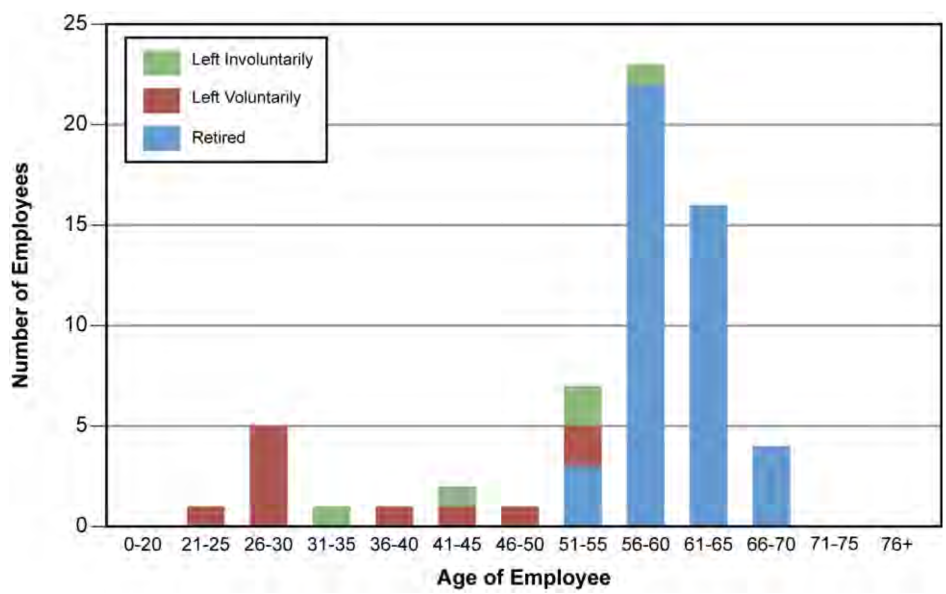


Notes:

During the reporting period, Savannah River Nuclear Solutions, the M&O Contractor for SRS, experienced two workforce restructuring actions. During these actions, many employees elected retirement.

Because the NNSA budgets were not as severely impacted as the DOE Office of Environmental Management budgets, SRTE was able to continue hiring employees during this time. SRTE was fortunate enough to continue hiring pipeline production operators and engineers through the Readiness Program as a way to ensure future continuity of operations.

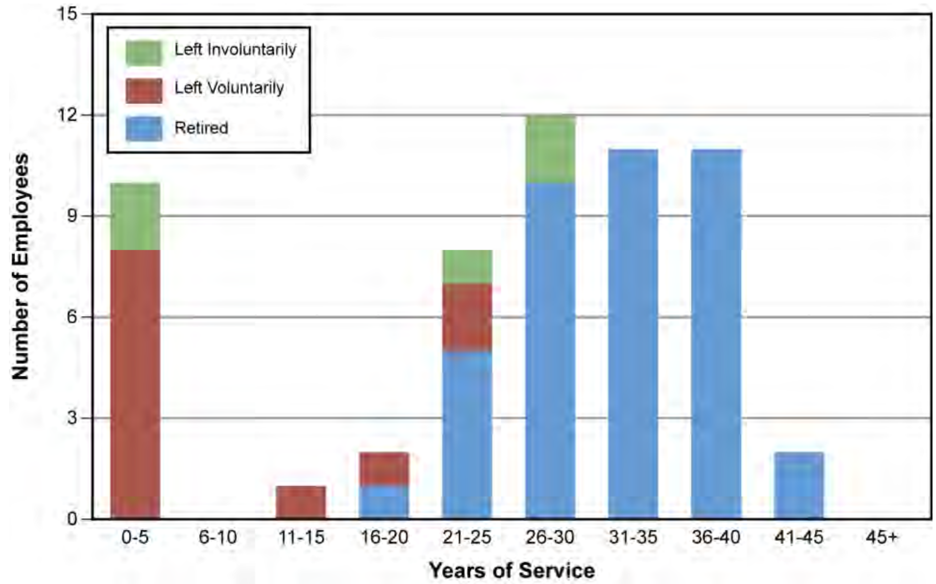
Figure D–72. Change in last two fiscal years at SRS (end of FY 2012 to end of FY 2014)



Notes:

By far, the largest workforce impact was the departure of those employees who elected to retire during the workforce restructuring efforts.

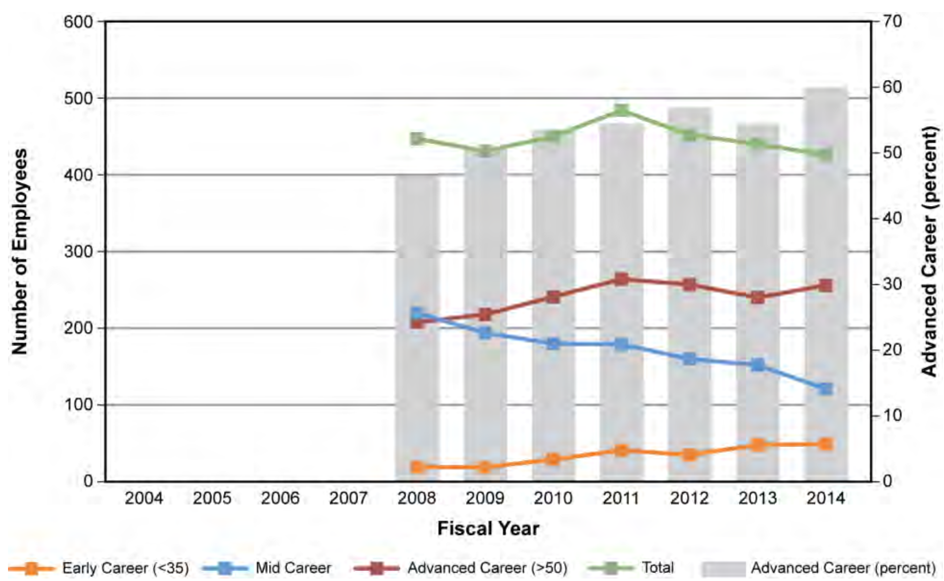
Figure D–73. Age of SRS employees who left service (end of FY 2012 to end of FY 2014)



Notes:

The trend of concern is the number of employees who left in the zero to five-year category (eight voluntary and two involuntary). This is attributed to employees finding other opportunities outside of the site.

Figure D–74. Years of service of SRS employees who left service (end of FY 2012 to end of FY 2014)

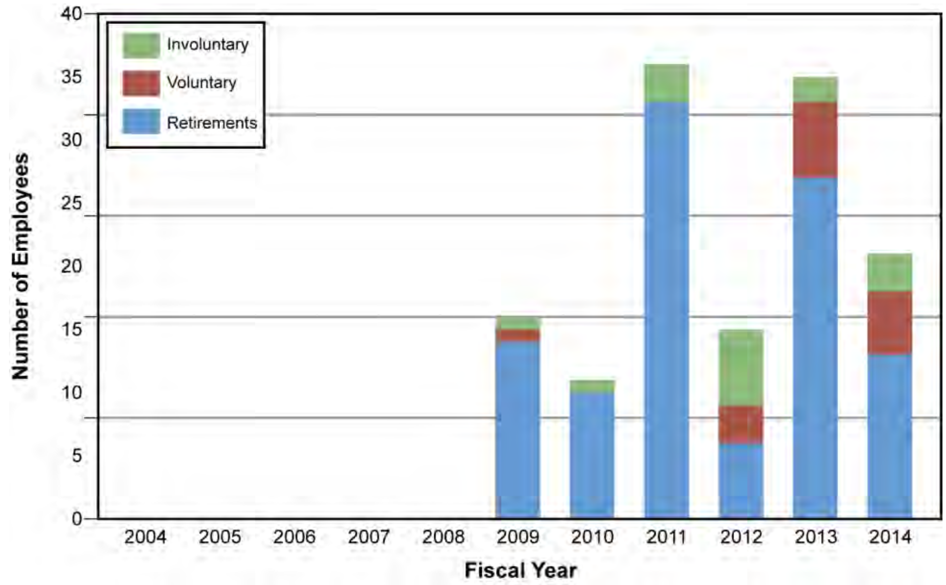


Notes:

Because of changes in how the SRTE personnel were captured in the human resources system, the data cannot be captured accurately prior to 2008.

This chart further illustrates the demographic issues that SRTE has experienced because a significant percentage of its employees are in the advanced-career category.

Figure D–75. SRS trends by career stage

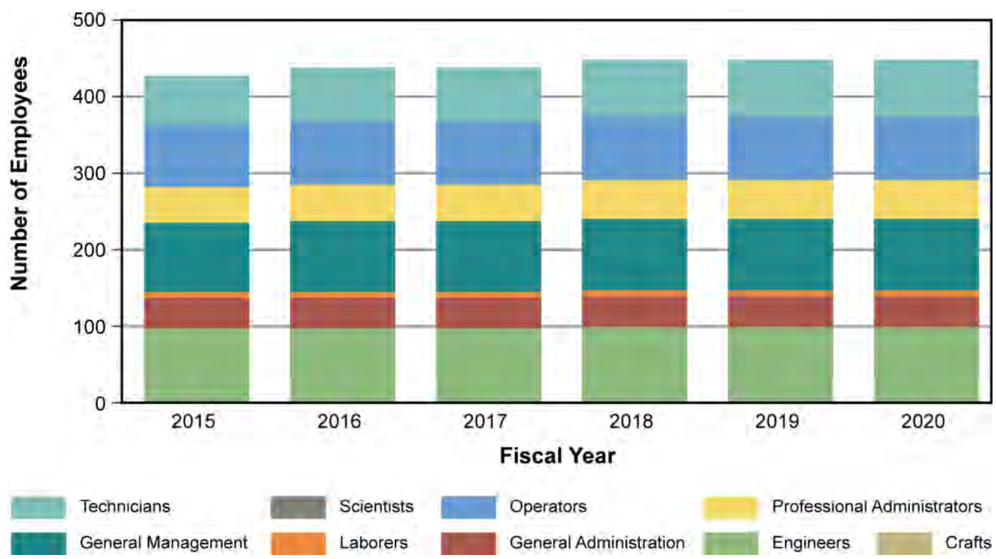


Notes:

As mentioned previously, between workforce restructuring and increasing retirement eligibility among the workforce, SRTE continues to experience a rise in attrition.

SRTE forecasts its future attrition based on historical data and workforce retirement eligibility.

Figure D–76. SRS employment separation trends



Notes:

SRTE does not expect significant workforce growth over the next five years outside of identified needs to cover TRIM Program project execution. Most of that TRIM workforce will be temporary.

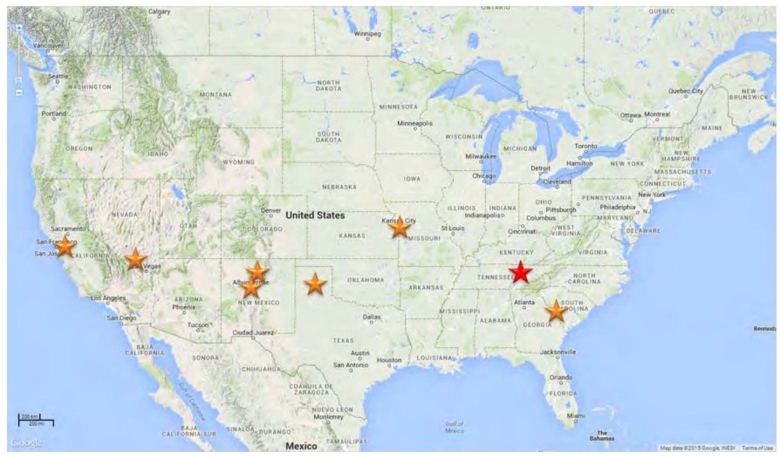
SRTE's larger challenge will be replacing attrition, as the expected increase in retirements will occur over this same time period.

Figure D–77. Total projected SRS workforce needs by COCS over FYNSP

D.3.4 Y-12 National Security Complex

D.3.4.1 Mission

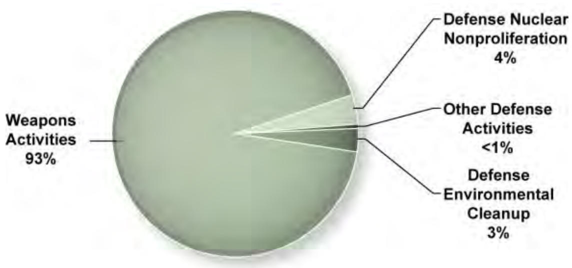
Dating back to World War II, Y-12, originally known as the Electromagnetic Separation Plant, has supported the nuclear security enterprise since its construction in 1943 in Oak Ridge, Tennessee. After separating the uranium for the “Little Boy” bomb, Y-12 continued with its uranium work and expanded its capabilities, facilities, and know-how to meet current and future needs. Today the primary Y-12 missions are maintaining a safe, secure, and effective U.S. nuclear weapons stockpile; providing safe and effective nuclear propulsion systems for the Navy; and reducing the global threat posed by nuclear proliferation and terrorism. Y-12 is the Nation’s only source for enriched uranium components for nuclear weapons. Y-12 manufactures uranium components for nuclear weapons, cases, and other weapons components and evaluates and tests these components. In addition, Y-12 serves as the main storage facility for Category I/II quantities of HEU; conducts dismantlement, storage, and disposition of HEU; and supplies HEU for use in naval reactors.



- Location: Oak Ridge, TN
- Total employees: 4,632
- Type: Multi-program nuclear weapons production facility
- Web site: www.y12.doe.gov
- Contract Operator: Consolidated Nuclear Security (CNS), LLC
- Responsible Field Office: NNSA Production Office Y-12

D.3.4.2 Funding

FY 2016 Site Funding by Source
(Total Y-12 FY 2016 Request = $1,375.1 M)



FY 2016 FYNSP for Weapons Activities
($1,283.6 M)

D.3.4.3 Mission Capabilities

Since 1943, Y-12 has played a key role in strengthening U.S. national security. Y-12 is a leader in nuclear technology and materials, security and consequence management, manufacturing, and technical services. Its expertise in nuclear technologies is also used in support of nonproliferation, homeland security, and other national security objectives. These areas of expertise are indispensable to the nuclear security enterprise and the Nation's nuclear capabilities.

The core capabilities of Y-12 include:

- uranium and other special materials;[1]
- SNM accountability, storage, protection, handling, and disposition;
- enabling infrastructure;
- counterterrorism and counterproliferation; and
- support of other missions and programs.

D.3.4.4 Revitalizing Physical Infrastructure

Most of Y-12's mission-critical facilities are more than 60 years old. To address this situation, Y-12 has been consolidating its operations, modernizing its facilities and infrastructure, and reducing its legacy footprint for more than a decade to assure mission capability and minimize life-cycle operating costs. These actions are consistent with and supportive of the NNSA enterprise transformation planning. Through modernization projects, deferred maintenance reduction, enhanced security measures, technology enhancements, infrastructure reduction, and innovative business practices, Y-12 is focused on providing responsive, cost-effective capabilities to a broad range of national security customers.

NNSA Real Property

Y-12 Ten-Year Site Plan for FYs 2014-2023

- 3,018 Acres (owned)
- 337 Buildings/trailers
  - 4,023,132 gsf active and operational
  - 1,123,080 gsf nonoperational
  - 772,141 gsf leased
- Replacement plant value: $ 8,743.9M
- Deferred maintenance: $ 510M

[1] *The strategy for uranium and lithium are presented in Chapter 4, Sections 4.3.3.1 and 4.3.3.2, respectively.*

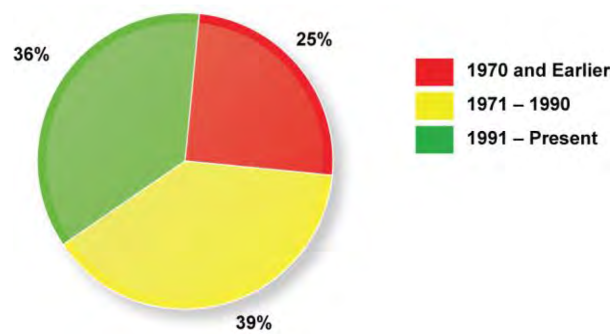
	FYNSP Period						Outyear (Planning) Period		Anticipated Capital Investments	
Y-12 Project Name	FY15	FY16	FY17	FY18	FY19	FY20	FY21-25	FY26-30	FY31-35	FY36-40
Uranium Processing Facility										
Emergency Operations Center										
Electrical Infrastructure for Nuclear Operations (Risk Reduction II)	→									
Lithium Production Facility										
Fire Station		→								
PIDAS Reduction								PIDAS 150->80 acres		PIDAS 80->20 acres
9215 Capability Replacement								→		
Applied Technologies Laboratory								→		

PIDAS = Perimeter Intrusion Detection and Assessment System

Project Key

(blue)	Total Project Costs $10M - $100M	(green)	Total Project Costs $100M - $500M	(orange)	Total Project Costs > $500M
→	Project Delayed from SSMP 2015	(gray)	Projects may not be affordable if preceding projects proceed at high cost estimates		
←	Project CD-4 accelerated from SSMP 2015				

Age of Assets and General Purpose Infrastructure



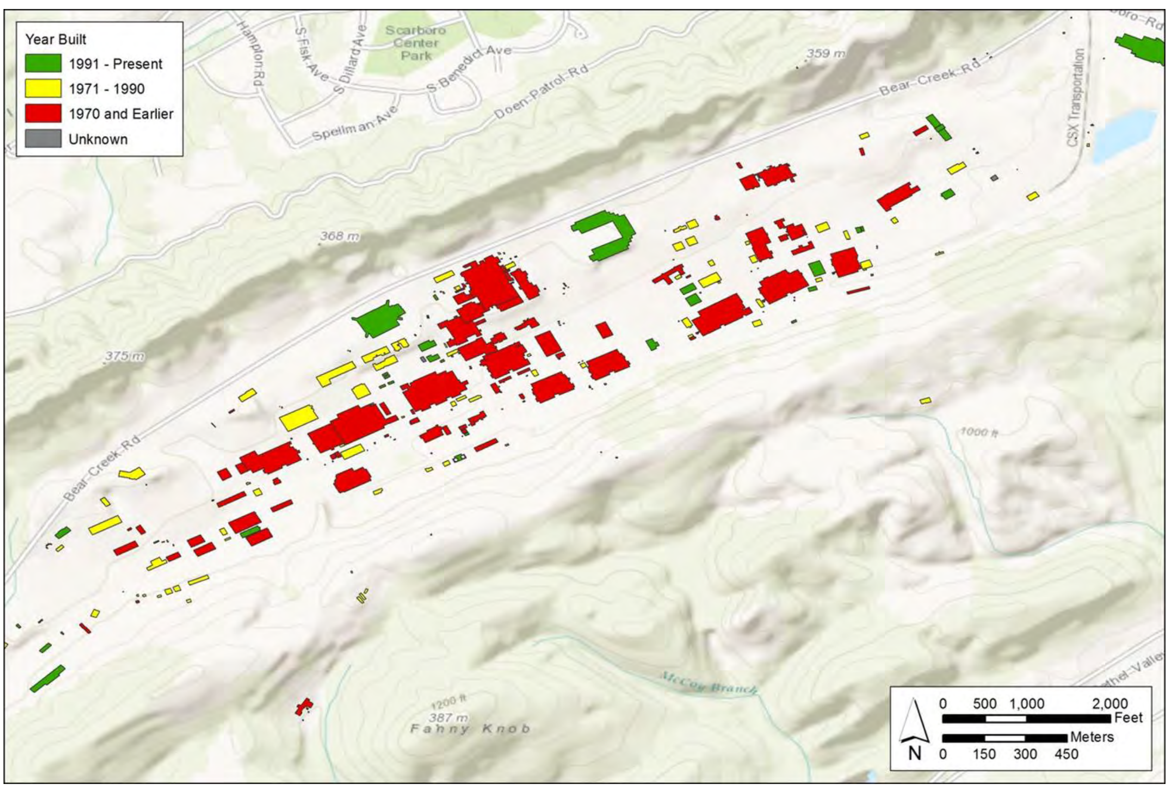


Figure D–78. Y-12 age of facility assets in Oak Ridge, Tennessee

Condition of Assets and Deferred Maintenance

Mission-critical operations are scattered across multiple 40- to 60-year-old facilities. The facilities are oversized, contain technologically obsolete equipment of low reliability, and require excessive maintenance to maintain minimum capability. Much of the critical infrastructure is approaching or beyond the expected design life. Projections beyond 2020 reveal that, with planned construction activities, the condition of mission-critical infrastructure will improve, especially when the Uranium Processing Facility and the Lithium Production Capability Project are operational. Continued investment in equipment and facility improvements for the aging mission-critical infrastructure is necessary to prevent the decline in condition for specific facilities.

The estimate for deferred maintenance is $510 million as reported in the *Y-12 Ten-Year Site Plan for FY 2014 to 2023*. Excess, nonoperational facilities awaiting deactivation and demolition represent $102 million of that amount.

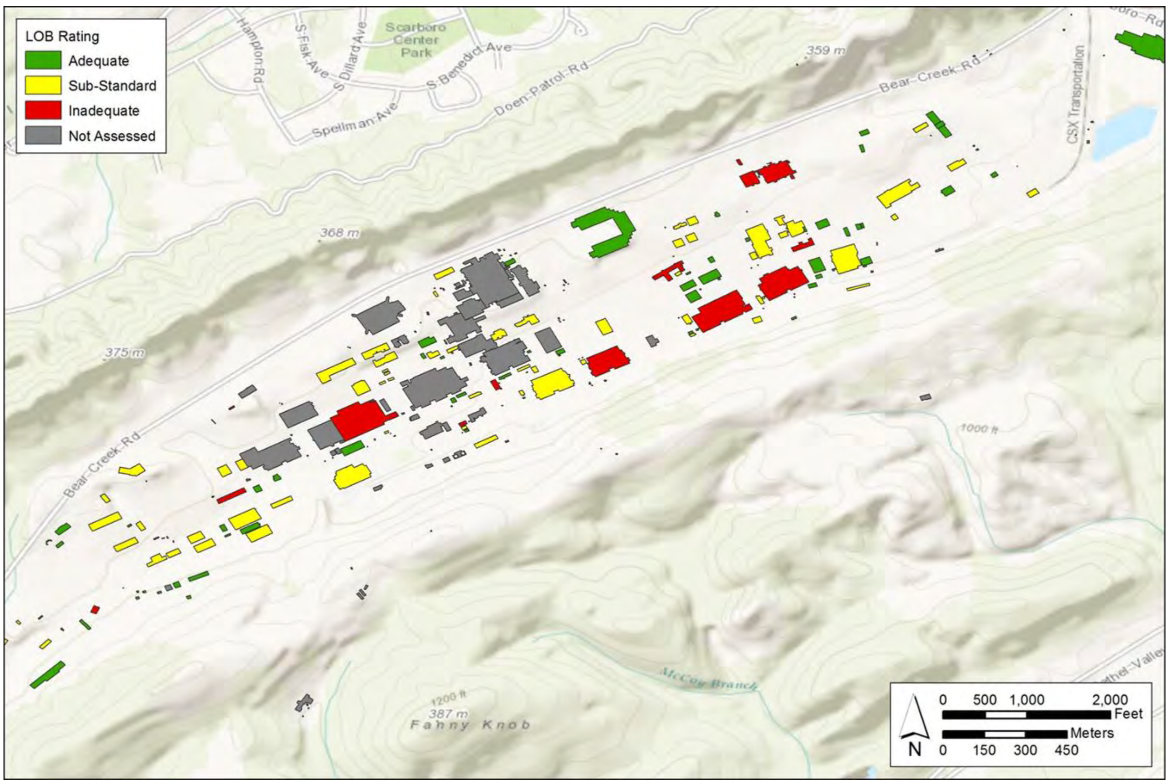


Figure D–79. Laboratory Operating Board rating for Y-12 facility assets in Oak Ridge, Tennessee

Taking into consideration the condition of Y-12 assets, the goals and objectives of U.S. nuclear deterrence strategy, and additional national security mission capability requirements, the following four major elements define the planned physical infrastructure improvement strategy at Y-12 over the planning horizon.

- **Replacement and Revitalization of Mission Capability.** The mission capability challenges for Y-12 lie primarily with uranium and lithium. The Uranium Processing Facility will replace most of the HEU production functions currently performed in Building 9212. The uranium strategy also includes upgrades and technologically advanced capabilities for the existing Buildings 9204-2E and 9215. A Lithium Production Capability Project is planned to replace the lithium production functions now performed in Building 9204-2.
- **Security Downsizing and Consolidation.** Y-12 continues to pursue opportunities to reduce the size of its Protected Area. Currently, opportunities exist to reduce the Protected Area from 150 acres to 80 acres. In addition, activities continue to consolidate SNM into fewer areas. Coordination of security projects and Defense Programs projects is being pursued to complete these consolidations, as well as downsizing.
- **Continued Operation of Enduring Facilities**. In addition to facility replacement, Y-12 is actively consolidating functions into fewer existing facilities and reducing the operating footprint. A number of “enduring facilities” must remain operational through the long term. The categorization of a facility as “enduring” is a factor in prioritizing repairs and maintenance. Facility assessments, facility risk-reduction initiatives, deferred maintenance analyses, and funding prioritization ensure these facilities continue to operate. Under the current Uranium Processing Facility plans, Buildings 9204-2E and 9215 will remain vital enduring facilities. While buildings like 9212 are not considered enduring, the critical nature of their functions demands appropriate risk reduction.
- **Deactivation and Demolition of Legacy Facilities**. Since 2002, Y-12 has demolished more than 1.4 million square feet of excess facilities. The NNSA Facilities Disposition Plan will identify and evaluate excess assets, prioritize their disposition, and propose the budget resources required for their disposition. This NNSA initiative, in concert with the DOE Office of Environmental Management deactivation and demolition program, is vital to future site management. Without a commitment to eliminate excess facilities, Y-12 and other NNSA sites will continue to use limited resources to safely maintain those facilities that no longer have a mission use.

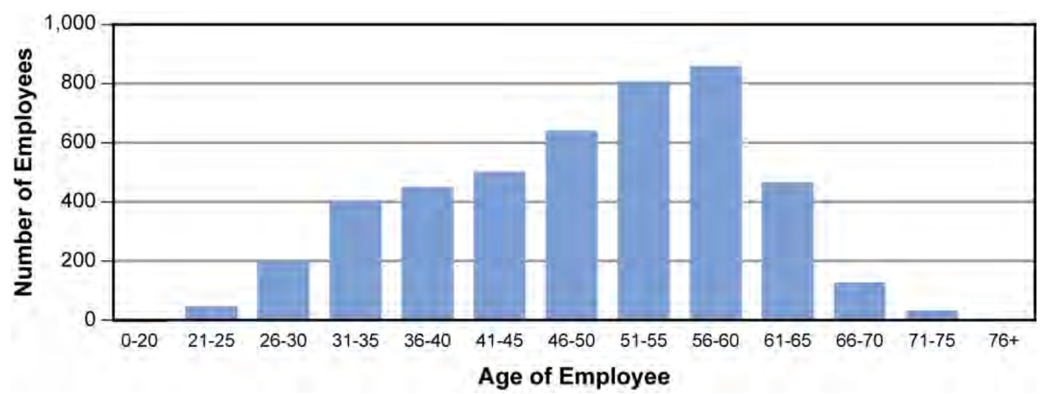
D.3.4.5 Y-12 National Security Complex Workforce

Notes:

The laborers category at Y-12 includes the security guard force, making it one of the largest groups.

The security guard force (563 personnel) was transitioned to the M&O payroll on October 29, 2012.

Figure D–80. Y-12 total headcount

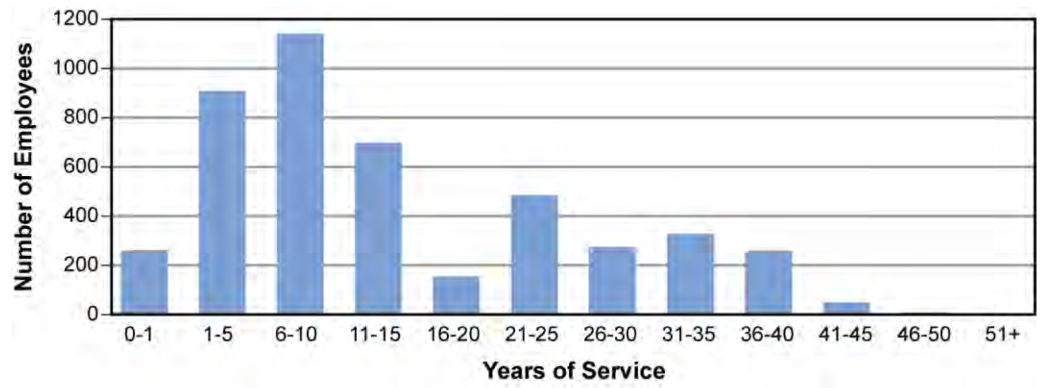


Notes:

Y-12 is steadily replacing its aging workforce.

The average age is 49 years old; 49 percent are age 50 or below, and 40 percent are eligible to retire.

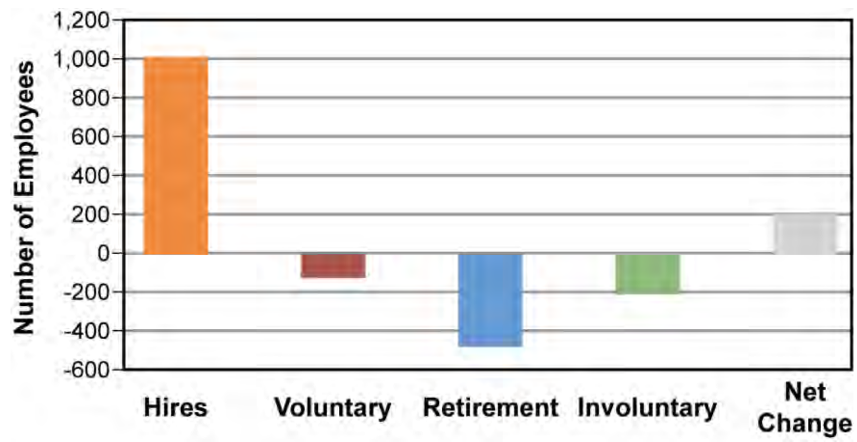
Figure D–81. Y-12 employees by age



Notes:

The average length of service at Y-12 is 14 years; 50.5 percent of employees have less than 10 years of service.

Figure D–82. Y-12 employees by years of service

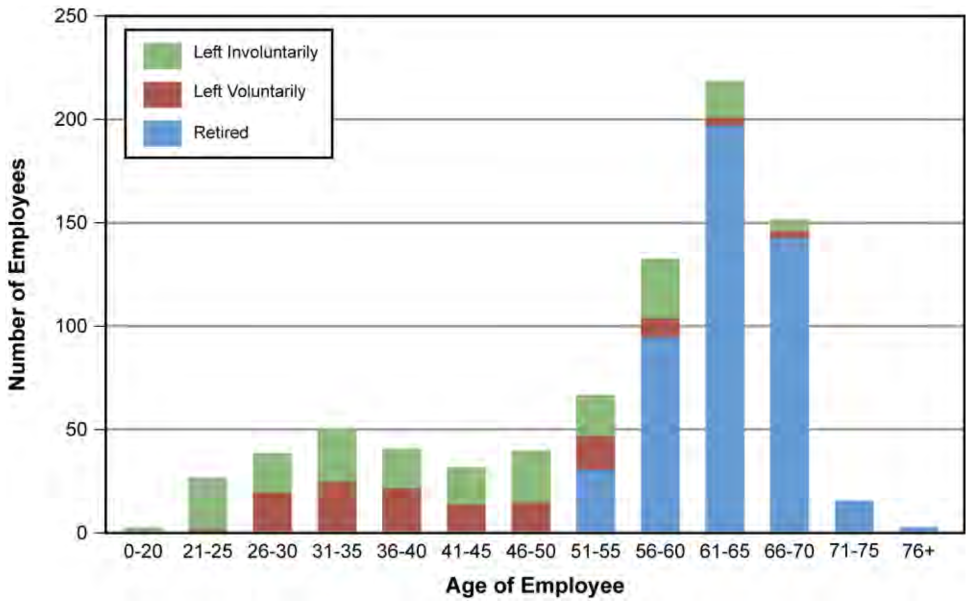


Notes:

A total of 563 security guard force employees were transitioned to the M&O payroll and began work as Y-12 employees on October 29, 2012.

A Voluntary Separation Program, normal retirements, and involuntary separations offset the increase associated with the security guard force.

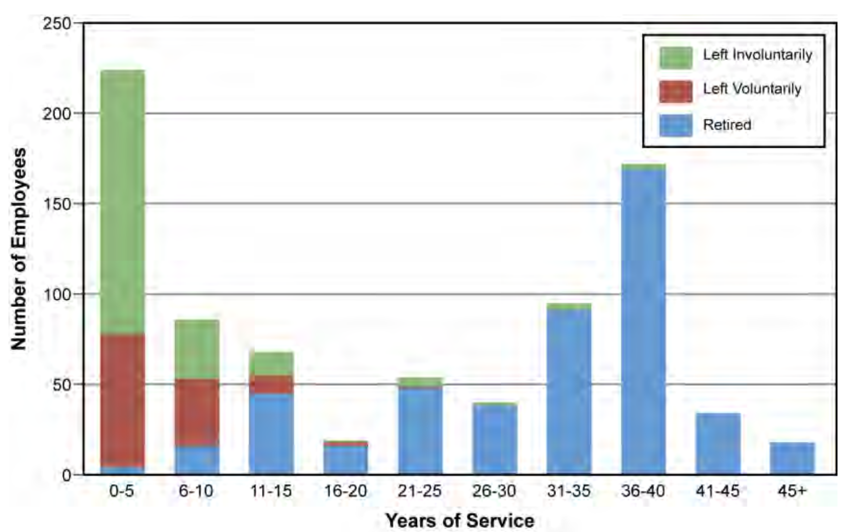
Figure D–83. Change in last two fiscal years (end of FY 2012 to end of FY 2014)



Notes:

There are no perceived irregularities with the separation data. Some 77 percent of the terminations were employees aged 51 and above. The group with the largest number of terminations was the 61 to 65 age band. A Voluntary Separation Incentive Program was offered on April 24, 2014, with terminations effective no later than June 30, 2014. The Voluntary Separation Incentive Program resulted in 105 terminations; in addition there were 7 involuntary reductions in force during FY 2014.

Figure D–84. Age of Y-12 employees who left service (end of FY 2012 to end of FY 2014)

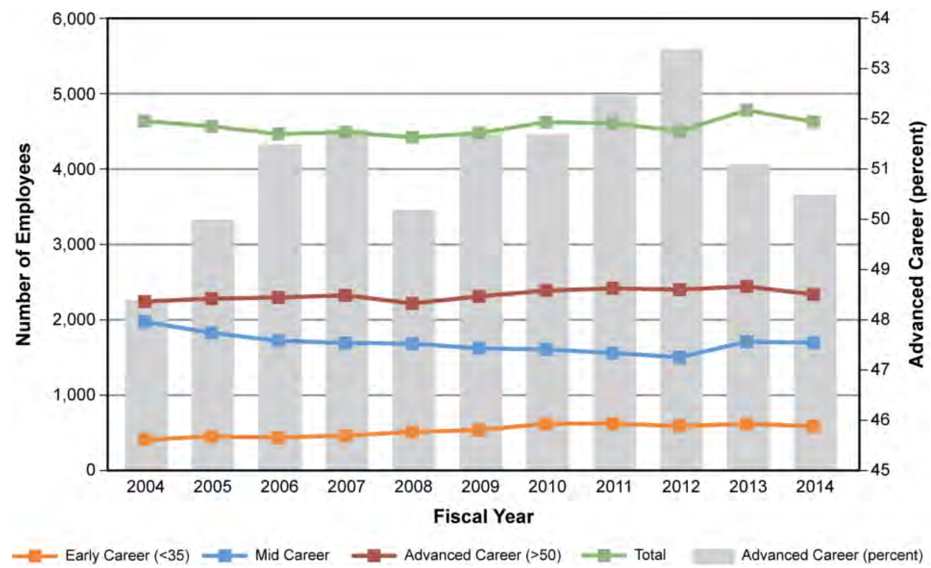


Notes:

Most voluntary separations are employees with less than five years of service.

Most retirees leave with 36 to 40 years of service.

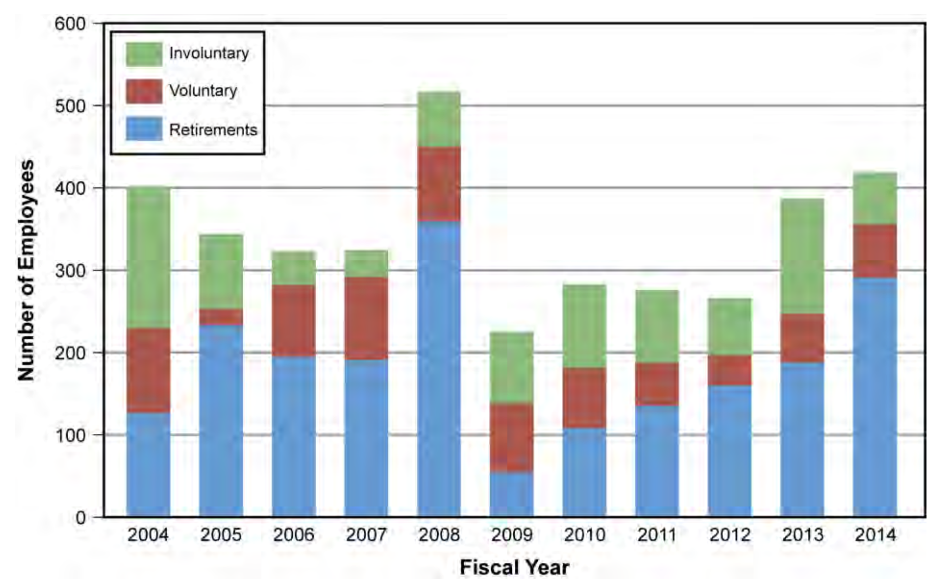
Figure D–85. Years of service of Y-12 employees who left service (end of FY 2012 to end of FY 2014)



Notes:

Most voluntary terminations are employees with less than 5 years of service; most retirees who leave have between 36 and 40 years of service.

Figure D–86. Y-12 trends by career stage

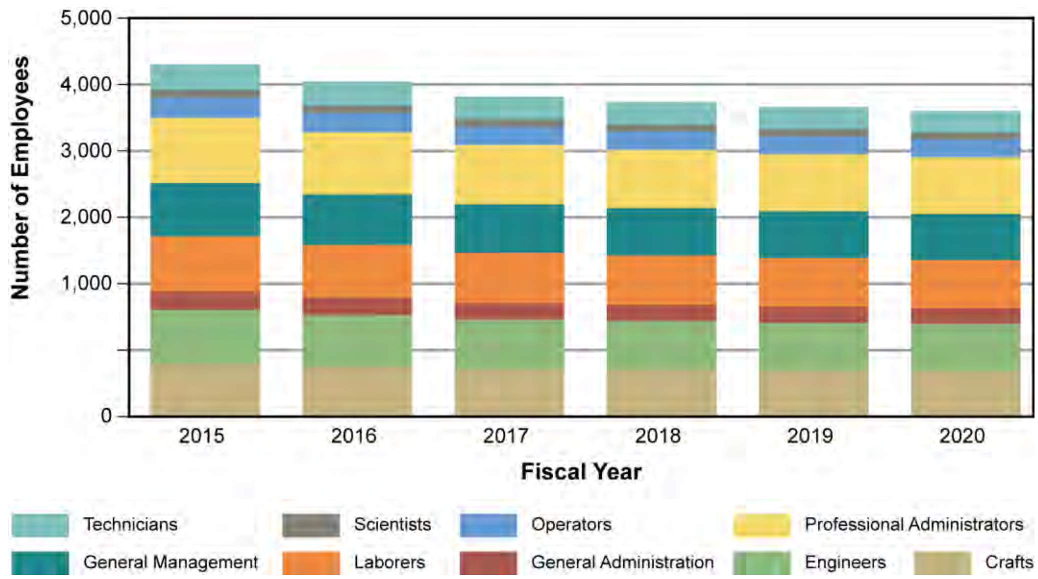


Notes:

In FY 2008, a Voluntary Separation Incentive Program was offered that accounted for the high number of retirements that year.

Effective July 1, 2014, Consolidated Nuclear Security became the new managing contractor for both Y-12 and Pantex. A Voluntary Separation Incentive Program was offered in April 2014 with terminations effective no later than June 30, 2014. The Voluntary Separation Incentive Program at Y-12 resulted in 105 terminations by way of voluntary separations, and there were 7 involuntary reductions in staff during FY 2014.

Figure D–87. Y-12 employment separation trends



Notes:

With the new contract in place for the operations of Pantex and Y-12, cost efficiencies and workforce optimization will be realized through systems and operational integration and other planned cost savings initiatives. This is reflected in the workforce projections for both Pantex and Y-12.

Figure D–88. Total projected Y-12 workforce needs by COCS over FYNSP

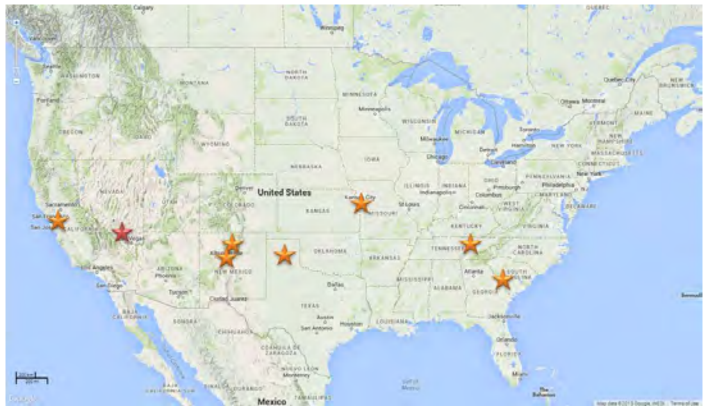
D.4 The Test Site

D.4.1 Nevada National Security Site

D.4.1.1 Mission

The Nevada National Security Site is host to a suite of key national security missions including helping to ensure a safe, effective, and reliable stockpile; ensuring compliance with treaty obligations; and protecting the homeland. Within these missions are a wide range of activities that include:

- planning and executing subcritical experiments and developing experimental platforms and diagnostic systems for defense experimentation and stockpile stewardship;
- supporting homeland defense through chemical, biological, radiological, nuclear, and explosive threat reduction, treaties and monitoring, and cyber security (*e.g.*, global security); and
- conducting waste and restoration programs (environmental and waste management).



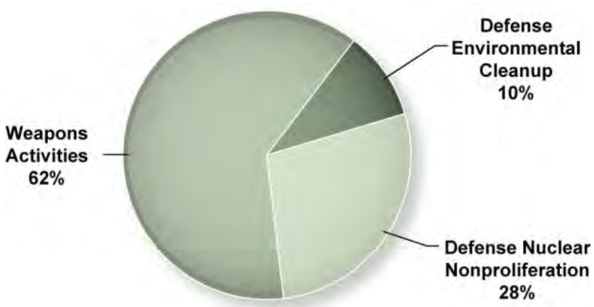
The Nevada National Security Site supports stockpile stewardship *via* plutonium and surrogate subcritical experiment execution, data capture and post processing, diagnostic R&D, and reanalysis of legacy underground test data. These activities support LANL and LLNL pit reuse options by building the science base and also increase the understanding of the performance of all weapon systems. Scaled subcritical experiments with plutonium and surrogates at U1a[1] provide a principal linkage to both scaled and full-scale hydrodynamic tests at other firing sites and to legacy underground nuclear test data. The subcritical experiments enhance predictive capability, challenge next-generation weapon designers, and build confidence in assessing the stockpile and certifying weapons modernized through LEPs. As one of the most useful multi-disciplinary technical activities, subcritical experiments enhance the competency of the Nevada National Security Site and national security enterprise workforce in the formality of underground and nuclear operations as part of test readiness.

- Location: Las Vegas, Nevada
- Additional Operating Capabilities: Support for offices at LANL, LLNL, and SNL; the Remote Sensing Laboratory at Nellis Air Force Base and Andrews Air Force Base; and the Special Technologies Laboratory in Santa Barbara, California
- Total employees: 2,133
- Type: Multi-program test site
- Web site: www.nv.energy.gov
- Contract Operator: National Security Technologies (NSTec), LLC

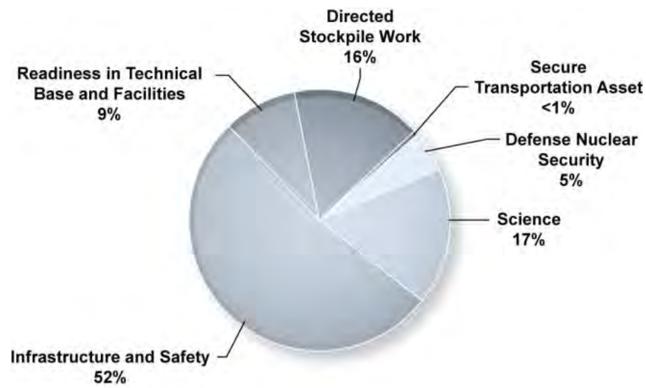
[1] *The U1a Complex, a Hazard Category 3 nuclear operation, is the only U.S. location authorized to conduct subcritical experiments with both HE and weapons-relevant quantities of plutonium.*

D.4.1.2 Responsible Field Office: Nevada Field Office Funding

FY 2016 Site Funding by Source
(Total NNSS FY 2016 Request = $397.1 M)



FY 2016 FYNSP for Weapons Activities
($245.2 M)



D.4.1.3 Mission Capabilities

This section summarizes the Nevada National Security Site's key experimental facilities that directly support ongoing assessments of the Nation's nuclear weapons stockpile. These facilities provide platforms for complex experiments with HE, SNM, and advanced diagnostic technologies.

- The 100,000 square-foot Device Assembly Facility is a Hazard Category 2 nuclear facility that supports nuclear weapon experimental capabilities. The Device Assembly Facility is one of two facilities in the nuclear security enterprise that allows colocation of HE and SNM, permits staging of large quantities of SNM in independent buildings, and provides the backbone to support various missions at the Nevada National Security Site. For stockpile stewardship, its glove box, downdraft table, and radiography capabilities support assembly of SNM targets for JASPER, as well as SNM and HE packages for subcritical experiments at U1a. The Device Assembly Facility also hosts the National Criticality Experiments Research Center, which is a unique asset that supports a mix of critical and subcritical benchmark quality experiments, as well as detector development, inspector and first responder and criticality safety training, and handling of damaged nuclear weapons.
- Subcritical experiments at U1a, which are Hazard Category 3 nuclear operations, focus on early explosion-time hydrodynamic (fluid-like flow) characterization of plutonium and its surrogates in weapon-relevant geometries. The data are critical to the mission of the national security laboratories to maintain a safe, secure, and effective stockpile. The Nevada National Security Site, LLNL, LANL, and SNL plan to enhance the U1a to enable well-diagnosed, early- and late-time radiographic and neutron reactivity measurements during hydrodynamic tests. The new data will facilitate assessing the effects of aging and manufacturing processes on stockpile weapons. The goal is to have these enhancements in place to support options for the B61-12 first production unit, the development phase of the W80-4 (the cruise missile warhead replacement), and IWs. These programmatic infrastructure investments will improve the understanding of the explosion life cycle of weapon primaries and the capability to certify modernized weapons.
- The JASPER facility at the Nevada National Security Site is a two-stage light gas gun for studying the behavior of plutonium and other materials at high pressures, temperatures, and strain rates.

Experiments on both plutonium and surrogates are conducted at this Hazard Category 3 nuclear facility. The JASPER experiments study weapon-related and other national security materials of various compositions, manufacturing processes, surface preparation, ages, and phases under weapon-like conditions and extreme states. The precision data obtained enable the calibration of nuclear weapons design codes.

- The Nevada National Security Site also includes a variety of administrative, R&D, mixed laboratory, calibration, and diagnostic development facilities that support Directed Stockpile Work and other national security missions.

D.4.1.4 Revitalizing Physical Infrastructure

The Nevada National Security Site is a unique national asset because of its remote location and physical characteristics, along with its history and ongoing execution of high-technology, high-hazard, and high-security operations and capabilities. That existing infrastructure investment will be lost if some of the funding support is not increased.

NNSA Real Property

Fiscal Year 2014 NNSA/NFO
Nevada Field Office Ten-Year Site Plan

- 868,492 Acres: (leased/owned)
- 462 Buildings/trailers: (leased/owned/permitted)
  - 2,670,497 gsf active and operational
  - 425,242 gsf nonoperational
  - 179,368 gsf leased
- Replacement plant value: $3,293,884,839 (total assets)
- Deferred maintenance: $ 211,843,438 (total assets)

The Nevada National Security Site has created a strategic framework to increase the understanding of the current and future infrastructure conditions and mission risk. The following three approved or proposed capital construction projects (also shown in Chapter 4, Figure 4–4) are integral to that strategic framework and represent steps toward revitalizing the Nevada National Security Site's critical infrastructure.

- **New 138-kV Power Transmission Corridor.** This approved project replaces the primary wood pole transmission line to provide power to the majority of the site *via* steel towers.
- **Water Supply and Distribution Systems Upgrades.** This proposed project replaces elements of the water supply and distribution systems to the critical forward-area facilities.
- **Consolidated Mission Support Facility.** This proposed project will be a centerpiece of site plans to combine targeted investments with the continued enhanced use of the newest facilities and support systems in one centralized, consolidated complex supporting the forward area.

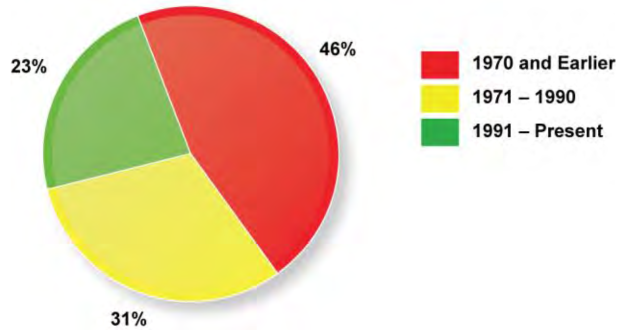
	FYNSP Period						Outyear (Planning) Period		Anticipated Capital Investments	
Nevada National Security Site Project Name	FY15	FY16	FY17	FY18	FY19	FY20	FY21-25	FY26-30	FY31-35	FY36-40
New 138kV Power Transmission Event Corridor										
Consolidated Mission Support Facility										
Water Supply and Distribution System										

Project Key

	Total Project Costs $10M - $100M		Total Project Costs $100M - $500M		Total Project Costs > $500M
→	Project Delayed from SSMP 2015		Projects may not be affordable if preceding projects proceed at high cost estimates		
←	Project CD-4 accelerated from SSMP 2015				

Age of Assets and General Purpose Infrastructure

A majority of the Nevada National Security Site facilities and infrastructure were built before 1990. Many of these have already reached the end of their useful lives, both structurally and technologically.



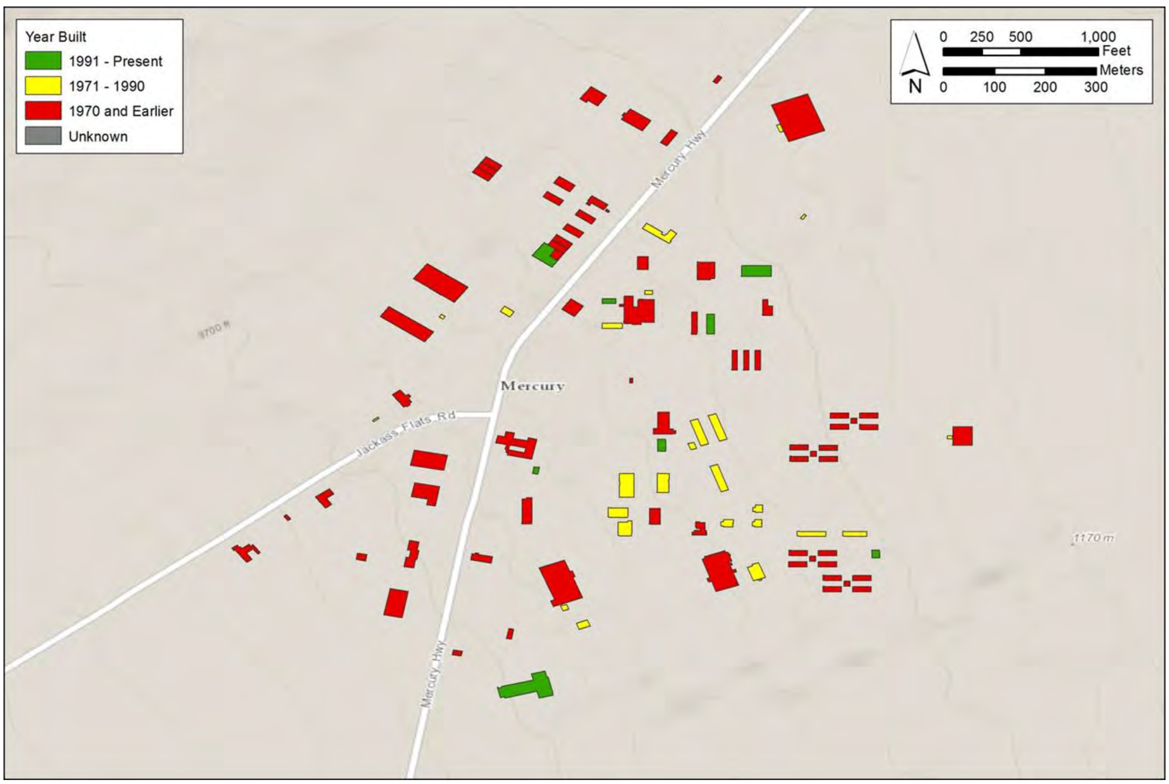


Figure D–89. NNSS age of facility assets in Mercury, Nevada

Facility Conditions and Deferred Maintenance

The current estimate for deferred maintenance at the Nevada National Security Site, as reported in the *Fiscal Year 2014 NNSA/NFO [Nevada Field Office] Ten-Year Site Plan*, is $211,843,438 (total assets). Deferred maintenance will continue to increase as preventive maintenance resources decrease and more facilities are classified for shutdown or allowed to run to failure as part of controlled degradation.

- Sixty-three percent of the building square footage is over 30 years old. This situation is exacerbated by a large number of temporary buildings that have been kept in operation for decades beyond their expected life.
- A large percentage of the utilities need major rehabilitation or replacement. Many elements in the electrical, water, and communications areas are rated as poor.
- The 138-kV wood pole transmission system, the backbone for providing electric power at the Nevada National Security Site, is over 50 years old and 20 years past its expected useful life.
- A significant portion of the road system is substandard. The estimated 1401 miles of the Nevada National Security Site roadways represent the entire spectrum of rural roadway construction. Most paved roadways were constructed prior to 1965. Approximately 106 miles of roadway is mission-dependent.
- Parts of the telecommunications and information technology infrastructure are technologically outdated and seriously degraded by age, weather, and maintenance issues.
- The trunked radio system, which is essential to continued Nevada National Security Site operations, is beyond its useful life and is beginning to experience outages that impact mission accomplishment, safety, and security.

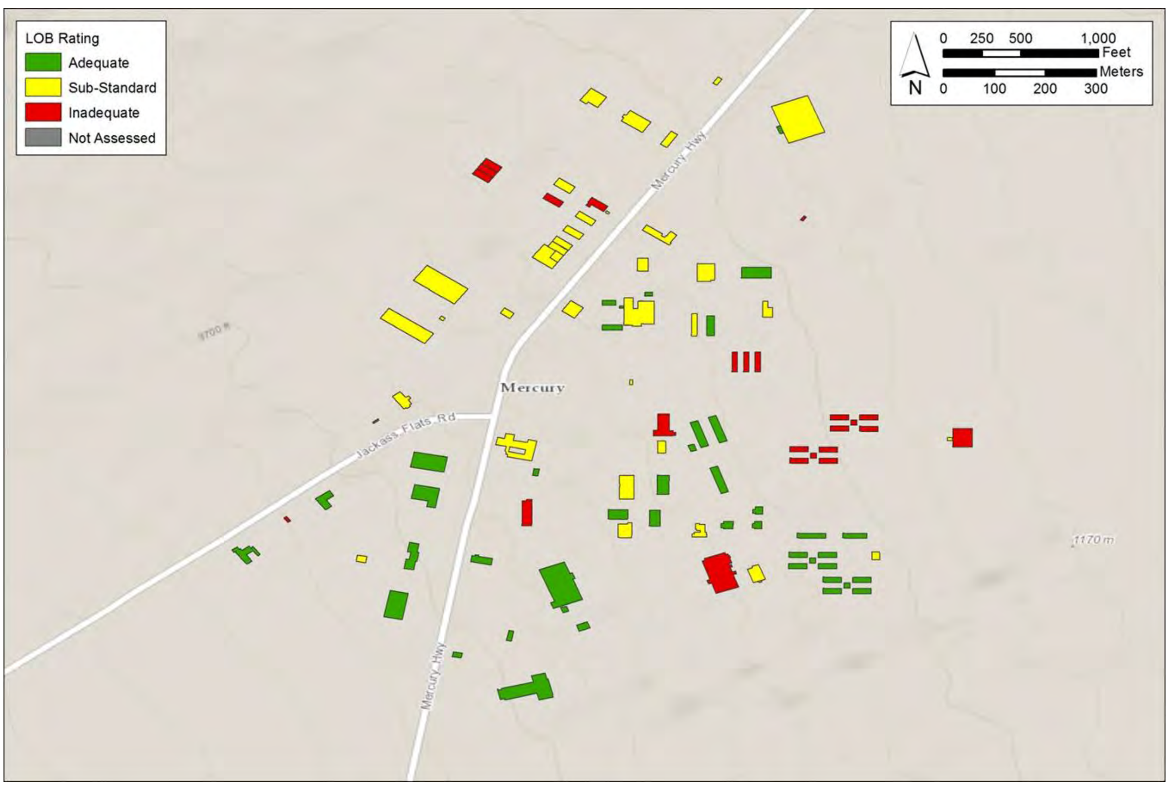
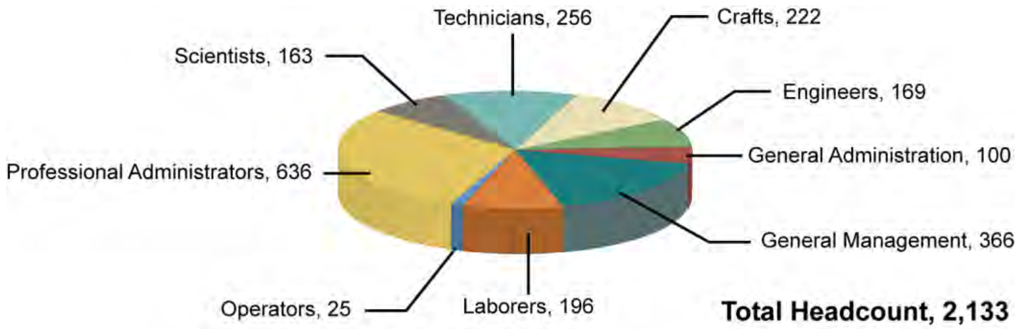


Figure D–90. Laboratory Operating Board rating for NNSS facility assets in Mercury, Nevada

D.4.1.5 Nevada National Security Site Workforce



Notes:

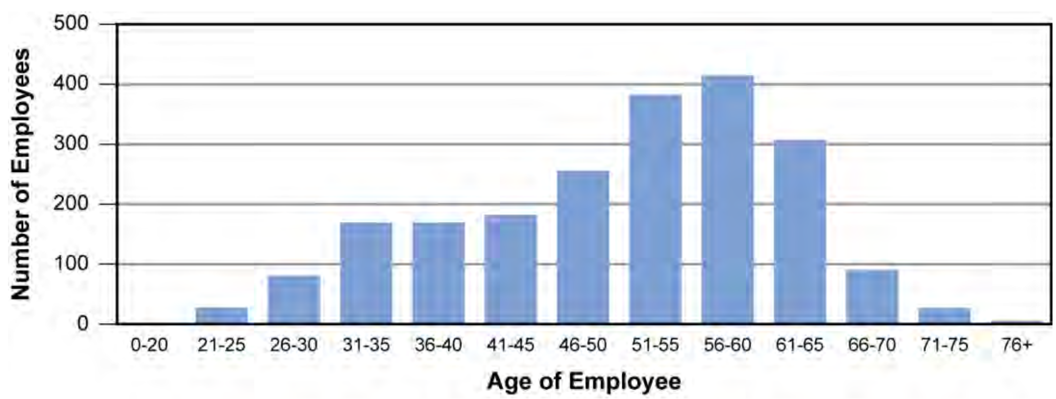
Crafts, laborers, and operators are all in represented positions (covered under collective bargaining agreements).

Of the total employee population, 27.5 percent occupy technical positions.

"Professional administrators" includes Information technology, accounting and finance, human resources, procurement, property, maintenance, facilities, project controls, security, operations specialists, pilots, quality assurance, quality control, non-management medical personnel, *etc.*

Site security is provided by approximately 290 Centerra-Nevada contractors; these personnel are not included in the total headcount of 2,133 detailed above.

Figure D–91. NNSS total headcount

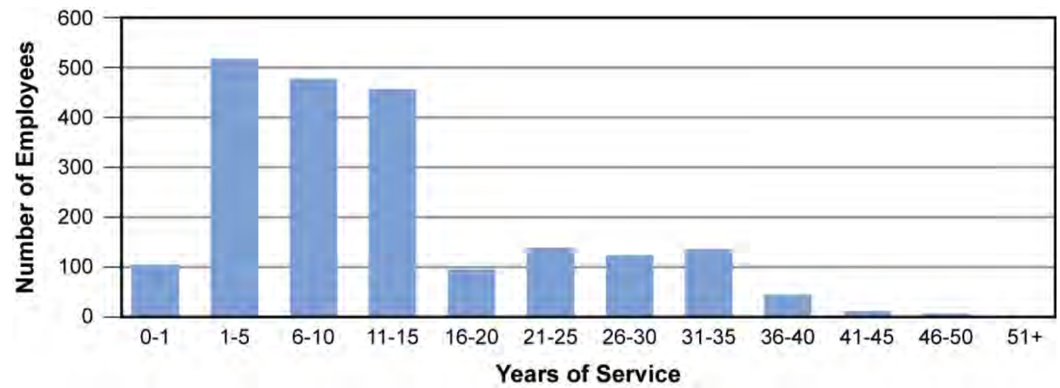


Notes:

Because retirement eligibility varies for each union, bargaining employees age 65 and over are considered eligible for retirement in the analysis of the data.

Non-bargaining employees are eligible to retire at age 55, with at least ten years of credited service. However, the actual average age at retirement has been above the full retirement age (65) for several years.

Figure D–92. NNSS employees by age

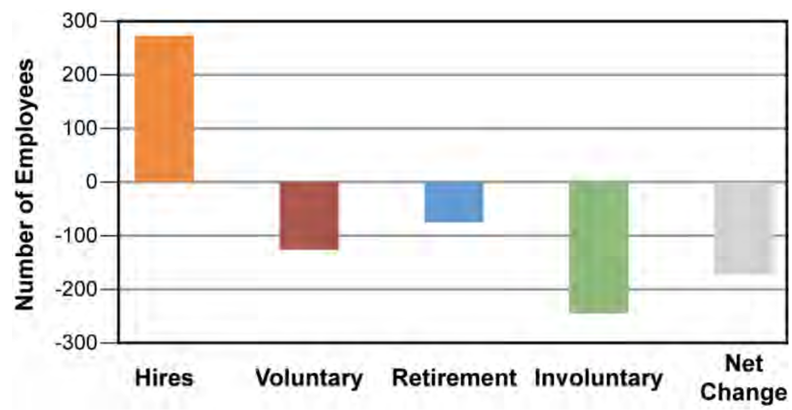


Notes:

In some cases, "Service" includes credited service at other DOE sites and/or with the parent company (*i.e.*, National Security Technologies).

Of the Nevada National Security site employee population, 52 percent have less than ten years of service.

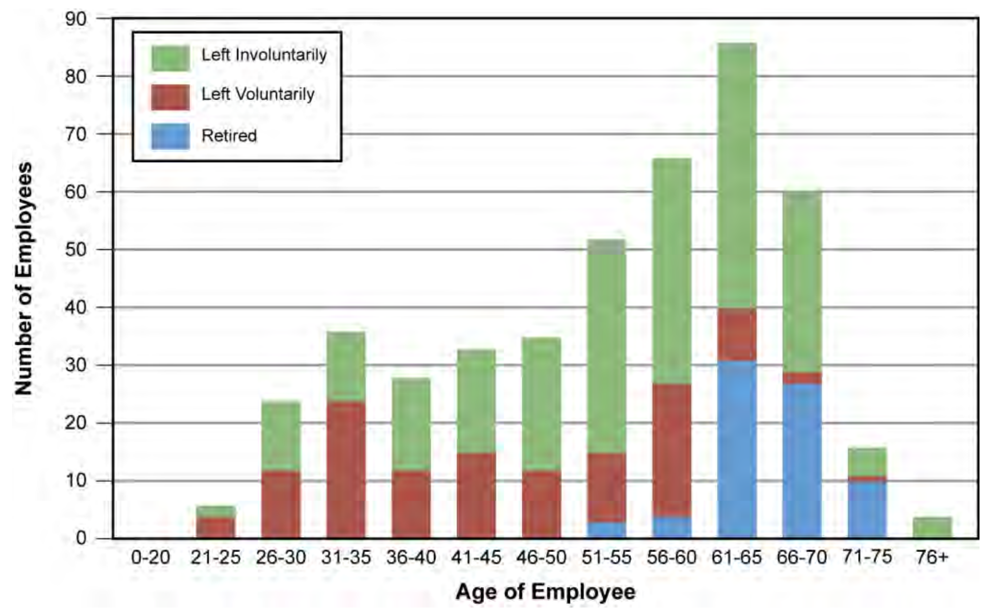
Figure D–93. NNSS employees by years of service



Notes:

"Involuntary" includes 43 employees who were approved to participate in National Security Technologies' Self-Select Voluntary Separation Program in December 2012 because their positions were eliminated, just as in an involuntary layoff.

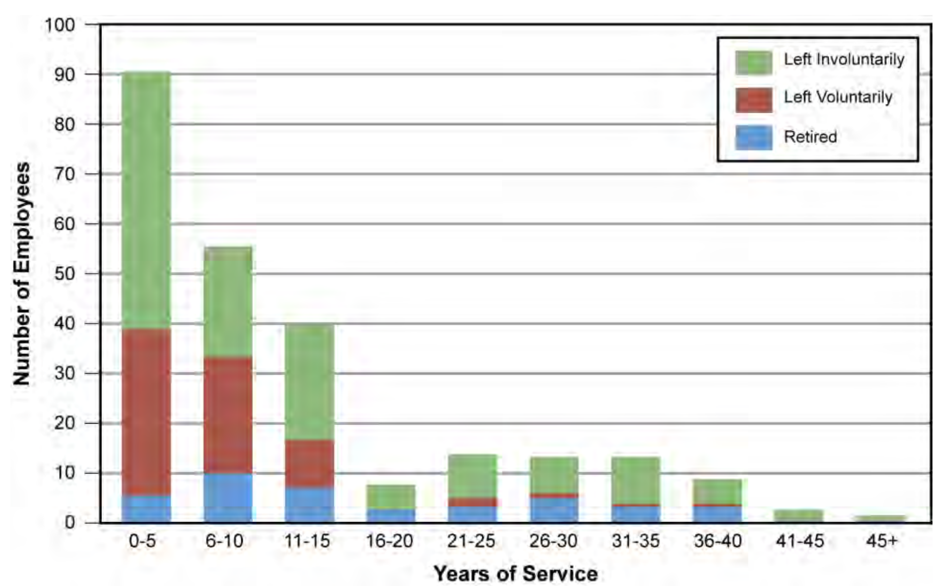
Figure D–94. Change in last two fiscal years (end of FY 2012 to end of FY 2014)



Notes:

With an average age at NSTec of 51, a higher percentage of older employees separating from the company is to be expected.

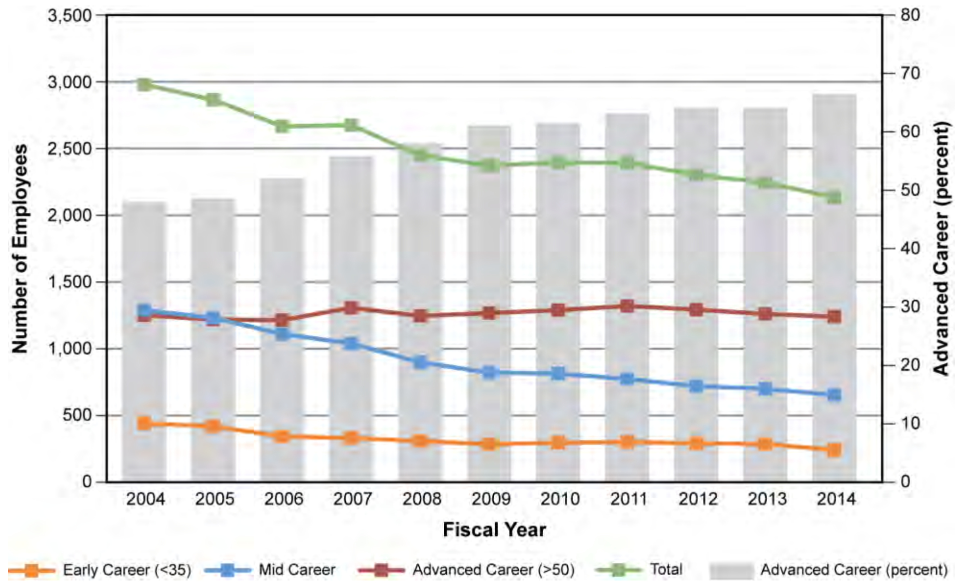
Figure D–95. Age of NNSS employees who left service (end of FY 2012 to end of FY 2014)



Notes:

Bargaining employees who were Laid Off - Short Call – < 6 months were included in this data. National Security Technologies tracks the number of employees who leave within two years of being hired on the monthly dashboard.

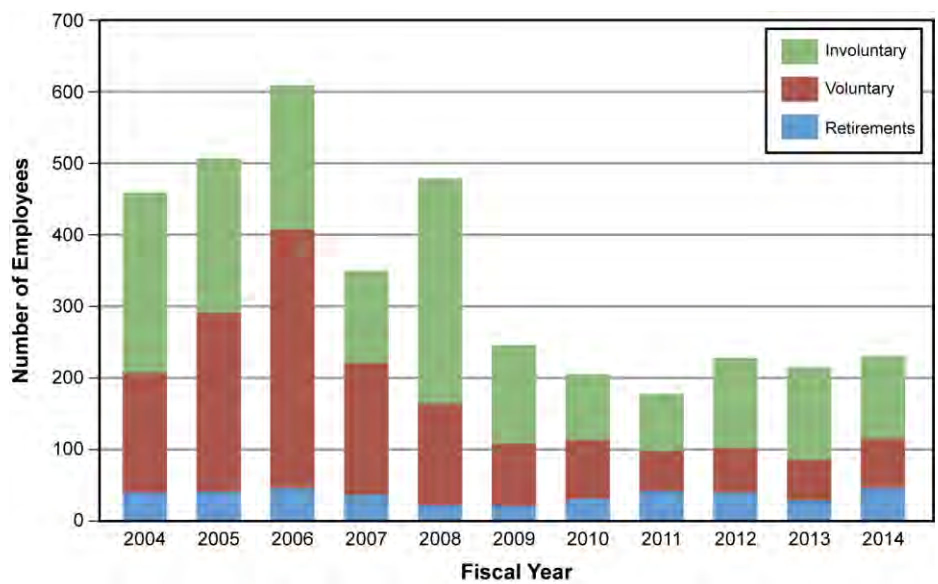
Figure D–96. Years of service of NNSS employees who left service (end of FY 2012 to end of FY 2014)



Notes:

With early career and advanced career (red) populations remaining basically stable, the decreases in overall headcount have come from the mid-career population (blue).

Figure D–97. NNSS trends by career stage



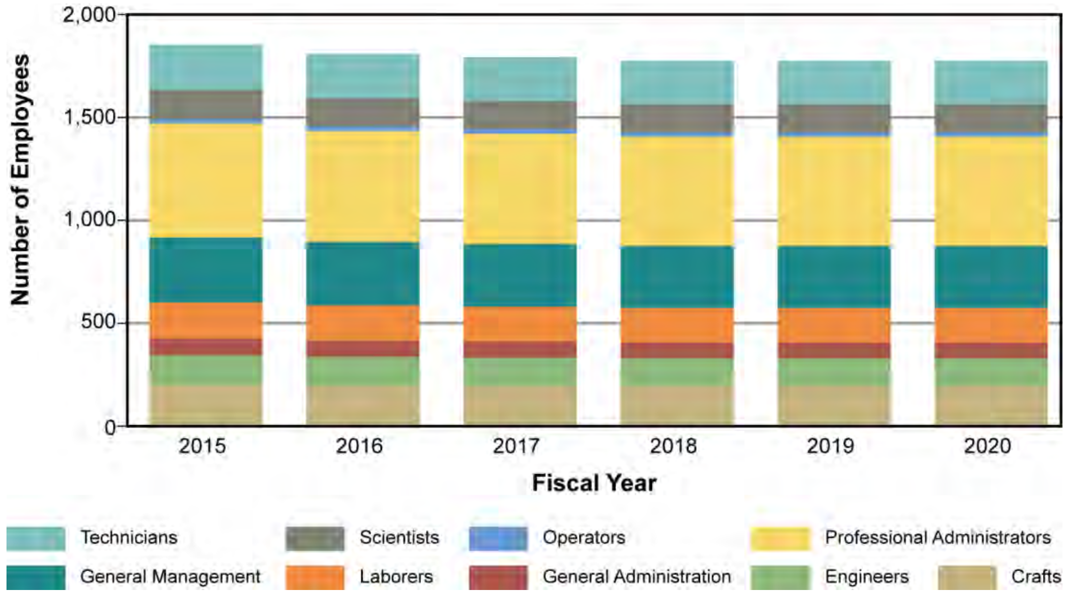
Notes:

The July 2006 contract change influenced the number of voluntary departures during that year.

In FY 2008 NSTec conducted both a voluntary and involuntary layoff (both are included in the involuntary numbers).

In 2012 "Involuntary" includes 43 employees who were approved to participate in National Security Technologies' Self-Select Voluntary Separation Program because the positions were eliminated, just as in an involuntary layoff.

Figure D–98. NNSS employment separation trends



Notes:

Based on the FY 2015 Continuing Resolution, National Security Technologies will reduce the technical workforce that supports Defense Programs over the FYNSP.

National Security Technologies projects that the workforce will be decreased by 24 engineers, 22 scientists, 35 technicians, and 190 other personnel. The guidance given for the remainder of the FYNSP period will bring more reductions until FY 2018 because of the decrease in Program Readiness funding.

Figure D–99. Total projected NNSS workforce needs by COCS over FYNSP

DOE/NA-0029

A Report to Congress

Fiscal Year 2016 Stockpile Stewardship and Management Plan

March 2015

U.S. Department of Energy
National Nuclear Security Administration
1000 Independence Avenue, SW
Washington, DC 20585