IDA

INSTITUTE FOR DEFENSE ANALYSES

Economic Analysis of National Nuclear Security Administration (NNSA) Modernization Alternatives

David E. Hunter, Project Leader
Christina S. Bittle
Frederick S. Celec
Gregory A Davis
Michael S. Helwig
Rob Mahoney
Joshua A. Minix
David J. Nicholls
Paul H. Richanbach
Robert W. Thomas
Laura M. Williams

November 2007

IDA Report R-411
Log: H 07-001498

This work was conducted under contract DASW01-04-C-0003, Task BA-7-2784, for the Office of the Director, Program Analysis and Evaluation. The publication of this IDA document does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

INSTITUTE FOR DEFENSE ANALYSES

IDA Report R-411

Economic Analysis of National Nuclear Security Administration (NNSA) Modernization Alternatives

David E. Hunter, Project Leader
Christina S. Bittle
Frederick S. Celec
Gregory A Davis
Michael S. Helwig
Rob Mahoney
Joshua A. Minix
David J. Nicholls
Paul H. Richanbach
Robert W. Thomas
Laura M. Williams

PREFACE

The Institute for Defense Analyses (IDA) prepared this report for Director, Program Analysis and Evaluation under a task titled “Support to OSD CAIG Analysis of NNSA Weapons Complex Modernization Approaches.” This report provides an economic analysis to support the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) in its evaluation of the proposed National Nuclear Security Administration (NNSA) weapons complex modernization plans.

James D. Silk, James L. Wilson, and James P. Woolsey of IDA were the technical reviewers for this report. Philip L. Major, Robert W. Selden, John S. Foster, and Robert B. Barker constituted the Senior Advisory Group for this study.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

INTRODUCTION

IDA was tasked to conduct an economic analysis of two proposed approaches to transforming and modernizing the U.S. nuclear weapons complex, one recommended by the Secretary of Energy Advisory Board (SEAB) Nuclear Weapons Complex Infrastructure Task Force and the other embodied in the National Nuclear Security Administration (NNSA) plan called “Complex 2030.”

In early 2007, NNSA began a full-scale Programmatic Environmental Impact Statement (PEIS) process. As part of that process, the NNSA Complex 2030 alternative was renamed “Distributed Centers of Excellence (DCE).” A Consolidated Nuclear Production Center (CNPC) alternative, based on the recommendation of the SEAB’s Nuclear Weapons Complex Infrastructure Task Force, was also included in the PEIS.

The Office of Management and Budget and the Office of the Director, Program Analysis and Evaluation, in the Office of the Secretary of Defense instructed IDA to use the PEIS alternatives in our analysis. Thus, this study compares the NNSA’s CNPC alternative with the NNSA’s DCE alternative.

BACKGROUND

The present nuclear weapons complex consists of eight sites: four production facilities (Pantex Plant, Y-12 National Security Complex, Kansas City Plant, and Savannah River Site), three laboratories (Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories), and one test site (Nevada Test Site). Only the two design laboratories, Los Alamos National Laboratory and Lawrence Livermore National Laboratory, can be considered as having similar missions. Each site in the production portion of the complex in particular has its own unique mission.

MODERNIZATION ALTERNATIVES

Some of the main elements of the two modernization proposals are similar. Both call for the following:

- Upgrading the Technical Area 55 (TA-55) plutonium facility at Los Alamos National Laboratory to produce plutonium pits at a rate of 50 pits per year;
- Constructing a new pit production plant, a Consolidated Plutonium Center (CPC), with a capacity of 125 pits per year, at one site;
- Modernizing secondary production facilities; and
- Maintaining assembly/disassembly capability.

The major difference between the proposals is the location of the production facilities. The DCE alternative proposes keeping assembly/disassembly at Pantex, keeping secondary production at Y-12, and building a CPC at one of five existing sites. The CNPC alternative proposes co-locating these activities at one existing site.

The CNPC alternative proposes closing Pantex and/or Y-12. Since only one assembly/disassembly site and only one secondary production site are now available, closing either of these sites would necessitate rebuilding the capability at the CNPC site. The question is whether the additional costs associated with rebuilding these capabilities are offset by the cost savings from closing the site(s).

ASSUMPTIONS

The following are the assumptions made for this study:

- Los Alamos National Laboratory, Savannah River, Pantex, Y-12, and the Nevada Test Site are the candidate sites for the CPC and the CNPC.
- If Los Alamos National Laboratory is chosen as the site for the CPC, TA-55 could be upgraded to achieve a capacity of 125 pits per year. If another site is chosen, a new CPC would have to be built, and pit production at TA-55 would end.
- The future pit production requirement is 125 per year, with a surge capability of 200.
- New facilities are needed for secondary production.
- Assembly/disassembly requirements will eventually be no more than 600 weapons activities per year.
- The CPC and CNPC will be capable of supporting both Life Extension Programs for legacy warheads and production of Reliable Replacement Warheads.

- The CPC and the CNPC will be operational in 2022.
- The U.S. nuclear stockpile will trend towards the Moscow Treaty numbers.
- There will be no further significant increases in security requirements due to changes in the Design Basis Threat.
- Construction costs were estimated assuming that established procedures, regulations, and practices for NNSA construction will remain in effect.
- Any savings that can be achieved through improvements in NNSA management or contracting practices or contracts can be achieved whether or not a facility is moved. Thus, we do not attribute to the CNPC alternative any savings due to improved NNSA practices, as we assume these savings could also be achieved in the DCE alternative.

COST AND SAVINGS ESTIMATES

Decontamination and Decommissioning Costs

The closing or downsizing of a site incurs significant and costly cleanup obligations. Historically, NNSA cleanup costs have ranged from $10 billion to more than $40 billion.

Although we did not directly estimate the likely decontamination and decommissioning costs, we considered the implications of cleanup costs on the modernization alternatives. If cleanup costs were considered, they would be sufficiently large enough to swamp any potential savings achieved from closing a site. Including cleanup costs would further weaken the case for the CNPC since the CNPC alternative would require more cleanup than the DCE alternative.

In this study, Y-12 and Pantex are candidates to close in the CNPC alternative. In the case of Y-12, large cleanup costs would be incurred regardless of whether Y-12 is closed or not, since the plan is to decontaminate and decommission the vast majority of the existing Y-12 infrastructure. For Pantex, these costs would be incurred only with the CNPC alternative, and only if the site were closed.

Major Investments

We estimated four major categories of investment costs: (1) pits, (2) secondaries (canned subassemblies), (3) assembly/disassembly, and (4) mission transition. The estimates for each category are as shown in Table S-1.

The estimated investment cost for NNSA's DCE alternative is $8.5 billion if pit production remains at Los Alamos National Laboratory and TA-55 is upgraded to 125 pits per year. The cost increases to $13.5 billion if a new CPC is constructed at another location. (All cost and savings figures are in FY 2007 dollars.)

Table S-1. Estimates of Investments by Major Category

Category	Cost (FY07$B)
Pits	
Upgrade TA-55 to 50 pits per year	$2.0B
A new pit plant (125 pits per year)	$6.0B
Increasing TA-55 capacity from 50 to 125 pits per year	$2.0B
Secondaries	
Modernization of the Y-12 plant	$4.0B
A new secondary plant at another location	$5.0B
Assembly/Disassembly	
Maintain the Pantex Plant	$0.5B
New assembly/disassembly plant at another location	$4.5B
Mission Transition	
Transitioning a function from one site to another	$1B per move

The estimated investment cost of the CNPC alternative is $15.5 billion if it is located at Pantex, $15.5 billion if it is located at Los Alamos National Laboratory, $18.5 billion if it is located at Y-12, and $20.5 billion if it is located at Nevada Test Site or Savannah River Site.

Potential Savings

We identified three potential sources of savings from adopting the CNPC alternative: (1) security, (2) transportation, and (3) other efficiencies. These savings include only the savings attributable to the CNPC alternative when compared to the DCE alternative. We purposely did not give the CNPC credit for savings that could be achievable under either modernization alternative (e.g., improved NNSA management practices).

We estimated the security cost savings from closing a site completely to be approximately $150 million per year. This estimate includes both security associated with the protection of special nuclear material and all other security costs (e.g., personnel security, site security). However, the CNPC site that receives these functions would need to increase its security, at an estimated cost of $40 million per year for each function received. Thus, if both Pantex and Y-12 are closed—and Los Alamos National Laboratory, Savannah River Site, or Nevada Test Site becomes the CNPC—total savings are estimated to be $220 million per year. If the CNPC is located at either Pantex or Y-12, the savings would be $110 million per year. These savings would start to accrue only after the site is closed and all Category I/II special nuclear material is removed.

We estimate that the CNPC alternative would result in a small decrease, about $15 million per year, in the direct costs associated with secure transportation. Although a CNPC would reduce the number of intra-NNSA convoys, it would have no effect on other convoys. Nor would it likely have any effect on the fixed costs of the Office of Secure Transportation operation.

Finally, we estimate that modernizing and re-sizing facilities and co-locating activities would result in savings of $13–35 million, depending on whether one site is closed (the CNPC is located at Pantex or Y-12) or two sites are closed (the CNPC goes to Los Alamos National Laboratory, Savannah River Site, or Nevada Test Site). We found that there are few economies of scale from co-locating unlike activities at one physical location.

The total annual savings that could be expected from the CNPC alternative are thus $138–270 million.

Summary of Results

Both the DCE and CNPC alternatives require substantial investments, many of which are common to both.

The DCE alternative with pit production at TA-55 at Los Alamos National Laboratory is the lowest cost alternative, at $8.5 billion. Table S-2 shows the comparison of the CNPC alternatives with the least cost DCE alternative.

Table S-2. Cost and Savings Summary of CNPC Compared to Least-Cost DCE Alternative ($8.5 billion) with Pit Production at Los Alamos National Laboratory

CNPC Location	Total Cost of CNPC	Delta Cost (CNPC – DCE)	Annual Savings from CNPC	Break-Even Year	Net Present Value
Los Alamos National Laboratory	$15.5B	$7B	$270M	2109	$0.4B
Pantex Plant	$15.5B	$7B	$147M	Never	–$2.0B
Y-12 National Security Complex	$18.5B	$10B	$138M	Never	–$4.3B
Nevada Test Site	$20.5B	$12B	$270M	Never	–$3.2B
Savannah River Site	$20.5B	$12B	$270M	Never	–$3.2B

The CNPC alternative requires an estimated investment of $15.5–20.5 billion, depending on the CNPC site, which is a minimum additional investment of $7 billion over and above the investments required in the least cost DCE alternative. In no instance is there an attractive payback period for the additional CNPC investments.

The primary reason for the difference in cost is that the CNPC alternative requires at least one, and possibly two, significant expenditures that are not required in the least-cost DCE alternative—the costs of relocating TA-55 and Pantex.

We could find no economic justification for the additional investment cost associated with the CNPC alternative. Savings from security, transportation, and improved efficiencies are too small to justify the investment.

Our conclusions differ significantly from the conclusions of the SEAB Nuclear Weapons Complex Infrastructure Task Force. According to the task force's report ("Recommendations for the Nuclear Weapons Complex of the Future: Report of the Secretary of Energy Advisory Board Nuclear Weapons Complex Infrastructure Task Force," Final Report, July 13, 2005), a CNPC would cost $5 billion. Our study estimates the total required investment for a CNPC would be between $15.5 billion and $20.5 billion, depending upon the site chosen. The SEAB report states their recommendations would generate $25 billion in savings over the period from 2016 to 2030. This equates to savings of $1.6 billion per year. We estimate that the total savings attributable to the CNPC would be $138 to $270 million per year, depending upon the site.

IMPLICATIONS OF PIT REQUIREMENTS

Both the DCE and CNPC alternatives assumed there would be a pit requirement of 125 pits per year. We examined the implications of a range of pit requirements on the NNSA modernization alternatives for pit production, assembly/disassembly, and secondary production.

For pit production, we found that not only would upgrading TA-55 be the least-cost alternative, it also would provide additional flexibility, as capacity would need to be added only as needed. We found no cost basis for relocating pit production from TA-55 at any pit production requirement up to 125 pits per year.

IDA could find no economic justification for relocating the assembly/disassembly mission out of Pantex. It would cost an additional $4 billion to rebuild, plus transition costs of $0.5–2.0 billion plus cleanup costs. Potential savings of $133 million per year could never recover the cost of the investment.

For secondary production, Y-12 currently plans to rebuild several of the required facilities at a cost of $4 billion. We estimate the additional cost to rebuild the Y-12 capability elsewhere at $1 billion plus transition costs of $0.5–2.5 billion, plus the extra cleanup costs from closing Y-12. We estimated savings from such a move would be $142 million per year, starting around 2025. The break-even year would be 2040 for total relocation costs of $1.5 billion and 2079 for total relocation costs of $3.5 billion, but considerable cost risks could extend these payback periods. A more detailed analysis would be required to understand fully the likely transition costs and risks associated with relocating the Y-12 mission.

I. INTRODUCTION

A. BACKGROUND

Established by Congress in 2000, the National Nuclear Security Administration (NNSA) is a semi-autonomous agency within the U.S. Department of Energy responsible for enhancing national security through the military application of nuclear science. NNSA maintains and enhances the safety, security, reliability, and performance of the U.S. nuclear weapons stockpile without nuclear testing; works to reduce global danger from weapons of mass destruction; provides the U.S. Navy with safe and effective nuclear propulsion; and responds to nuclear and radiological emergencies in the United States and abroad.[1]

In 2005, in response to congressional concerns, the Secretary of Energy asked the Secretary of Energy Advisory Board (SEAB) to assess the implications of past and potential Presidential decisions regarding the size and composition of the U.S. stockpile of nuclear weapons. The SEAB's Nuclear Weapons Complex Infrastructure Task Force[2] issued a report in July 2005 that made several recommendations regarding the potential transformation of the weapons complex.[3] A major recommendation was that the NNSA create a Consolidated Nuclear Production Center (CNPC).

In October 2006, NNSA released its own transformation and modernization plan, Complex 2030.[4] The central element of this plan was the proposal to "Modernize in Place" rather than consolidate all nuclear weapons production in one location, as advocated by the SEAB.

---

[1] National Nuclear Security Administration, "About NNSA", http://www.nnsa.doe.gov/aboutnnsa.htm/, accessed November 16, 2007.

[2] Hereafter referred to as "the SEAB Task Force."

[3] U.S. Department of Energy, Secretary of Energy Advisory Board, "Recommendations for the Nuclear Weapons Complex of the Future: Report of the Secretary of Energy Advisory Board Nuclear Weapons Complex Infrastructure Task Force," Final Report, July 13, 2005.

[4] U.S. Department of Energy, National Nuclear Security Administration, Office of Defense Programs, "Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century," October 23, 2006.

B. OBJECTIVE AND SCOPE

IDA was tasked by the Office of the Director, Program Analysis and Evaluation (PA&E), within the Office of the Secretary of Defense, to conduct an economic analysis of the NNSA and SEAB modernization approaches.

At the beginning of this study, the two modernization approaches were not completely defined, but they became more refined over the course of our study. In early 2007, NNSA began a full-scale Programmatic Environmental Impact Statement (PEIS) process. As part of that process, the NNSA Complex 2030 alternative was renamed "Distributed Centers of Excellence (DCE)." In addition, a CNPC alternative was included, based on the recommendation of the SEAB Task Force. The PEIS process also included a no action alternative and a capability-based alternative. A consolidated nuclear center option, combining only the plutonium and uranium operations, was later added as well. The Office of Management and Budget and PA&E instructed IDA to analyze the NNSA's CNPC and DCE alternatives as defined in the PEIS process. Note that these alternatives differ from the original SEAB and Complex 2030 alternatives from which they were derived.

C. CONTENTS OF THE REPORT

We start in Chapter II with a brief introduction to the NNSA nuclear weapons production complex. In Chapter III, we describe the DCE and CNPC alternatives, and our approach to and methodology for the economic analysis. We also detail the assumptions we made for this study.

Chapter IV provides the details of our economic analysis of each modernization alternative. We first provide descriptions and cost estimates for the major investments required for each of the alternatives. We then provide descriptions and estimates of savings that can be attributable to each estimate. We also present the cost-benefit analysis for the modernization alternatives.

In Chapter V, we conduct an excursion on the assumption of pit production requirements. We present analyses of the implications of various pit production requirements on the modernization choices.

We summarize the findings of our study in Chapter VI.

In addition to analyzing the modernization alternatives, IDA was asked to provide an evaluation of the NNSA Nuclear Enterprise Model and assess its suitability for estimating the cost of the competing modernization approaches. Our description and evaluation of the NNSA Nuclear Enterprise Model are contained in Appendix A.

Appendix B contains charts illustrating the estimated annual investments required for each of the modernization alternatives.

II. OVERVIEW OF THE NUCLEAR WEAPONS COMPLEX

A. INTRODUCTION

Over the last 15 years, the nuclear mission has focused on the maintenance of the stockpile with no production of new weapons and no testing. In the 1980s, the nuclear weapons complex contained 14 sites; it contains eight today:

- *Production facilities:* Pantex Plant, Y-12 National Security Complex, Kansas City Plant (KCP), and Savannah River Site (SRS)
- *Laboratories:* Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and Sandia National Laboratories (SNL)
- *Test site:* Nevada Test Site (NTS).

The only sites that can be thought of as having similar missions are the two design laboratories, LANL and LLNL. The production complex, in particular, has been downsized to the point that there is no duplication of mission and each site is unique. Figure 1 depicts the locations of the current U.S. nuclear weapons complex sites.

In 2006, NNSA had a budget of $6.5 billion. Figure 2 shows the breakout of spending for each site. Note that several of the sites do significant work for organizations other than NNSA. Funding for work for other organizations is not included in this chart.

The remainder of this chapter describes each site in the nuclear weapons complex. Because this study is concerned with the production aspect of the nuclear weapons complex—in particular, the infrastructure and facilities responsible for the manufacture of plutonium pits (the core of nuclear weapons), the production of nuclear weapon secondaries (or canned subassemblies), and the assembly/disassembly of weapons—we describe the three sites that perform these functions in more detail first. We then provide an overview of the other five sites.

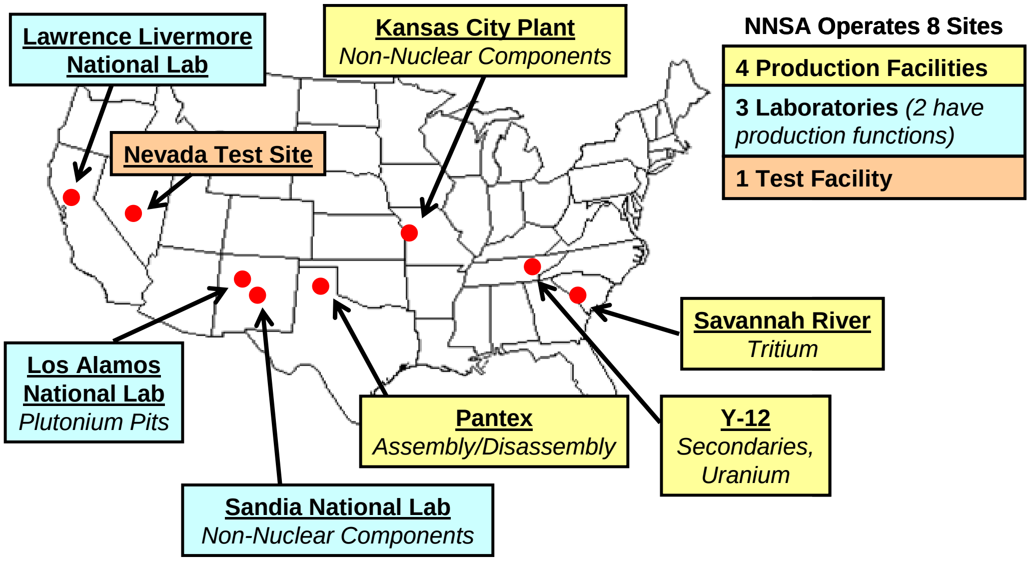
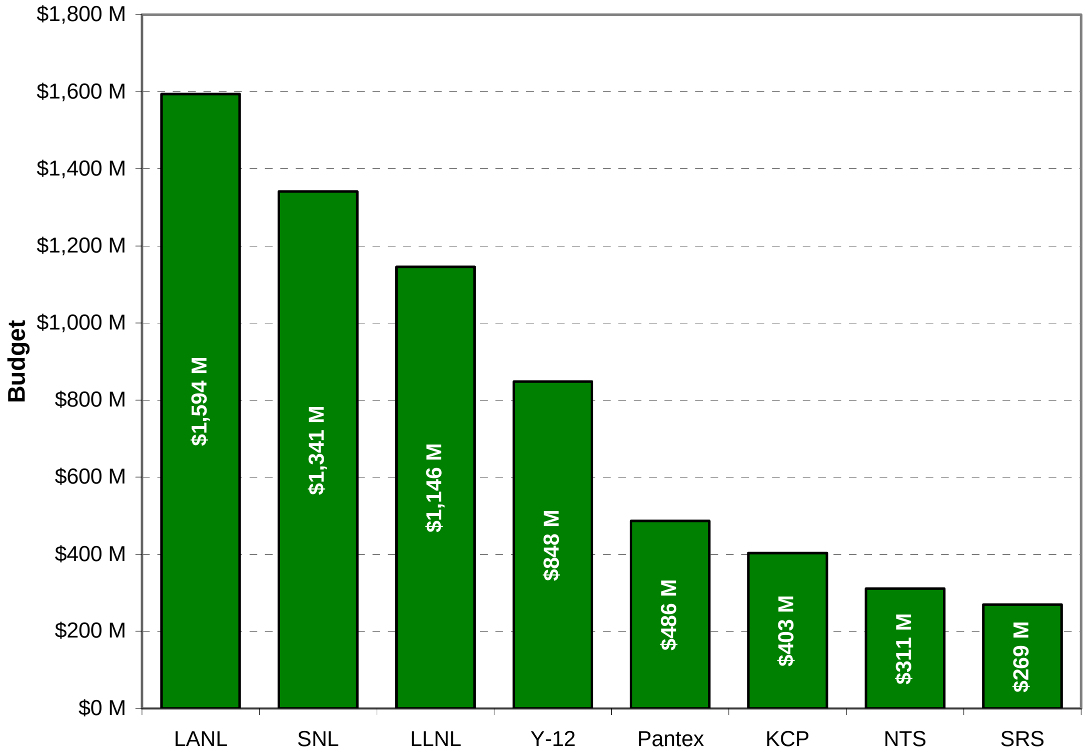


Figure 1. U.S. Nuclear Weapons Complex



Source: FY 2008 President's Budget.

Figure 2. NNSA Spending by Site, FY 2006

B. LOS ALAMOS NATIONAL LABORATORY

LANL is located on 39 mountainous square miles in and around Los Alamos, New Mexico. After being managed by the University of California for over 50 years, LANL has been managed since 2006 by Los Alamos National Security, LLC, which includes Bechtel National, University of California, BWX Technologies,[5] and Washington Group International.

The laboratory's mission is to "develop and apply science and technology to ensure the safety, security, and reliability of the U.S. nuclear deterrent; reduce global threats; and solve other emerging national security challenges."[6] The portion of the LANL mission that is most relevant to this study is the manufacture of plutonium pits.

Plutonium pits were manufactured at the Rocky Flats plant in Colorado from 1968–1989. After the close of the Rocky Flats plant, and until 1998, the nation had no pit manufacturing capability. Since 1998, LANL has been re-establishing the capability to make pits in a portion of the TA-55 site—successfully certifying its first pit in 2007.

The estimated current capacity of TA-55 is 10–20 pits per year; however, a facility required to maintain this capacity, the Chemistry and Metallurgical Research (CMR) facility, is unsafe to continue operations past 2010. Applied chemical and metallurgical research capabilities are crucial to the pit surveillance program, enhanced surveillance program, primary physics, and pit manufacturing. Consequently, the CMR Replacement (CMRR) project has been implemented. The project is split into three phases:

- The CMRR Radiological Laboratory/Utility/Office Building (CMRR-RLUOB) will house radiological laboratory space, a training center, four classrooms, two nonradiological training simulation labs, a utility building that supports all CMRR facilities, and office space to support 350 personnel in segregated cleared and uncleared areas.
- CMRR Special Facility Equipment (CMRR-SFE) covers the acquisition of glove boxes, long-lead facility, and actinide chemistry/materials characterization (AC/MC) equipment whose uniqueness, long-lead fabrication, and limited production capabilities necessitate individual procurement.
- The CMRR Nuclear Facility (CMRR-NF) will house Hazard Category II AC/MC and actinide Research and Development operations, special nuclear

---

[5] Babcock & Wilcox (B&W) Company recently combined with BWX Technologies, Inc. This combined company, using both names, has part of the Management and Operating contracts for several NNSA sites.

[6] Los Alamos National Laboratories, "Our Mission," http://www.lanl.gov/, accessed October 31, 2007.

material storage vaults, and large-vessel handling capabilities, all located behind perimeter fences at TA-55.

At this time, the RLUOB and SFE phases of the CMRR project are in the Critical Decision 3 (CD-3) phase, which means their final design has been approved and construction/procurement has begun. On the other hand, the NF is still in CD-1, preliminary design, and funding for the project has been put on hold until official decisions have been made with respect to infrastructure transition and modernization. The CMRR-NF is central to the discussion of pit production capabilities at TA-55.

The pit production capacity requirement is an open policy debate. In 2001, when NNSA was designing the Modern Pit Facility, the range under consideration was 125 to 450 pits per year. Currently, the range under discussion is 0 to 125, and is dependent on assumptions for nuclear stockpile size and how quickly the proposed Reliable Replacement Warhead (RRW) should replace legacy weapons. Chapter V examines the implications of this requirement on infrastructure modernization and transformation decisions.

C. Y-12 NATIONAL SECURITY COMPLEX

Y-12 is located in Oak Ridge, Tennessee, and is part of the Department of Energy’s Oak Ridge Reservation. The Management and Operating (M&O) contractor is B&W Technical Services Y-12, LLC.

The Y-12 National Security Complex has five primary missions:[7]

- Producing, refurbishing, and dismantling nuclear weapons components;
- Safeguarding special nuclear material (SNM);
- Preventing the proliferation of weapons of mass destruction;
- Providing the United States Navy with safe, militarily effective nuclear propulsion systems; and
- Providing support for other national security needs and customers as required.

Y-12 manufactures or remanufactures unique components for nuclear weapon secondaries, also known as canned subassemblies. This nuclear manufacturing includes depleted and enriched uranium operations, special materials operations, assembly, disassembly, and storage.

---

[7] Y-12 National Security Complex, “History,” http://www.y12.doe.gov/about/history/60thann/missions.html/, accessed November 16, 2007

Many facilities currently in use at Y-12 were designed and built in the 1940s as temporary structures, designed to last until the end of World War II. Y-12 has embarked on an infrastructure reduction and modernization plan, which has demolished over one million square feet of structures since 2001, and has plans to demolish another 40 buildings totaling 500,000 square feet.[8]

As part of Y-12's modernization plans, numerous construction projects are underway or planned for the future. Some are refurbishments or upgrades to plant systems, such as those for potable water, electrical distribution, compressed air, and steam. Others involve construction of new buildings, like the new records storage facility, the New Hope Center, and the Jack Case Center, all recently opened. Additionally, for the production mission, three additional buildings are planned:

1. The Highly Enriched Uranium Materials Facility (HEUMF), a uranium storage facility, is currently under construction at Y-12.
2. The Uranium Production Facility (UPF), currently in preliminary design, will consolidate all enriched uranium operations:
    a. Processing (chemical, metallurgical, and mechanical)
    b. Component production
    c. Secondary assembly and disassembly
    d. Dismantlement
    e. Quality verification, surveillance, and certification
    f. Packaging and shipping
3. The Consolidated Manufacturing Complex (CMC) is planned for lithium, depleted uranium, special materials, and general manufacturing operations. It has been identified in the NNSA's Integrated Construction Program Plan, but is not yet approved for conceptual design.

These consolidation and modernization efforts will shrink the footprint of the Y-12 complex from 125 acres to 15, thereby reducing maintenance and security requirements.

D. PANTEX PLANT

"Pantex Plant…is charged with maintaining the safety, security, and reliability of the nation's nuclear weapons stockpile. Work performed at Pantex includes support of the Life Extension Programs, weapon dismantlement, the development, testing and

---

[8] Y-12 National Security Complex, "Infrastructure Reduction," http://www.y12.doe.gov/missions/defenseprograms/infrareduce/, accessed November 16, 2007

fabrication of high explosive components and interim storage and surveillance of plutonium pits."[9] The Pantex Plant is on a 25 square mile site near Amarillo, Texas. The M&O contractor is Babcock & Wilcox Technical Services Pantex, LLC, a venture of B&W, Honeywell, and Bechtel.

While Pantex currently has no major facilities construction or modifications planned, there have been major issues in recent years with regard to its overall productivity. In FY 2005, Pantex had a capacity of about 10 percent of the throughput in the 1980s with about the same hands-on work force as in the 1980s.[10] However, through management and process improvements (no significant capital improvements) the plant's overall productivity has significantly improved over the past 2 years. As an example, warhead dismantlement has been accelerated by more than 49 percent from FY 2006 to FY 2007, and the surveillance backlog was eliminated in FY 2007. The number of weapon activities accomplished has grown to over 1,000 for FY 2007.

Plant management is currently committed not only to sustaining the achieved improvement, but to accomplishing 1,200 weapon activities in FY 2008. If this level of throughput is sustained, our study found that there is sufficient capacity at Pantex for the foreseeable future workload.

E. SAVANNAH RIVER SITE

SRS is located on a 310 square mile site in South Carolina near Augusta, Georgia. The site M&O contractor is Washington Savannah River Company, a wholly owned subsidiary of Washington Group International. A separate contractor, BWXT, is responsible for the tritium facilities.

SRS has had numerous missions in the complex in the past. Currently, the NNSA mission of purification and storage of tritium is a small fraction of the site's mission. SRS is primarily responsible for the Environmental Management mission of disposal of unwanted plutonium and highly enriched uranium by turning them into forms not usable for nuclear weapons. Much of the site is undergoing decontamination and decommissioning.

---

[9] BWXT Pantex, http://www.pantex.com, accessed November 13, 2007.

[10] Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, Defense Science Board, "Report of the Defense Science Board Task Force on Nuclear Capabilities: Report Summary," December 2006.

F. KANSAS CITY PLANT

KCP manufactures and purchases non-nuclear components which are sent to Pantex for assembly into nuclear weapons. KCP sits on 122 acres inside Kansas City, Missouri. Honeywell is the M&O contractor at KCP.

G. LAWRENCE LIVERMORE NATIONAL LABORATORY

LLNL is primarily located on a single square mile campus in Livermore, California. The M&O contractor is Lawrence Livermore National Security, LLC, a combination of Bechtel National, University of California, BWXT, Washington Group International, and Battelle.

LLNL is a multipurpose laboratory like LANL, but without a manufacturing mission. Like LANL, it has designed nuclear weapons and continues to certify them for the stockpile. LLNL has an area called “Superblock” that currently contains Category I SNM for research purposes, but the NNSA plans to move these materials and the mission to LANL and NTS in the next few years.

H. SANDIA NATIONAL LABORATORIES

SNL’s main campus is in Albuquerque, New Mexico, but three other sites are located in Livermore, California; Kauai, Hawaii; and Tonopah, Nevada. Sandia Corporation, a Lockheed Martin company, is the M&O contractor.

Scientists and engineers at SNL design the non-nuclear components for weapons whose physics packages are designed at LANL or LLNL. SNL also holds the complex’s only manufacturing capability for neutron generators. This mission was taken on after the Pinellas Plant closed in 1997. SNL plans to remove all Category I/II SNM from its location in Albuquerque, New Mexico, before the end of 2008.

I. NEVADA TEST SITE

NTS occupies 1,375 square miles of Nevada desert surrounded by other unpopulated government land. The primary mission of NTS is to be ready should national leadership decide to restart the nuclear weapons testing program. In addition, several SNM-related missions, such as sub-critical experiments from LANL, have moved or are expected to move to NTS. Since 2006, the M&O contractor has been National

Security Technologies, LLC, which has representation from Northrop Grumman, AECOM, CH2M Hill, and Nuclear Fuel Services.

III. APPROACH TO ANALYSIS OF MODERNIZATION ALTERNATIVES

The IDA analysis of the Distributed Centers of Excellence (DCE) and Consolidated Nuclear Production Center (CNPC) proposals focuses on three of the main components of the nuclear weapons production complex. These are (1) plutonium and pits, (2) uranium and secondaries, and (3) assembly and disassembly. We first describe the two modernization alternatives in more detail in the context of these components. Then we move on to descriptions of our approach and methodology.

A. MODERNIZATION ALTERNATIVES

1. Distributed Centers of Excellence

The DCE alternative proposed by NNSA would increase pit production capacity, modernize secondary production, and maintain the current assembly/disassembly capability.

For pit production, the DCE alternative would first invest in a larger pit production capacity at TA-55, increasing the current capability to 50 pits per year. This would be accomplished through the completion of the Chemistry and Metallurgical Research Replacement Nuclear Facility (CMRR-NF) and Radiological Laboratory/Utility/Office Building (CMRR-RLUOB).

The DCE alternative will further upgrade pit production capability to 125 pits per year by the year 2022. This involves constructing a Consolidated Plutonium Center (CPC) with "a baseline capacity of 125 units per year net to the stockpile by 2022"[11] at one of the five following sites:

- Los Alamos National Laboratory (LANL)
- Nevada Test Site
- Savannah River Site

---

[11] Op. cit., Complex 2030, p. 11.

- Y-12 National Security Complex
- Pantex Plant

If LANL is chosen as the site for the CPC, the TA-55 facility there would be upgraded to achieve a capacity of 125 pits per year. If another site is chosen, a new CPC would be built, TA-55 production would end, and all Category I/II special nuclear material (SNM) would move to the new CPC. TA-55 would most likely remain open as a research facility.

The DCE alternative calls for a completely modernized secondary production capability. The plan is to complete construction of the Highly Enriched Uranium Materials Facility (HEUMF) and to replace most of the rest of the Y-12 complex with two new buildings, the Uranium Production Facility (UPF) for uranium operations and the Consolidated Manufacturing Complex (CMC) for production involving non-fissile materials.

The DCE alternative anticipates no significant changes to Pantex and its assembly/disassembly capabilities and mission. Throughput may continue to be improved, but no major investments are planned.

2. Consolidated Nuclear Production Complex

The CNPC alternative proposed by the Secretary of Energy Advisory Board (SEAB) would also increase pit production capability and modernize secondary production. It would, however, provide for these capabilities in a new set of co-located facilities. The CNPC proposal would also add a new, but smaller, assembly/disassembly facility, co-located with the other production facilities.

The CNPC proposal for pits is identical to the DCE proposal. First TA-55's production capability would be increased to 50 pits. Then a CPC with a capacity of 125 pits per year would be built at one of the five sites specified above and would be operational in 2022. If Los Alamos is not chosen as the site, then TA-55 production would end, and all Category I/II SNM would move to the new CPC.

Just like the DCE proposal, the CNPC proposal calls for a completely modernized secondary production capability. This capability would definitely be at Y-12 with the DCE alternative, but it might be located elsewhere with the CNPC alternative. If another site is chosen, the "new Y-12" would be co-located with the rest of the production complex at the CNPC.

Finally, the CNPC proposal envisions a new assembly/disassembly facility co-located with the other facilities at the single CNPC site. If Pantex is chosen as the CNPC site, this would be equivalent to the DCE alternative. If another site is chosen, a smaller assembly/disassembly capability would be created at the CNPC site.

Note that some of the assumptions in the NNSA CNPC alternative vary from the original SEAB proposal in important ways, including:

- The CNPC proposal in the SEAB report assumes a requirement of 300 weapons activities, whereas the NNSA CNPC alternative (evaluated by IDA) assumes a requirement for 600.
- The NNSA CNPC alternative assumes that the assembly/disassembly facility will be capable of handling both insensitive and conventional high explosives. The SEAB version of the CNPC assumes that all conventional high explosive warheads are dismantled in Pantex (as part of an accelerated dismantlement program), and then the new facility handles only Reliable Replacement Warheads (RRWs) with insensitive high explosive warheads (because the SEAB assumed the future nuclear stockpile will consist of only RRWs).
- The CNPC comes online in 2022 in the NNSA CNPC alternative evaluated by IDA; in the SEAB version it would have come on line in 2015.

The SEAB report also contained several additional transformation recommendations, not directly related to the CNPC. These include:

- Significant reductions to and consolidations of Research and Development activities and laboratory facilities;
- Closure and replacement of the Kansas City Plant with outsourced commercial parts;
- A single management contract for production (to promote improved efficiency); and
- Increased rate of weapon dismantlement as a part of deterrence.

Note that these recommendations are separate and independent of whether or not a CNPC is built. Any or all of them could be undertaken in either alternative. Therefore, we did not attribute to the CNPC alternative any savings due to these recommendations. This study only examined the investment costs and savings associated with the CNPC and DCE modernization alternatives.

Table 1 highlights some of the main elements of the two modernization alternatives.

Table 1. Comparison of Key Elements of Modernization Alternatives

Element	DCE	CNPC
Plutonium Pits	Upgrade TA-55 facility Build a CPC	Upgrade TA-55 facility Build a CPC
Secondaries	Modernize Y-12 complex	Rebuild secondary production capability at CNPC site
Assembly/Disassembly	Maintain current capability at Pantex	Rebuild capability at CNPC site

It is important to note that although the CNPC alternative proposes closing one or two sites (Y-12 and/or Pantex), closing either of these sites necessitates rebuilding the capability at the CNPC site. The nuclear complex now has only one assembly/disassembly site and one secondary production site. The question is whether the additional investment costs associated with rebuilding these capabilities are offset by the cost savings from closing a site.

B. ASSUMPTIONS

Based on the two alternatives just described, IDA made the following assumptions about the future nuclear weapons complex:

- Los Alamos, Savannah River, Pantex, Y-12, and the Nevada Test Site are the candidate sites for CPC and CNPC.
- The future pit production requirement is 125 per year, with a surge capability of 200.
- A new facility (or set of facilities) is needed for secondary production.
- Assembly/disassembly requirements will eventually be no more than 600 weapons activities per year.
- The CPC and CNPC will be capable of supporting both Life Extension Programs for legacy warheads and production of RRWs.
- The CPC and CNPC will be operational in 2022.
- The U.S. nuclear stockpile will trend towards the Moscow Treaty numbers.
- There will be no further significant increases in security requirements due to changes in Design Basis Threat.
- Construction cost estimates are based on current NNSA practices and prior NNSA construction experiences.
- Any savings that can be achieved through changes in NNSA management or contracting practices can be made whether or not a facility is moved. Thus, we do not attribute to the CNPC alternative any savings due to improved

management practices, as we assume these savings could also be achieved in the DCE alternative.

C. METHODOLOGY

The major investments for which we estimated the costs were as follows:

- Pit production, which included the costs to upgrade TA-55 capacity to 50 pits per year and to 125 pits per year, as well as the cost to construct a "green-field" CPC with a capacity of 125 pits per year.
- Secondary production, which included the cost to build the HEUMF, the cost to build the UPF, the cost to build the CMC for non-highly enriched uranium, secondary components, and the cost of replacing required plant support facilities.
- Assembly/disassembly and high explosive production facilities, which included the cost of building similar facilities to those currently at Pantex but for a smaller capacity, as defined by NNSA.
- Transition costs, which included the costs to potentially operate duplicate facilities during the qualification and certification processes for the new facility, the costs associated with separating or moving personnel, and the cost to move any SNM stored at a closing site.

For each potential major investment, we note the assumptions made in this study and then show our cost estimate. Our methodology was to use the NNSA definitions for the size and content of each facility. We did not attempt to determine if the facilities as defined were correct or optimal. We note that NNSA is currently in the process of defining the alternatives and assumptions through their Programmatic Environmental Impact Statement (PEIS) process. As such, several major assumptions, such as the size of the research facilities for the CPC, changed over the course of the study. Whenever possible, we updated our analysis to incorporate the latest NNSA assumptions.

We provide cost estimates for each of the potential major investments; however, there were some challenges in estimating these costs. Several of the major investments are early in the design process, thus the data that would usually be available in a cost analysis requirement document has not yet been developed. In addition, due primarily to the lack of appropriate historical analogies, there are no well developed cost estimating relationships (CERs) for nuclear construction. Consequently, while the estimates below are adequate for their purpose here, which is to inform a choice among several modernization alternatives, they are less precise than typical budget quality estimates.

We note that the risk associated with the investment cost estimates is skewed to the right. That is, while there is some chance that actual costs could be substantially below this estimate, there is a much larger chance of costs substantially exceeding our estimate.

To estimate these costs, we employed two approaches. Our preferred approach was to build on existing or historical cost estimates. This was done in four stages. The first stage was to find an existing estimate for a representative facility. For example, when costing the "greenfield" CPC, we looked at prior cost estimates done for the Modern Pit Facility. Second we adjusted the estimate to account for any differences in the facility design from that in the original estimate; for example, if the facility were a different size or included an additional laboratory. Next we adjusted the estimate to account for cost growth. NNSA construction projects have historically seen large cost growth from the time of their initial estimates to the completion of the project, so we adjusted our estimates accordingly. Finally, we compared our final estimate to applicable analogies to verify its reasonableness.

When an appropriate estimate could not be found, such as for the replacement of the assembly/disassembly facilities, we considered the square footage and types of construction (glove box, storage, support facilities, infrastructure, etc.) needed for the desired facility. We then looked at historical NNSA construction to determine the average cost per square foot of each type of facility. Applying this cost to our square footage numbers gave us a cost estimate for the desired facility.

Historical NNSA construction cost and schedule data were used in the study to calibrate the NNSA cost estimates that we received. The data showed that NNSA construction projects tend to cost substantially more and take substantially longer than first estimated. Several factors appear to contribute to this systematic underestimation, including changing requirements, pressure to keep initial estimates low, unpredictable funding flows, and political and environmental delays. We assumed that the same types of issues that have caused cost and schedule growth in the past will still be pertinent for the projects under consideration in this study.

Historical projects included in our analysis were the National Ignition Facility, the HEUMF, the Tritium Extraction Facility, the Criticality Experiments Facility, and the Special Nuclear Materials Requalification Facility. The Mixed Oxide Fuel Fabrication Facility, the Pit Disassembly and Conversion Facility, and Hanford's Waste Treatment Plant were not included because these projects are not far enough along for there to be any confidence in their final cost or schedule.

Table 2 contains the schedule estimates versus actuals for the included projects. These data were obtained from NNSA annual budget submissions.

Table 2. Actual and Estimated Schedules (Years)

	Initial Construction Estimates	Final Years	Ratio
Tritium Extraction Facility	5.5	7.75	1.4
National Ignition Facility	6.0	11.75	2.0
HEUMF	3.5	5.5	1.6
Criticality Experiments Facility	1.75	2.75	1.6
SNM Component Requalification Facility	1.0	1.75	1.8

Table 3 contains the cost estimates versus actuals for the included projects. These data were also obtained from NNSA annual budget submissions (adjusted to FY07$).[12] The budget documents did not contain construction estimates for the Criticality Experiments Facility and SNM Component Requalification Facility.

Table 3. Actual and Estimated Costs (Millions of FY07$)

	Initial Estimates	Final Estimate	Ratio
National Ignition Facility	$1,435	$2,451	1.7
Tritium Extraction Facility	$448	$567	1.3
HEUMF	$281	$561	2.0

Historically, cost growth is correlated with schedule growth. This is particularly true for schedule growth that occurs during the construction phase of the project, as manpower costs usually continue until construction is completed. For this reason, slips in schedules have resulted in corresponding increases in costs.

For the above data, the average schedule growth ratio was 1.68 and the average cost growth ratio was 1.67. We used these data to arrive at our cost growth factor of 1.7.

---

[12] The final estimate we used for the National Ignition Facility is substantially less than the current estimate at completion. The reason for this is the current estimate at completion also includes the billion dollar National Ignition Facility Demonstration Program, which is not truly a construction cost and was not part of the original baseline. (It was carried in the budget of the Inertial Confinement Fusion Ignition and High Yield Campaign prior to FY 2001).

As stated above, many of the cost estimates used in this study were based on NNSA estimates of the same or similar facilities. In developing our cost estimates, we evaluated these estimates with regard to the historical cost growth for pre-CD-2 NNSA cost estimates. In most cases, we applied the 1.7 cost growth factor to the NNSA estimates.

With regard to schedule growth, we found the SEAB proposal for the CNPC to be completed by 2015 to be implausible considering past construction history. However, the current NNSA estimates for the CPC to be completed by 2022 and the CNPC by 2025 represent a nominal 10-year schedule for the construction of each facility. This appears to be consistent with historical experience. In this study, construction schedule growth would impact only the savings estimates (savings begin to accrue only after the new facility is operational).[13]. Given that construction projects have a tendency to be delayed, rather than completing early, there is some risk that the savings we project could be delayed, hurting the case for the CNPC.

D. DECONTAMINATION AND DECOMMISSIONING

One potentially large cost relevant to our alternatives is decontamination and decommissioning costs. These costs are incurred when a site is closed or downsized and the existing facilities need to be cleaned up and/or demolished. Past NNSA experience indicates that these costs are significant, ranging from about $10 billion (Rocky Flats) to over $40 billion (Savannah River and Hanford).

In our analysis of the modernization alternatives, Pantex and Y-12 are candidates for cleanup costs. In the DCE alternative, Pantex would continue to operate in its existing facilities and there would not be any cleanup costs associated with closing the facility. In the CNPC alternative, Pantex would be closed if not selected as the CNPC site, incurring sizeable cleanup costs for its approximately 3 million square feet of facilities.

For Y-12, there are significant cleanup costs with both the DCE and CNPC alternatives. NNSA currently plans to significantly downsize Y-12 and has plans to decontaminate and decommission the majority of its existing facilities. The costs associated with this plan apply equally to both the DCE and CNPC cases. In the CNPC case, however, there are arguably somewhat larger cleanup costs due to decontamination and decommissioning of the HEUMF and possibly due to closing and leaving the site.

---

[13] The construction outlay schedules used to develop the affordability graphs in Appendix B would also be affected by schedule growth.

Previous analyses of alternatives have differed in their treatment of decontamination and decommissioning costs. Some, such as those for the BRAC, excluded cleanup costs entirely from their analysis, arguing that cleanup costs are a sunk cost and that they did not want decisions based upon decontamination and decommissioning costs that would otherwise dominate the analysis.[14] Other analyses have included decontamination and decommissioning costs arguing that there is value in delaying a cost indefinitely.

As we show in Chapter IV, even if decontamination and decommissioning costs are excluded, there is no economic case for the CNPC alternative. If decontamination and decommissioning costs were included, it would further weaken the case for the CNPC since the CNPC alternative would require more cleanup than the DCE alternative.

Although we did not explicitly estimate the decontamination and decommissioning costs, historical experience suggests that these costs likely overwhelm any savings from closing a site.[15]

The CNPC alternative requires more decontamination and decommissioning than the DCE alternative. Thus, including those costs in the analysis would be disadvantageous to the CNPC alternative. We show in Chapter IV that even if decontamination and decommissioning costs are excluded, the comparison of benefits and costs does not support a case for the CNPC alternative.

---

[14] The acronym *BRAC* stands for Base Realignment and Closure and it is the congressionally authorized process used by the Department of Defense and Congress to close excess military installations. The first four BRAC rounds (1989–1995) closed more than 350 installations and have produced an estimated recurring savings of approximately $7 billion annually. The most recent round of BRAC was completed in the fall of 2005.

[15] As shown in Chapter IV, we estimated annual savings of $138 to $270 million from consolidation at a CNPC. The savings depend on whether one or two sites are closed.

IV. COST ANALYSIS OF MODERNIZATION ALTERNATIVES

A. MAJOR INVESTMENTS

The major categories of investment are:

- Pit production
  - TA-55 upgrade
  - Consolidated Plutonium Center (CPC)
- Secondary production
  - Highly Enriched Uranium Materials Facility (HEUMF)
  - Uranium Processing Facility (UPF)
  - Consolidated Manufacturing Complex (CMC)
  - Plant support
- Assembly and disassembly
  - New assembly/disassembly facility
- Mission transition
  - Moving missions from existing to new facilities

1. Pit Production

Plutonium pits are the key component of a nuclear weapon primary. Pits are currently manufactured on a limited basis at TA-55, the area within the Los Alamos National Laboratory (LANL) site where plutonium operations are performed.

According to LANL personnel, an investment of about $500 million would be needed to maintain a reliable pit production capability at the current level. The current Future Years Nuclear Security Plan funds required maintenance on the PF-4 facility such as roof and heating, ventilating, and air conditioning (HVAC) system repairs, as well as additional equipment purchase and installation. To account for the loss of the Chemistry and Metallurgical Research (CMR) facility in 2010, LANL proposes to reconfigure a wing of the PF-4 facility to accommodate the analytic chemistry capabilities required for pit production. Analytic chemistry on smaller samples could be accomplished in the Chemistry and Metallurgical Research Replacement Radiological Laboratory/Utility/

Office Building (CMRR-RLUOB), available in 2010, but this is not sufficient for pit production.

Both the DCE and CNPC alternatives would increase production at TA-55 to 50 pits per year and then build a CPC with capacity of 125 pits per year at one of five potential sites with initial operating capability in 2022. The following subsections detail the associated costs, as well as the cost to further upgrade TA-55 to 125 pits per year rather than building a greenfield CPC.

a. Upgrade TA-55

Both alternatives plan to upgrade TA-55 to increase capacity to 50 pits per year in a single shift from its current stated capacity of 10–20 per year. The PF-4 facility is the building within the TA-55 complex of most interest to our study, as it is the pit production facility.

It is important to note in the following discussions that pit production capacity at TA-55 is, at a basic level, dependent upon the available floor space for glove box production lines. Current NNSA plans are to build an additional facility, the CMRR Nuclear Facility (CMRR-NF), within the TA-55 complex to increase the capacity of plutonium operations. According to the NNSA, the CMRR-NF facility is needed to provide the floor space for glove box operations and the additional special nuclear material (SNM) vault space to support a pit production capacity of 50 pits per year in a single shift.

In this study, we did not conduct a detailed examination of facility usage within PF-4 to determine whether additional space for pit production could be made available by eliminating or moving some of the missions currently performed there. We took as given the NNSA assumption that the additional floor space provided by CMRR-NF would be required to achieve a pit capacity of 50 pits per year.

We estimated the cost of the CMRR-NF would be $1.5 billion. This is based on the most recent estimate by LANL personnel.[16] The total estimate for achieving a capacity of 50 pits per year at TA-55 in a single shift, including both the cost of maintaining the current production capability and the cost of gaining additional capacity by building the CMRR-NF, is approximately $2 billion.

---

[16] Brett Kniss, “2030 Business Case Data Package and Analysis for the CPC,” briefing, August 2007.

For the CMRR-NF we used an unofficial LANL estimate of $1.5 billion rather than using our standard methodology of applying a historical cost growth factor to the available official estimated cost. Applying the historical cost growth factor of 1.7 to the official CMRR-NF cost estimate of $674 million provided in the FY 2007 Integrated Construction Program Plan (ICPP) produced an estimate of $1.1 billion.[17] A comparison of the cost per gross square foot for the two CMRR-NF estimates showed that the $1.5 billion estimate is approximately $6,700 per gross square foot, while the $1.1 billion estimate is approximately $4,900 per gross square foot. In comparison, the HEUMF cost per square foot is approximately $5,200. Considering that the HEUMF is essentially a warehouse, while the CMRR-NF is a modern production facility with equipment needs as well as structures, we would expect that using the HEUMF as an analogy would provide a low cost estimate. This makes $1.1 billion appear to be a low estimate. Although the CMRR-NF has not achieved CD-2, we did not further escalate the $1.5 billion estimate because the cost per gross square foot of $6,700 seemed reasonable in comparison with CPC, UPF, and HEUMF.

b. Building the CPC at a Greenfield Site

The CPC would combine all plutonium production, research, and development activities within the nuclear weapons complex at one site. As described in Chapter III, NNSA is considering five sites for a CPC. If a site other than LANL is chosen, we assumed that this facility would be built on unoccupied land within that site.

The CPC would consist of multiple structures within one technical area. Enclosed within a Perimeter Intrusion Detection and Assessment System (PIDAS) would be located (1) a production facility, (2) an analytic support facility, and (3) a plutonium research facility. These facilities might be located in one, two, or three buildings. For purposes of the cost estimate, we assumed three buildings. Outside of the PIDAS would be located additional laboratory facilities, a utilities building, an administrative building, and environmental control structures.

The only pit facility in the United States, the TA-55 complex described above, now has a stated capacity of around 10 pits per year. The planned production rate for a new facility is 125 pits per year in a single shift operation.

---

[17] The total project cost for CMRR in the FY 2007 ICPP is $838 million; however, $164 million is due to the CMRR-RLUOB. We therefore assumed $674 to be the estimated total cost project for the CMRR-NF.

The first building within the PIDAS would be the plutonium production facility. NNSA estimates 470,000 gross square feet are needed. Net useful space requirements are estimated at about 180,000 square feet.[18]

The second building within the PIDAS would be the actinide chemistry/material characterization (AC/MC) facility. This facility would provide about 276,000 gross square feet with about 44,000 net square feet of laboratory space. The laboratory functions would support the work of the production facility by assuring that pits meet the metallurgical and materials standards set by the weapon designers.

The third building within the PIDAS would house plutonium research facilities for activities that involve Category I/II amounts of plutonium. These activities would include research to improve pit manufacturing processes, research on pit characteristics and pit aging, fabrication of plutonium samples for testing, research on methods to increase surety, and surveillance of weapons in the stockpile. These activities would be collocated with the production facility. This building would be about 194,000 gross square feet with about 25,000 net square feet of laboratory space.

A number of additional buildings would complement the key elements of the CPC. These structures, which would be housed outside the PIDAS, include an analytic laboratory; a support structure for administrative activities; an engineering support structure; and a utilities structure to house HVAC equipment, transformers, and communications.

Table 4 summarizes the space requirements for the CPC. Overall, the facility would involve 940,000 gross square feet (a footprint of 455,000 square feet) within the PIDAS. Support facilities are estimated by NNSA to have a footprint of another 315,400 square feet.

---

[18] "Gross square feet" is the total area in a building for all floors measured to the outer surface of exterior walls. Gross square feet also includes major vertical penetration areas, such as shafts, elevators, stairs, or atrium space. "Footprint" is the total area of the ground floor, again measured to the outer surface of exterior walls. For a one-story building without a basement, footprint should equal gross square feet. "Net square feet" is the usable space for the functionality intended for the building.

Table 4. Space Requirements for the Consolidated Plutonium Center

	Gross Square Feet	Facility Footprint Square Feet	Net Square Feet
Category I/II Facilities			
AC/MC Laboratory	276,000	120,000	44,000
Plutonium Research and Development Facility	194,000	125,000	25,000
Production Facility	470,000	210,000	179,400
Subtotal, Category I/II	940,000	455,000	248,400
Support Facilities			
Non-hardened, Inside PIDAS			
Entry Control Facility	17,400	17,400	
Support Structure	240,200	75,000	
Low-Level Waste Management	22,000	22,000	
Subtotal, Inside PIDAS	279,600	114,400	
Non-hardened, outside PIDAS			
Engineering Support	40,000	20,000	
Utilities	10,000	10,000	
Commodities Warehouse	10,000	10,000	
TRU Waste Cert.	21,000	21,000	
Sand Filter/Fan House	140,000	140,000	
Subtotal, Outside PIDAS	221,000	201,000	
Subtotal Support	500,600	315,400	
Grand Total	1,440,600	770,400	248,400

Note: Net square feet estimates are from the Modern Pit Facility study group. Gross square feet and footprint estimates are from estimates compiled by the NNSA Business Case study team.

Cost estimates for the Modern Pit Facility (MPF) made by members of the MPF study team in 2004 form the foundation of our estimate for the CPC.[19] These estimates are contained in a document agreed to by the MPF project manager in January 2002. That document presented estimates for three versions of the MPF, with capacities for 125, 250, and 450 pits per year, respectively, in single-shift operations. In what follows, we restrict ourselves to the 125 pit-per-year case; however, note that the 125 pit-per-year case actually builds a facility sized to the higher 250 pit-per-year capacity, but equips it only for 125 pits per year. This approach was one way the NNSA built some flexibility into its production complex to respond to potential changes in stockpile needs.

---

[19] National Nuclear Security Administration. “Modern Pit Facility Cost Estimate Summary,” MPF CD-0, Volume II–Mission, Requirements, and Strategies, February 2002.

Key assumptions made by the MPF study team are summarized below:

- Estimates are for a generic facility and do not include site-specific factors such as infrastructure improvements, grade and fill to provide a level site, or access roads.
- Requirements for process equipment and systems are based on input from the national laboratories and former staff at the Rocky Flats plant (closed since 1989).

The CD-0 estimate for the MPF was presented as a range estimate with a low of $2.2 billion and a high of $3.0 billion for the 125 pit-per-year case.[20] This estimate was revised in 2004 to a range of $2.5 billion to $3.5 billion (in 2007 dollars). That estimate—which we refer to as "CD-0 prime"—was the starting point for our estimate for the CPC.

The planned MPF for which those estimates were made is not the same as the proposed CPC. The new CPC design includes a plutonium research facility to house the research functions presently conducted at PF-4 at LANL and Building 332 at LLNL. Including the research facility in the complex requires an increase in the workload and size of the AC/MC laboratories and also an increase in support facilities. To adjust for this added content, we used an estimate for a third building to house the plutonium research, with some increases in the size of support facilities, originally developed by the MPF analytic team. Overall, the increases were estimated to add from $325 million to $373 million to the cost. This yields an adjusted CD-0 prime estimate of $2.8 billion to $3.9 billion.

Applying the cost growth factor of 1.7 raises the CPC cost to a range of $4.8 billion to $6.6 billion. In our summary analysis, we used $6 billion as the cost estimate for the CPC.

The estimate presented above for the cost of a greenfield CPC builds on the considerable analysis of the requirements for and costs of an MPF undertaken by NNSA analysts in the first part of this decade. It also reflects the realities of cost estimating and makes allowance for the historical cost growth in NNSA construction projects.

This estimate does not allow for several factors, however. Perhaps the most significant of these is changes in construction specifications, methods, and costs that might result from changes in the perceived security threat faced by nuclear facilities. The

---

[20] The Critical Decision (CD) levels are as follows: CD-0, approve mission need; CD-1, approve system requirements and alternatives; CD-2 approve project baseline; CD-3, approve start of construction; and CD-4, approve start of operations.

original CD-0 estimate was done in 2001 and published in February 2002, well before the Nuclear Regulatory Commission published its orders reflecting changes to the Design Basis Threat (DBT) in 2003.[21] While the revised estimate upon which IDA relied was released in September 2004, and therefore might have been expected to reflect changes arising from the 2003 DBT revisions, the discussion accompanying the estimate gives no indication of any DBT-driven changes to the estimate. A search of the MPF document database failed to reveal any document dealing with the subject of DBT changes.

In the absence of any firm analysis on which to base our numbers, this estimate makes no allowance for increases in costs resulting from either the 2003 or 2005 DBT revisions. This omission means the cost estimates may understate actual costs to meet present DBT standards.[22]

A second issue is that the estimate is for a generic greenfield facility; it does not reflect site-specific costs. These costs—for access roads, site preparation and grading, infrastructure improvements, and other site-dependent factors—are discussed in the section on transition costs.

A third issue deals with technology and the way it is embodied in equipment requirements. The cost of the production facility includes the cost of equipment needed to support a production rate of 125 pits per year. That equipment bill, however, reflects the NNSA's understanding of production requirements circa 2001. If pit production engineering has changed the process since then, those changes are not reflected in IDA's estimate. Such changes may add to or subtract from costs. Furthermore, changes in production standards might also affect facility requirements. One example is changes in safety standards that might require increased spacing of glove boxes, with a concomitant increase in overall size requirements for processing areas. All of these factors might affect the costs for the CPC.

c. Locating the CPC at TA-55

An alternative to building a greenfield CPC would be to further expand TA-55 to achieve a capacity of 125 pits per year. We previously estimated a cost of $2 billion to increase TA-55 capacity to 50 pits per year. To upgrade capacity further to 125 pits per year, LANL personnel estimate that two additional facilities analogous to the CMRR-RLUOB and CMRR-NF would be needed. These buildings would provide the floor space for the additional glove box

---

[21] U.S. Nuclear Regulatory Commission, "NRC Approves Changes to the Design Basis Threat and Issues Orders for Nuclear Power Plants to Further Enhance Security," NRC News No. 03-053, April 29, 2003.

[22] Remember that the estimates have been increased by 70 percent over the figures reported by MPF team members to reflect historical cost growth.

production lines required to achieve the desired manufacturing throughput. The additional cost of these facilities is estimated to be $2 billion.

Thus, the total cost of increasing TA-55 capacity from its current level of 10 to 125 pits per year is estimated to be $4 billion.

2. Secondary Production

Nuclear weapon secondaries, or canned subassemblies, are produced with myriad unique materials, most notably uranium. Along with the plutonium pits, they constitute the nuclear physics package of the weapon. Secondary production is currently performed at the Y-12 plant. Secondary production facilities are categorized into four areas, HEUMF, UPF, CMC, and plant support.

a. HEUMF

An HEUMF is currently being constructed at Y-12, with operations expected to begin in FY 2010. This 110,000-square-foot facility will support the consolidation of long-term storage of highly enriched uranium materials into a state-of-the-art facility. Construction is approximately 50 percent complete with a total cost at completion estimated by the project manager to be $569 million. This CD-3 estimate is considerably larger than the CD-1 estimate ($281 million).

We assumed that the HEUMF will be completed at Y-12, and thus is, in essence, a sunk cost for future decisions. If secondary production were relocated from Y-12, a facility such as this would need to be built at the CNPC site.

We estimated the replacement cost of the HEUMF to be $0.5 billion. Because we had a CD-3 cost estimate, we did not apply the historical cost growth factor.

We weighed arguments that a replacement HEUMF would have a different cost than the HEUMF at Y-12. Future increases in construction costs may drive the cost of the HEUMF higher. However, the design work is completed on the HEUMF, which might lower the cost of a replacement facility. Part of the cost growth may have been the result of changes in the DBT during construction. Thus, it may be possible that replicating the HEUMF would cost less than the original HEUMF. Of course, that possibility rests on the assumption that other problems don’t occur during the construction period. In balance, we judged that $0.5 billion is an appropriate point estimate for replicating the HEUMF.

b. UPF

Both of the modernization approaches assume that a UPF will be built. In the DCE alternative, it is built at Y-12. In the CNPC alternative, it is built at the CNPC site. We computed a single cost estimate for the UPF. We assumed that the construction cost of the UPF is independent of the site. However, our estimate of transition costs, which is applied if Y-12 is relocated, provides for some site-specific infrastructure construction.

The computation of UPF costs was based on the CD-1 estimate of $2 billion. Like estimates for other NNSA projects, that estimate was based on a detailed engineering estimate. The distribution of costs over the categories was roughly similar to the HEUMF at CD-1 and so there did not appear to be any irregularities. We applied a historical growth factor of 1.7 to arrive at an estimate of $3.4 billion.

We asked about the processes to be used in the UPF to determine if there was anything unusual. Although several processes planned for the new facility will be different from those currently in use, all of these have been demonstrated in the current facility with prototypes. Problems may be expected either with scale-up or production quality components (e.g., their durability). But, we did not find any specific issue of concern. Overall, we concluded that this appeared to be a typical CD-1 estimate.

We used analogies as a cross-check for our UPF cost estimate. We first used available data for facilities with a containment area for hazardous materials (a "hot zone") or glove box facilities (equipped with glove boxes for safely handling hazardous material). The available data were for the footprint of these facilities and are provided in Table 5.

Table 5. Estimate of Costs for Hot Zone/Glove Box Facilities

Facility Name	Status	Cost/sq.ft. (footprint)
Tritium Extraction Facility	Operating	$15,000
Defense Waste Processing Facility	Operating	$15,000
Mixed Oxide Fuel Fabrication Facility	Under construction	$15,000
Foster Wheeler Transuranic Waste Packaging Facility	In startup	$12,000
Rokkasho-Mura Reprocessing Plant	Operational	$25,000

Source: Advanced Reactor Systems and Safety Group, Nuclear Science and Technology Division, Oak Ridge National Laboratory.

For our comparison, we used $16,000 per square foot of footprint for glove box facilities. Multiplying the footprint of the UPF, 149,000 square feet, by the $16,000 per square foot average cost results in an estimate of $2.4 billion for the UPF.

Although the analogous facilities in Table 5 were for nuclear facilities, they did not require heavily reinforced concrete, double walls for security as would the UPF. As was the case with estimating the HEUMF, it is not just the cost of the labor and material for these walls, it is also the cost of inspecting (and revising the work) that makes this type of construction expensive. Therefore, we judged that an estimate based on this analogy would be somewhat low.

In addition, we compared the UPF with the HEUMF. For this comparison, the data for cost per gross square foot were available. The HEUMF is 110,000 gross square feet with an estimated cost of $569 million, $5,200 per gross square foot. The UPF estimate is for 388,000 gross square feet. Applying the cost per square foot from the HEUMF yields an estimate of $2 billion for the UPF. Of course, the HEUMF is essentially a warehouse, while the UPF is a modern production facility with equipment needs as well as structures. So using the HEUMF as an analogy probably represents a lower bound estimate for the UPF.

We rounded our estimate of $3.4 billion to the nearest half-billion and used $3.5 billion as our cost estimate for the UPF cost. We note that the cost of the UPF is common to both modernization alternatives.

c. CMC

In addition to the HEUMF and UPF, other facilities are needed for work with lithium, depleted uranium, special materials, and general manufacturing operations. These operations are currently performed in buildings dispersed throughout the Y-12 complex; however, plans for Y-12 call for building a new CMC that would be operational in FY 2017. The CD-0 cost estimate for a single 100,000 square foot facility that would consolidate all these operations is $535 million.

The cost per square foot of the NNSA estimate is comparable to the cost per square foot for the HEUMF, roughly $5,000. Although the CMC is a manufacturing center and would require specialized process equipment not needed for the HEUMF, it is not a Category I/II nuclear facility—which argues for a lower cost. In comparison, the CD-2 cost estimate of the High Explosive Pressing Facility planned for Pantex, which should represent a comparable manufacturing environment to the CMC, is $1,500 per square foot. We determined that $0.5 billion is a reasonable point estimate for the CMC. We note that the CMC is common to both modernization alternatives.

d. Plant Support

Additional plant support facilities for office space, laboratories, medical facilities, cafeteria, shipping/receiving, and so on are needed if secondary production is relocated. Y-12 staff estimates that roughly 2 million square feet of buildings will be needed to house these functions and support the HEUMF, UPF, and CMC. However, many of these proposed new facilities would also be built at Y-12 if secondary production stays at Y-12. We estimated the amount of additional square feet of buildings required for plant support to be closer to 1 million square feet. This is consistent with the estimated plant support required to relocate Pantex.

Since this construction is all non-nuclear, we use a construction cost per square foot of $400, which is derived from NNSA recent actual costs for similar construction at Pantex. We thus use $0.5 billion as our cost estimate for additional plant support.

3. Assembly/Disassembly Facilities

Weapon assembly and disassembly is currently performed at the Pantex Plant in Amarillo, Texas. Work performed at Pantex includes support of the Life Extension Programs; weapon dismantlement; development, testing, and fabrication of high explosive components; surveillance of plutonium pits; and interim storage of pits. The plant has about 640 buildings covering almost 3 million square feet, 55 miles of paved roads, 60 miles of fences, 17,000 pieces of equipment, and 3,600 full time employees.[23] To estimate the cost of rebuilding the capability encompassed at the Pantex Plant, we started with a categorization of square footage of various types of facilities that was assembled by the NNSA for the Programmatic Environmental Impact Statement (PEIS). The assumptions used for this analysis are that the facility must be capable of handling both conventional high explosives (CHE) and insensitive high explosives (IHE) and have a capacity of 125 assemblies, 400 disassemblies, and 75 surveillances per year.

Weapon assembly and disassembly activities require two specialized types of facilities, assembly cells and assembly bays. When the main charge in the weapon is made from CHE, the physics package assembly must be conducted in an assembly cell. Assembly cells are designed with nearly 7 meters of gravel overlaid on the roof to absorb the blast pressure from a detonation

---

[23] According to a Pantex Info Fact Sheet, “Infrastructure, Staffing and Economic Impact,” June 2007, available from the Pantex public Web site, http://www.pantex.com/about/facts/index.htm.

of up to 192 kilograms of plastic-based explosives and to minimize the release of radioactive material in the event that the CHE detonates. After the physics package is cased, the potential for detonation is greatly reduced, and the physics package may be moved to an assembly bay. The physics package for a weapon using an IHE main charge can be assembled in a bay. To estimate the cost of rebuilding both the assembly cells and assembly bays, we used the replacement value found in the Department of Energy's Facilities Information Management System (FIMS) database, adjusted for historical cost growth by a factor of 1.7. For assembly bays, we used $1,500 per gross square foot, which was adjusted for historical cost growth to $2,500. For assembly cells, we used $4,200 per gross square foot, adjusted for historical cost growth to $7,140.

Developing, testing, and fabricating high-explosive (HE) components also requires specialized facilities. The activities involved are research and development to find the best formulations of HEs for use in nuclear weapons, synthesizing and formulating energetic materials (explosives) with other materials as appropriate, and finally, pressing and machining the HEs to the configurations needed for use in nuclear weapons. To estimate the cost of rebuilding HE development, testing, and fabrication facilities, we used a cost per square foot of $1,500 based on the CD-2 estimate for the HE Pressing Facility.

Finally, Pantex is also responsible for surveillance and interim storage of plutonium pits. After removal from nuclear weapons, pits are packaged in storage containers and placed in secure storage locations designated for special nuclear material. The plant currently uses multiple types of storage locations for plutonium pits: Modified-Richmond magazines, Steel Arch Construct, magazines and one bay. To estimate the cost for weapon and component storage facilities, we used the Pantex conceptual estimate for building additional Modified-Richmond magazines, $7,000 per gross square foot, adjusted for historical cost growth to $11,900.

In addition to the assembly bays and cells, HE facilities, and weapon storage facilities, several standard buildings will have to be built to house personnel, laboratories, maintenance activities, and so on. To estimate the cost of these buildings, we used the cost per square foot of $400 for the Protective Forces facilities now under construction at the site.

Table 6 shows the estimated space requirements within the PIDAS area for the different functions, the type of building needed and the construction cost estimate (in millions of FY 2007 dollars). Table 7 shows the space and cost estimates for the required facilities outside the PIDAS area. In total, the estimate to rebuild the capability currently housed at the Pantex site is $4.5 billion.

Table 6. Assembly/Disassembly Space and Cost Estimates Inside PIDAS Area

Facility	Space Required (sq. ft.)	Construction Type	Construction Cost Estimate (FY07$M)
Nuclear Facilities			
Cells	70,000	Cell	$500
Bays	155,000	Bay	$395
Joint Test Assemblies/ Testing Bays	135,000	Bay	$344
Pit Reuse/Qualification	50,000	Bay	$128
SNM Weapon Staging	50,000	Magazine	$595
SNM Components	50,000	Bay	$128
A/D Support Facilities			
Production Stores	125,000	Bay	$319
Testing Laboratories	24,000	Steel Building	$10
Maintenance	37,000	Steel Building	$15
HE Staging	21,000	Magazine	$250
Security			
Security Towers	4,000	HE Pressing	$6
Guard Stations	14,000	Magazine	$167
Ramps	140,000	Steel Building	$56
Total	875,000	—	$2,855

Table 7. Assembly/Disassembly Space and Cost Estimates Outside PIDAS Area

Testing Facilities	Space Required (sq. ft.)	Construction Type	Construction Cost Estimate (FY07$M)
WETL, Metrology	68,000	Steel Building	$27
HE Operations			
Synthesis, Formulation	53,000	HE Pressing	$80
Processing, Extrusion	9,000	Bay	$23
Pressing, Machine, Test	126,000	HE Pressing	$189
Storage, Disposal	35,000	Magazine	$417
HE Operations Support	21,000	Bay	$54
Firing Sites	25,000	Cell	$179
Plant Support			
Chemical Laboratory	21,000	Steel Building	$8
Manufacturing Stores	18,000	Steel Building	$7
Waste Treatment	39,000	Steel Building	$16
Production Support	307,000	Steel Building	$123
Maintenance Support	129,000	Steel Building	$52
Security Support	121,000	Mixed	$182
OST Support	72,000	Steel Building	$29
Training	42,000	Steel Building	$17
Central Computing	32,000	HEPF	$48
Central Computing	32,000	HEPF	$48
Personnel Offices	229,000	Steel Building	$92
Ramps	128,000	Steel Building	$51
Total	1,475,000		$1,591

4. Mission Transition

Re-siting nuclear production functions would incur additional costs that are not included in the foregoing construction estimates. For example, additional costs would be incurred during the startup period for a new facility (the period after construction is complete, but before full-up production capability has been achieved) due to operation of both the old and new facilities. Other categories of mission transition costs we considered are the costs of accomplishing personnel changes (for employees that are separated, relocated, or hired), secure transport of SNM, and infrastructure improvements at the receiving site (such as PIDAS, utilities, and access roads).

These transition costs are difficult to estimate precisely since the costs incurred for any specific move will be dependent not only on the mission to be moved, but also on the available infrastructure at the receiving site, the geography of the terrain, state regulatory processes, and on policy decisions and management practices. Adding to the uncertainty is the fact that little historical data exists for use in developing a parametric cost estimate. Although nuclear production functions have been transferred before—as in the transfer of pit production from Rocky Flats, neutron generators from Pinellas Plant, and detonators from Mound Facility—the transfer either resulted in a lengthy gap in production or was for the purpose of reducing excess capacity in the system. As previously discussed, the current nuclear weapons complex has only one site performing each of the production functions.

Additional discussion on each of the transition cost categories is supplied below. For the DCE versus CNPC discussion, we used $1 billion as our estimate of the transition cost per mission moved.

a. Overlap in Operations

In the transfer of mission capability from one site to another, the amount of “overlap” in operations is a policy trade-off between the additional cost and the length of the gap in production capability for the mission under consideration. Each facility relocated will require a period of time after construction is complete to startup production operations. This time includes personnel and process qualification, operational readiness reviews, and so on. The length of the startup time depends on specifics about the facility and site, but recently observed and estimated startup times have been 2 to 3 years.[24] The startup time typically involves a period of no production capability followed by a period of production ramp-up. To mitigate mission risk (for example, to be capable of performing weapon surveillance and to have the ability to remediate any issues that may be discovered), the original site may remain fully operational during some portion of the new site startup period. If this is the case, additional operations and maintenance (O&M) costs will be incurred.

We show below the additional O&M costs because of overlapping operations for various periods of time. The assessment of how much mission risk is acceptable, and therefore how long the original facility should remain in operation, is a policy decision left to the appropriate decision maker.

Figure 3 shows an example where the original site begins shutdown at the same time that the new site begins its startup. For ease of calculation, the original site is assumed to ramp down at the same rate that the successor site ramps up. In this case, the gap in production capability is significant; this increases mission risk, but there is no additional cost to the system for overlapping operations.

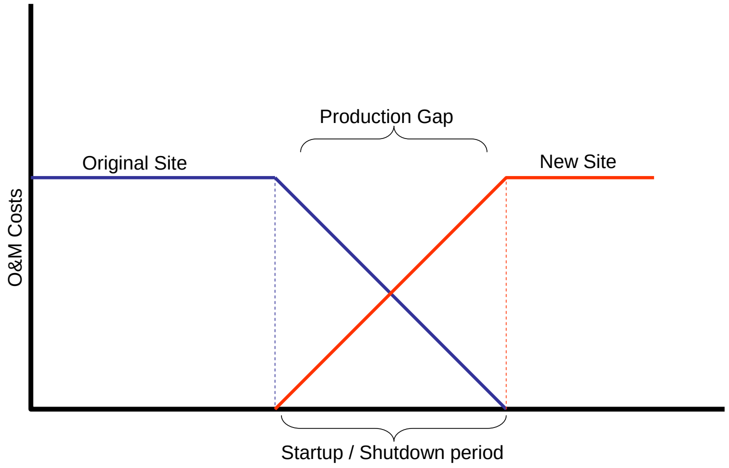


Figure 3. No Delay in Shutdown of Original Site

Figure 4 shows the opposite extreme, where the original site is kept fully operational until the new site is also fully operational. In this case, there is no gap in production, and the

---

[24] Based on actual startup times for the Tritium Extraction Facility at the Savannah River Site and the Neutron Generator Facility at Sandia and estimated startup times for the UPF and CMRR-NF.

additional cost to the system consists of the O&M cost for the existing site over the period that the shutdown was delayed, represented by the green area.

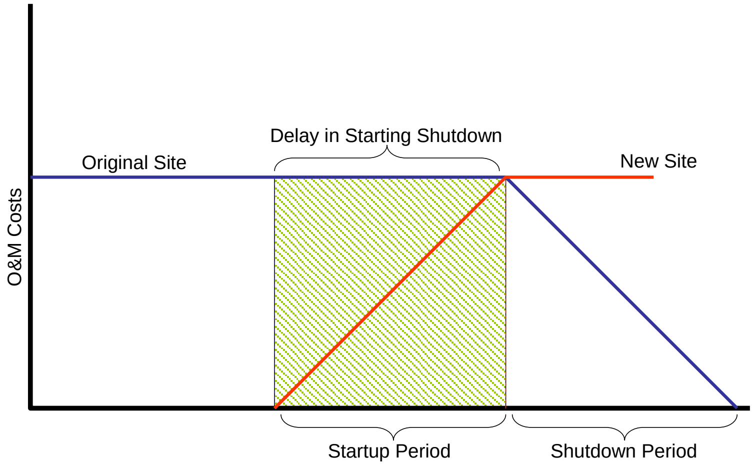


Figure 4. Delay Shutdown of Original Site until New Site is Fully Operational

Finally, Figure 5 shows an example of delaying the shutdown of the original site for some period after beginning the startup of the new site, but not for the full duration of the startup period. The additional cost to the system consists of the O&M cost for the existing site over the period that the shutdown was delayed, represented by the green area.

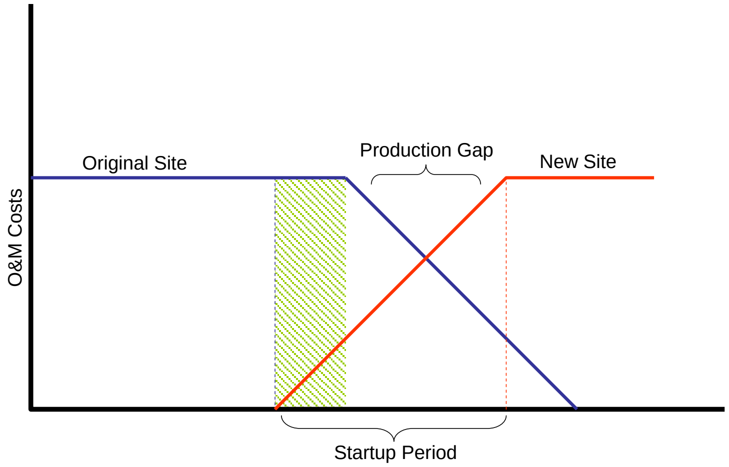


Figure 5. Some Delay in Shutdown of Original Site

For this study, we estimated the costs of moving the production missions of Y-12, Pantex, and the TA-55 complex within LANL. To determine Y-12 and Pantex production operations costs (O&M), we included costs allocated to NA-12 (Military Application and Stockpile Operations), excluding facility recapitalization (new facilities are being built), security (handled separately), and inertial confinement research (not a production function). For LANL, we used NNSA's NA-11 (Office of Research, Development, and Simulation) costs for pit production as a proxy for pit production operations. Table 8 shows the production operations costs for FY 2006, obtained from NNSA Standard Accounting and Reporting System (STARS) data. These costs were escalated to FY 2007 for our calculations.

Table 8. Production Operations Costs

	Cost	
Site	FY06$M	FY07$M
Y-12	$588	$601
LANL	$504	$515
Pantex	$334	$341

Source: NNSA STARS data.

Using these numbers as a basis, we calculated the total cost in overlapping operations for delaying the shutdown of the specified site for a range of years. Table 9 shows the results.

Table 9. Cost of Overlapping Operations

Delay in Shutdown (Years)	Cost (FY07$M)		
	Y-12	LANL	Pantex
0.5	$301	$257	$171
1.0	$601	$515	$341
1.5	$902	$772	$512
2.0	$1,203	$1,029	$682
2.5	$1,503	$1,287	$853
3.0	$1,804	$1,544	$1,024

In addition to operations costs, we must account for the additional security costs associated with operating duplicate facilities. Full security must be maintained at the original site until all Category I/II quantities of SNM are removed, and full security for SNM must also be in place at the new site before it can accept any materials. Other security costs would need to be ramped up as personnel and activity increased. Additional security costs are calculated for various cases using a 3-year startup period and $40 million as the cost of adding security for a new production function at an existing site (see subsection B.1 for further information).

Figure 6 shows the “low” case for additional security costs. In this case, the original site begins shutdown as soon as the new site begins startup, but the security costs remain at their original levels until the site is closed. Security costs for the new site are assumed to ramp up over the startup period, with full security achieved before Category I/II levels of SNM are present at the site. The additional cost to the system is represented by the cost to secure the new site during the startup period and is shown by the red area.

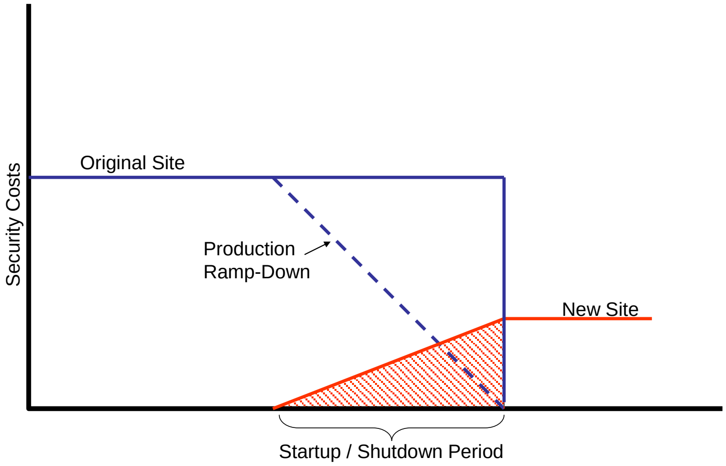


Figure 6. “Low” Additional Security Costs

Figure 7 shows a “high” case for additional security costs. In this case, the original site does not begin to shutdown until the new site is fully operational. As before, security costs for this site remain at their original levels until the site is closed. Also, in this higher case, we assume that full-up security must be in place at the beginning of the startup period for the new site. The additional cost to the system is due to the delay in beginning the shutdown of the original site (blue area) and the cost to secure the new site during the startup period (red area).

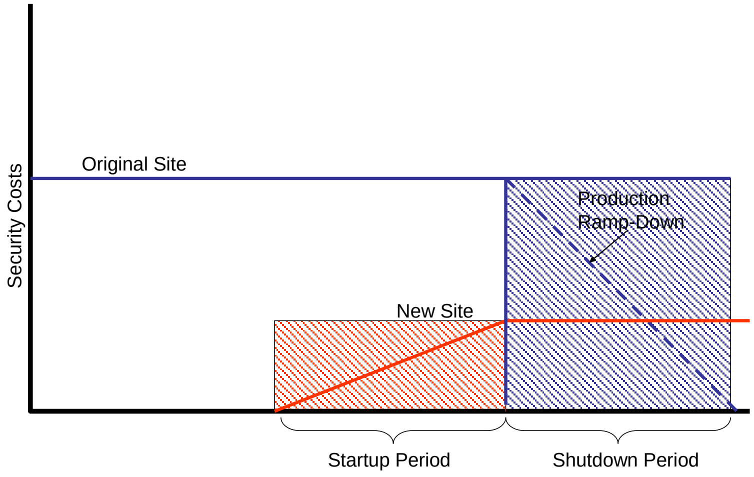


Figure 7. “High” Additional Security Costs

Table 10 shows the estimated additional security costs for the two cases.

Table 10. Additional Security Cost for Relocating Facility

	Cost (FY07$M)	
Site	Low	High
Y-12	$60	$570
LANL	$60	$240
Pantex	$60	$570

In summary, the cost due to operating duplicate facilities during the transition of a mission from one site to another ranges from approximately $230 million to over $2 billion, depending on which site is to be closed, how long the closing site will remain at full operations, and how the security costs at the new site will ramp up. The total overlap cost is dependent upon the length of time the original site remains at full production, which will be a policy decision based on the amount of mission risk—due to a potential gap in production—deemed acceptable.

b. Personnel Costs

In addition to costs for operating multiple facilities, some additional personnel costs will be incurred in the transition. Personnel costs will include separation pay and benefits for employees not making the transition, relocation costs for those that do move, and rehiring costs at the new site.

According to a 1999 GAO Report,[25] during the mid- to late-1990s, the Department of Energy downsized its contractor workforce by 46,000 employees in response to the end of the cold war and ensuing change in mission needs. These employees received separation benefits (which included not only a separation allowance, but also extended medical coverage, relocation assistance, educational assistance, and outplacement assistance), the magnitudes of which depended on the employees' length of service and base pay. On average, each separated employee received $25,100 in FY 1998. Additionally, an average of $6,500 per job lost was paid in community assistance. In FY 2007 dollars, this amounts to about $39,100 per separated employee, somewhat more than the currently allowable amount ($25,000) for separated federal employees.

According to the GAO report, the Department of Energy paid separation benefits to about 88 percent of the defense facility contractor employees who separated during FY 1997 and FY 1998. Experience shows that only a small percentage (5–10 percent) of employees will typically relocate in this type of site move. Based on these assumptions (90 percent separate, 88 percent of those receive benefits), total separation benefits were calculated for NNSA personnel by site.[26] These costs are shown in Table 11.

Table 11. Separation Benefits by Site

Site	Total Cost (FY07$M)
Y-12	$123
LANL	$101
Pantex	$93

For those personnel who relocate to the new site (assumed to be 10 percent), additional benefits are also paid. According to the Worldwide Employment Relocation Council, the average domestic relocation costs in FY 2006 were $64,235 for homeowners and $18,376 for renters[27]. Using these figures, we calculated a range of estimates for the relocation of personnel for each of the sites, as Table 12 shows. The high point of the range assumes that all relocating employees are homeowners, and the low end assumes all are

---

[25] Government Accountability Office, "Department of Energy Workforce Reduction: Community Assistance Can Be Better Targeted," GAO/RCED-99-135, May 1999.

[26] Obtained from full-time equivalent data submitted by NNSA to the Cost Analysis Improvement Group in the Office of the Secretary of Defense, 3,930 at Y-12, 2,987 at Pantex, and 3,252 at LANL.

[27] Worldwide ERC (Employee Relocation Council)—The Association for Workforce Mobility, http://www.erc.org/, accessed November 16, 2007.

renters. Presumably there would be a mix of homeowners and renters in the population of relocating employees, so the total relocation cost should be within this range.

Table 12. Relocation Costs by Site

Site	Cost (FY07$M) Low	Cost (FY07$M) High
Y-12	$7	$25
LANL	$6	$21
Pantex	$5	$19

In summary, we estimated personnel costs for the transition of a mission to a new site would range from about $100 million to $150 million for separation benefits and relocation costs. We did not estimate additional small costs that may occur for hiring personnel at the new site and for any training costs not covered by the additional operations costs we estimated.

c. Secure Transport of SNM

In order to close a site, all of the SNM inventories must be removed using secure transportation. The Office of Secure Transportation (OST) provided results of their transportation planning model for baseline transportation workload, plus the movement of required SNM inventories to a CNPC at each of the five proposed sites. The OST modelers assumed that the movement would take place over a 10-year period. From their results we inferred the number of standard convoys needed to “de-inventory” each of the three sites that are under consideration for relocation.

The OST budget of approximately $220 million per year provides for 4.5 transportation teams (personnel and vehicles), increasing to 6 teams by FY09. Each team provides a capacity of approximately 22 convoys per year. The transportation planning model uses an average direct cost per standard convoy of about $280,000. Direct costs include:

- Labor costs such as travel, per diem, night differential, and overtime;
- Vehicle costs such as fuel and maintenance;
- Scheduling; and
- Tracking.

The direct cost per convoy does not, however, include factors for vehicle depreciation, personnel salaries, training, and so on. Another alternative is to use a total cost per standard convoy of $1.8 million, derived from dividing the total OST budget by the number of convoys per year. While the direct cost per convoy does not consider costs associated with maintaining the secure transportation capability, the total cost method overstates the case since it includes costs, such as headquarters personnel, that are more correctly considered fixed. The available budget and accounting data do not allow us to more accurately assign these costs.

Table 13 shows the resulting one-time secure transportation costs for relocating each of the potential sites using both direct cost and total cost.

Table 13. One-time Transportation Costs

	Cost (FY07$M)	
Site	Direct	Total
Y-12	$20	$140
LANL	$10	$70
Pantex	$60	$420

Finally, note that, though we discuss the cost of moving the SNM inventories due to site relocation, we assumed that the OST will move these shipments without a corresponding increase in the number of transportation teams (other than what is already planned). There is thus no real increase in cost to the NNSA for these moves; however, there is an opportunity cost in the form of other transportation convoys (for Environmental Management, Department of Defense, or other missions) that may be cancelled or delayed.

d. Infrastructure Improvements

In each of the construction estimates presented thus far, we included both mission essential facilities and some plant support facilities (personnel offices, maintenance support, production support, storage, and waste treatment, for example). Depending upon the available infrastructure at the receiving site, though, a variety of other improvements may have to be made. These could include PIDAS construction, access roads, and improvements to utilities such as electrical substations and steam plants. For example, the MPF study indicated a range of about $100 million to $500 million for additional infrastructure, depending on the site.[28] This is an area that requires a detailed analysis

---

[28] Modern Pit Facility Life-Cycle and Total Project Cost Comparison for the MPF Facility Configuration Alternative Study (U), November 2004.

and cost estimate to determine the necessary improvements for any specific relocation decision. This type of analysis was outside the scope of this study.

B. POTENTIAL SAVINGS FROM CNPC

Turning now to savings that would be achieved in the CNPC alternative relative to the DCE alternative, we considered the following three elements:

- Security savings associated with the closure of facilities (partly offset by increases in security cost at the CNPC site);
- Transportation savings associated with not having to transport weapons components across country between Pantex, Y-12, and LANL if production facilities were consolidated at one site; and
- Other efficiencies associated with modernizing/resizing facilities or collocating facilities.

1. Security

One of the major potential sources of savings for the CNPC alternative is security costs. Security costs have risen sharply as a direct result of increases in the assumed Design Basis Threat (DBT) after September 11, 2001. The NNSA's Weapons Safeguards and Security budget was $449 million in FY 2002 (before a $106 million Emergency Supplemental) but is projected to be $847 million in FY 2008, according to the NNSA's FY 2008 congressional budget submission.

Closing a site saves the security costs at that site. These savings are partially offset by increases in security costs at the CNPC site. In the CNPC alternative, Y-12 and/or Pantex would be closed. Thus, for Pantex and Y-12, we needed to project the long-term, steady-state security costs at these sites under the DCE option.

The NNSA provided the FY 2012 budget projection for security at both these sites. By this time, both sites plan to be fully compliant with the latest DBT. These budget projections, expressed in FY 2007 dollars, were $159 million for Pantex and $176 million for Y-12. Note that these estimates include Defense Nuclear Security and Cyber Security costs.

In the DCE option, Y-12 plans to consolidate its production facilities. This consolidation is expected to lower the security costs at Y-12 as the Category I/II security area will be reduced and the new facilities are designed to be more defensible.

Y-12's FY 2007 UPF Business Case Analysis estimates security savings of about $35 million per year.

If we incorporate these savings due to consolidation, the estimate of Y-12 annual security costs in the DCE alterative becomes $142 million in FY 2007 dollars.

Given the uncertainty of future security costs and the similarity of the expected security costs for the two sites, we rounded these estimates and used $150 million as the average security costs at Y-12 and Pantex in the DCE alternative.

We also estimated both the amount that security would have to be increased at the CNPC because of the additional SNM function(s) and the larger number of people and buildings (personnel and other non-SNM security costs would also increase). One data point we received was that LLNL estimates that security costs will be reduced by $29 million a year, out of a $100 million security budget, if the SNM function was removed from LLNL. Additionally, Nevada Test Site, which recently acquired an SNM mission, estimates that annual security costs increased by $51 million. Personnel from the NNSA's Office of Defense Nuclear Security indicated that the LLNL estimate is likely a bit low and that the Nevada Test Site number might be too high. For our analysis, we used the average of these ($40 million) as a point estimate.

Thus, in the CNPC alternative, if one site is closed, we estimate the yearly security savings as $110 million. If two sites are closed, the savings would be twice that. But these savings would accrue only after all Category I/II SNM is removed from the closing site(s); thus, not before 2025.

Note that pit production could be transferred out of LANL in some alternatives, but that LANL would remain open. The net security savings of transferring pit production would be approximately zero since the security savings associated with removing an SNM function from LANL would be offset by the security costs associated with adding an SNM function at the receiving site.

2. Transportation

If all production operations were consolidated into a CNPC, there would be some reduction in required secure transportation convoys of weapon components. In particular, the transportation legs between Pantex, Y-12, and LANL would be eliminated.

According to OST modeling, the CNPC alternative would require 32 fewer baseline workload convoys per year than the 2012 baseline of 71 convoys. Note that some of the decrease in baseline workload over the time period is due to having completed the dismantlement of the pre-Moscow Treaty stockpile, thereby not having to move the dismantled components.

As discussed previously, there are multiple ways to calculate the cost savings due to the reduction in convoy workload. Direct costs alone account for approximately \$15 million in savings. The total cost, including allocated fixed costs, attributable to this reduction in convoys is approximately \$95 million.

We used the direct cost of \$15 million as our estimate of the potential transportation savings due to consolidation.

Finally, we should note that though we discuss the savings in transportation due to consolidation of the production functions, we assumed that OST will not decrease the number of transportation teams due to the backlog in demand for secure transportation assets. Thus, there is no decrease in the NNSA budget for transportation due to consolidation.

3. Other Efficiencies

In this section, we explore the cost savings from improved efficiencies under the CNPC alternative. These are the estimated yearly recurring savings from improved efficiencies of the CNPC alternative when compared to the DCE alternative.

Since we are interested in estimating the increased savings from the CNPC alternative, we excluded any savings that could be achieved under either alternative (e.g., improvements in NNSA contracting practices).

The CNPC alternative offers two possible ways to achieve savings due to greater efficiency. The first is by modernizing and resizing. When a new production facility is built, the newest technology can be used, and the facility can be sized to meet current mission needs. This potentially yields both operations and security savings as outdated or abandoned facilities do not have to be maintained and guarded.

In our analysis, we considered possible savings from modernizing or resizing Y-12, Pantex, and TA-55 at LANL. In the case of Y-12, this facility is going to be modernized and resized under both alternatives. We assumed any recurring operation savings resulting from this modernization could be realized under both the DCE and CNPC alternatives. Thus, rebuilding Y-12 under the CNPC alternative would not lead to additional efficiency savings compared to the DCE alternative.

For Pantex, we estimated that rebuilding the assembly/disassembly capability elsewhere will not result in significant efficiency savings. The CNPC proposal is to build a smaller assembly/disassembly facility with 25 bays and 10 cells. However, if this is all that is required, Pantex can downsize and achieve nearly the same result.

Both the CNPC and DCE alternatives would initially upgrade the production capability at TA-55 at LANL to 50 pits per year. Both alternatives then consider either building a new Consolidated Plutonium Center (CPC) or upgrading TA-55 at LANL to increase pit capacity to 125 pits per year. Upgrading TA-55 production capabilities will require investments to improve the flow of material through the building. Once this is accomplished, no substantial efficiency savings would be realized from a new CPC compared to an upgraded TA-55.

The second means of achieving efficiency savings is by co-locating different activities. If facilities for different activities are in the same location, it’s possible that common support functions can be shared to provide savings. We considered the yearly recurring cost savings from co-location.

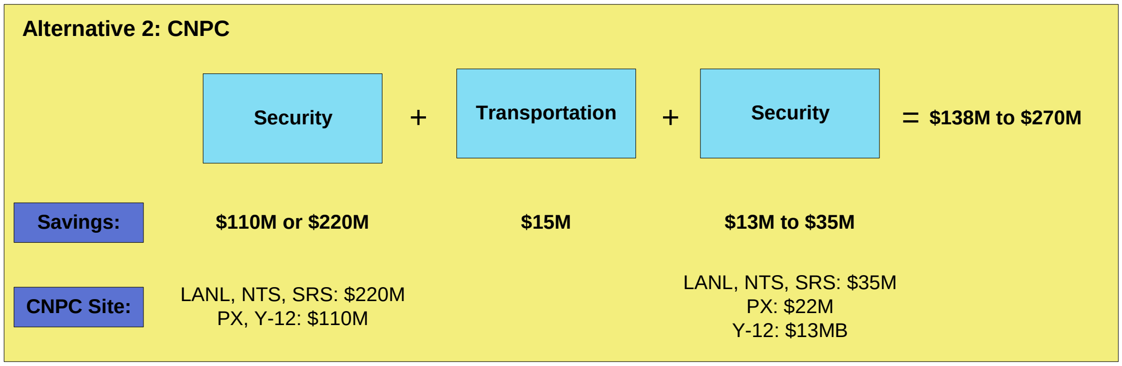
To compute these savings, we considered historical examples of co-location. We looked at a study of hospitals that have merged, a study of consolidation in the missile industry, and a survey of the commercial industry. These studies revealed a yearly savings from co-location ranging from 0 percent to 15 percent. Note, however, that most of these studies analyzed forecasts of potential savings, not actual savings. We also considered Base Realignment and Closure (BRAC) forecasts. They estimated that 7–15 percent of the cost of common support functions could be saved due to co-location.

In general, we found that previous experience showed that consolidating like activities often, but not always, resulted in some cost savings. However, there is scarcely any evidence we could find on savings resulting from co-locating dissimilar activities. The CNPC alternative largely represents co-location of disparate activities. The capabilities under consideration, plutonium pit production, uranium and secondary production, and weapon assembly/disassembly, have few shared activities. None of the other sites has suitable spare capacity to be leveraged. To put it another way, we could find no economies of scale, and few economies of scope.

After considering all the historical data, we estimated a 10 percent savings in non-security indirect costs as a result of co-location.

4. Summary of Savings Associated with CNPC

Figure 8 shows that our estimates of annual savings due to consolidating production operations range from $140 million to $270 million in non-discounted, FY 2007 dollars. The largest component of these savings is from security, which we estimated to range from $110 million to $220 million, depending upon whether one site or two sites are closed. We estimated the savings associated with transportation as $15 million because a large portion of the transportation resources would still be required for other missions, and a large portion of the transportation budget is relatively fixed (e.g., command and control and training). We estimated other efficiencies associated with consolidation to be $13–35 million, depending upon the site.



Alternative 2: CNPC

Security + Transportation + Security = $138M to $270M

Savings: $110M or $220M; $15M; $13M to $35M

CNPC Site:

LANL, NTS, SRS: $220M
PX, Y-12: $110M

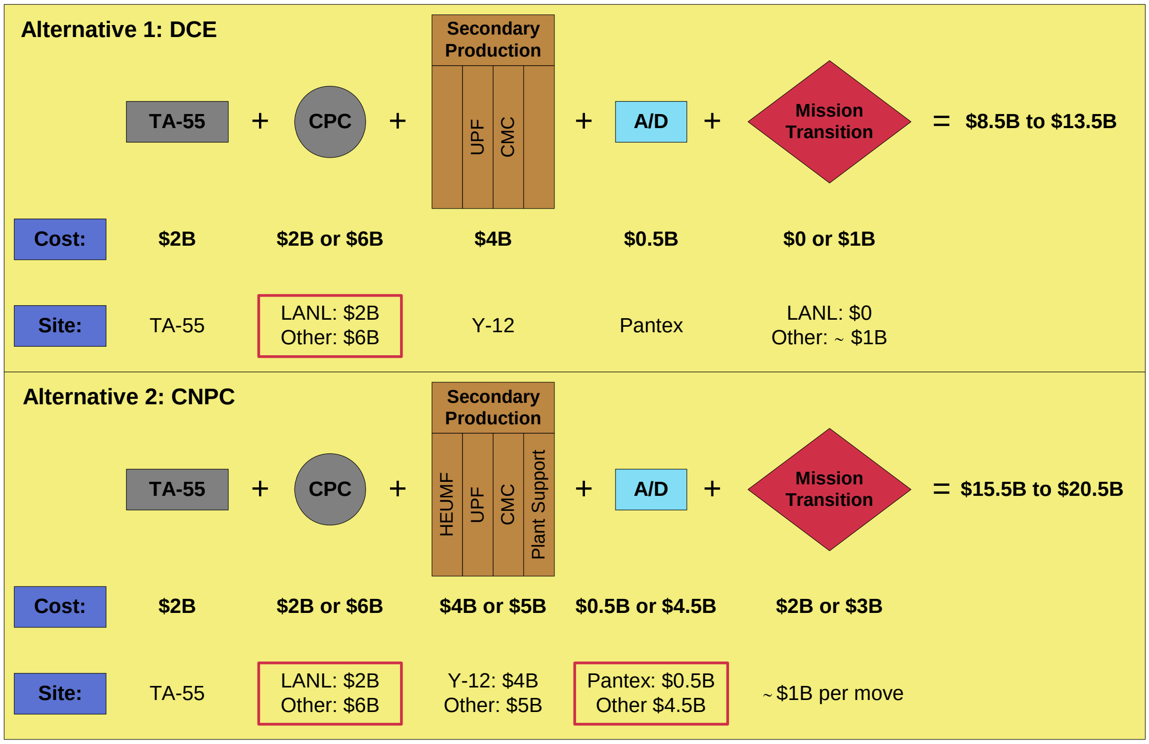
LANL, NTS, SRS: $35M
PX: $22M
Y-12: $13MB

Note: Costs are in undisounted FY 2007 dollars.

Figure 8. Savings from Consolidation of Production Operations

C. COMPARISON OF DCE AND CNPC

Figure 9 summarizes our estimates of the major investments required for the DCE and the CNPC alternatives in undiscounted FY 2007 dollars and without decontamination and decommissioning costs. Note that the figures for the total cost of each alternative are point estimates associated with decisions as to where to locate the CPC and CNPC; Figure 9 does not indicate the likely ranges around the point estimate.



Note: Costs are in undisounted FY 2007 dollars. Cleanup costs are excluded.

Figure 9. Estimates of DCE and CNPC Alternative Costs (FY07$B)

From an investment perspective, costs are lowest for options that employ the most existing production capacity and infrastructure. Only the DCE alternative—and only if the CPC is built at LANL—makes use of all existing facilities. This is the basis of the lowest investment cost case ($8.5 billion) for the DCE alternative. Building the CPC elsewhere increases the cost of the DCE option by $5 billion (an additional $4 billion for facilities and an additional $1 billion for transition). In the CNPC case, substantial investment is needed in reproducing facilities that currently exist at LANL or Pantex or both. Thus, the lowest cost CNPC alternative is $7 billion more than the lowest cost DCE alternative.

The lowest cost DCE option retains pit production at LANL and is estimated to cost $8.5 billion. To compare this to the cost of the CNPC alternative, we calculated the net present value of the CNPC alternative for each CNPC location. First, for every CNPC location, we determined the difference between the lowest cost DCE alternative ($8.5 billion) and the cost for a CNPC at that site. For example, a CNPC at LANL would cost $7 billion more than the lowest cost DCE alternative while a CNPC at Savannah River or Nevada Test Site would cost an additional $12 billion. Then, using historical construction outlay profiles and projected completion dates of each major investment,[29] we determined how these costs would be allocated in each year from 2008 to 2025. Finally, we calculated the total net present value of the investment using a 3 percent discount rate.[30]

We similarly determined the net present value of the savings for each CNPC location. We assumed that annual savings would begin in 2025 and continue indefinitely. We applied the same 3 percent discount rate, and calculated the net present value of the savings.

For the overall net present value of the CNPC option, a positive result indicates that the money invested to build the CNPC at that site would eventually be recouped by the annual savings that would result from the consolidation. The only CNPC location with a positive net present value is LANL, but break-even would not occur until year 2109, well beyond any reasonable time horizon.[31] Table 14 summarizes these results.

Table 14. Summary of Results

CNPC Location	Total Cost of CNPC	Delta Cost (CNPC – DCE)	Annual Savings from CNPC	Break-Even Year	Net Present Value
Los Alamos National Laboratory	$15.5B	$7B	$270M	2109	$0.4B
Pantex Plant	$15.5B	$7B	$147M	Never	–$2.0B
Y-12 National Security Complex	$18.5B	$10B	$138M	Never	–$4.3B
Nevada Test Site	$20.5B	$12B	$270M	Never	–$3.2B
Savannah River Site	$20.5B	$12B	$270M	Never	–$3.2B

As shown in Table 14, the net present value is negative for all but the case with the CNPC at LANL, which, however, does not break even until just over a century. We show in Chapter V that the small positive net present value associated with the CNPC at LANL results from a negative net present value from moving Pantex to LANL and a slightly

---

[29] See Appendix B.

[30] Per Office of Management and Budget Circular A-94, 30-year Real Interest Rates on Treasury Notes and Bonds of Specified Maturities

[31] We calculated the break-even year by distributing the costs for each major investment from 2007–2025. For each year, we summed the costs for each investment and apply a discount factor. Summing over all years gave the total discounted investment cost for the alternative. We assumed savings accrue every year, starting in 2025. We applied a discount factor to determine the total discounted savings each year. The year when the total discounted savings is greater than the discounted investment cost is the break-even year.

larger positive net present value from moving Y-12 to LANL. Overall, comparison of benefits and costs does not make a case for the CNPC.

There is considerable uncertainty with respect to both our cost and savings estimates. However, the uncertainty is not symmetrical, meaning that costs are more likely to increase and savings are more likely to not materialize or be delayed (by schedule growth in the new construction, for example). Increases in cost or decreases in savings would tend to worsen the case for the CNPC.

V. IMPLICATIONS OF PIT REQUIREMENTS ON MODERNIZATION

One of the driving assumptions in this study is the pit production requirement. Under the assumptions provided to us by NNSA, pit production capability is increased in two steps. First, TA-55 is upgraded to provide an interim capability of 50 pits per year. Second, a Consolidated Plutonium Center (CPC) is established in 2022 with a single-shift capacity of 125 pits per year. This CPC can be either an expanded TA-55 or a new facility. As detailed in Chapter IV, we estimated that building a new CPC would cost $6 billion, $4 billion more than the estimated cost to further upgrade TA-55.

The pit requirement assumption is common to both the DCE and CNPC modernization alternatives. However, it does play into the comparison of DCE with CNPC due to the large cost associated with relocating the CPC. This is because the CNPC alternative can either avoid the high cost of the CPC or the high cost of replacing Pantex, but not both.

Since the pit production requirement is a policy decision under active discussion, we examined its implications on infrastructure decisions for the nuclear weapons production complex. For this excursion, we analyzed the cost basis for relocating each of the three production activities: pit production, secondary production, and assembly/disassembly. These are in essence separable decisions, and we treat them as such in this chapter.

A. SHOULD PIT PRODUCTION BE RELOCATED?

We found that the NNSA has options to incrementally expand the pit production capability at TA-55 at Los Alamos National Laboratory (LANL). Various infrastructure investments provide for an increase in the pit production capacity.

As we showed in Chapter IV, the current pit production facility, PF-4, needs about $500 million in upgrades to maintain a reliable pit production capability at its current level. The Chemistry and Metallurgical Research Replacement Nuclear Facility (CMRR-NF) is estimated to cost $1.5 billion and will increase pit production capacity to 50 pits per year. The total estimate for achieving 50 pits per year at TA-55 is therefore approximately $2 billion. As noted previously, the 50 pits per year is for a single shift operation.

According to LANL personnel, a CMRR-NF design with an additional 9,000 square feet would increase pit production capacity to 80 pits per year. The estimated added cost for the larger CMRR-NF is $0.5 billion, for a total of $2.0 billion. Since the upgrades to PF-4 would also have to be done, the total investment cost for this capability would be $2.5 billion.

As discussed in Chapter IV, to upgrade capacity at TA-55 from 50 pits per year to 125 pits per year, two additional facilities, analogous to the CMRR-RLUOB and CMRR-NF would be needed. We estimated the additional cost of these facilities to be $2 billion. Thus, the total cost of increasing TA-55 capacity from its current level of 10 to 125 pits per year was estimated to be $4 billion.

In summary, expanding the capability at TA-55 is the least-cost alternative for any pit production capacity between 10 and 125 pits per year. If the pit requirement is lower than 125 pits per year, there is an even a stronger case for keeping pit production at LANL. This option also provides additional flexibility to decision-makers because the modular nature of the upgrade plan allows for obtaining the capability for 50 pits per year now and reserving the decision for a larger capacity to a later date.

B. SHOULD ASSEMBLY/DISASSEMBLY BE RELOCATED?

As detailed in Chapter IV, we estimated a cost of $4.5 billion to rebuild an assembly/disassembly facility capable of 125 assemblies, 400 disassemblies, and 75 surveillances per year, plus the high explosive research, development, and testing function. The required size of the assembly/disassembly capability is not a function of the pit production requirements, but rather the surveillance, Life Extension Program, RRW production, and dismantlement schedules. The Pantex Plant has more than sufficient capacity to handle the projected future workloads.

No major investments are now required at Pantex, but we estimated approximately $0.5 billion would be needed for various capital improvements, such as the Perimeter Intrusion Detection and Assessment System (PIDAS) improvement project. Since we estimated a cost of $4.5 billion to rebuild this capability elsewhere, the additional investment cost required to relocate the Pantex capability is $4 billion. Additionally, relocating these capabilities would incur transition costs. Although a detailed assessment of these costs was outside the scope of this study, we estimated that transition costs are likely to range between $0.5 billion and $2 billion, depending on how long Pantex remains at full production during the startup phase of the new facility (see Chapter IV for information on our methodology for estimating transition costs).

Some cost savings would result from the closing of the Pantex Plant. We estimated that security costs would be reduced by $110 million per year as soon as the site is de-inventoried of all Category I/II SNM. Also, the cost of transportation of weapons components would be reduced by an estimated $10 million per year if assembly/disassembly were relocated to LANL or Y-12. Finally, we estimated a savings of $13 million per year in indirect costs due to co-locating two activities. In all, we estimated savings of $133 million per year, to begin in 2025, from the closing of the Pantex Plant.

Table 15 shows the break-even data for relocating Pantex for a range of transition costs, calculated using a 3 percent discount rate.

Table 15. Relocation of Pantex Break-Even Analysis

	Additional Investment	Transition Cost	Total Cost	Break-Even Year
Low Transition Cost	$4.0B	$0.5B	$4.5B	Never
Middle Transition Cost	$4.0B	$1.0B	$5.0B	Never
High Transition Cost	$4.0B	$1.5B	$5.5B	Never

Our study found that cost savings do no provide a basis for closing the Pantex Plant. The savings that would accrue would not offset the additional investment needed to rebuild the facilities, even when significant decontamination and decommissioning costs are ignored. In addition, closing the Pantex Plant would incur an additional risk of having a gap in capability if there is delay in the construction or qualification of processes for a new facility.

C. SHOULD SECONDARY PRODUCTION BE RELOCATED?

The outcome of our analysis of secondary production costs is slightly different than either the pit production or the assembly/disassembly outcomes. In this case, the required size of the secondary production capability is not a direct function of the pit production requirements, but rather of the surveillance, Life Extension Program, new production, and dismantlement schedules. However, unlike Pantex, Y-12 has major investments planned. The Y-12 site is in the midst of a comprehensive infrastructure re-investment project, which includes new facilities for storage, production, and support. We considered the following costs for these projects:

- $0.5 billion to rebuild the Highly Enriched Uranium Materials Facility (HEUMF)
- $3.5 billion to construct the Uranium Processing Facility (UPF),
- $0.5 billion to construct the Consolidated Manufacturing Complex (CMC), and
- $0.5 billion to construct additional plant support facilities such as laboratories, administrative and office spaces.

We assumed both the UPF and the CMC would be built whether or not secondary production is relocated. Thus, we estimated the additional investment required to relocate the secondary production mission as $1 billion (the cost of rebuilding the HEUMF and plant support).

Closing Y-12 would also require substantial decontamination and decommissioning costs. However, we found that Y-12 is currently planning to decontaminate and decommission the majority of the current footprint.[32] Thus, large decontamination and decommissioning costs will likely be required whether the Y-12 site is closed or not.

We estimated that transition costs associated with moving the secondary production function likely range from $0.5 billion to $2.5 billion, depending on how long Y-12 remains at full production during the startup of the new facility. See Chapter IV for a description of the methodology we used to estimate transition costs. Detailed estimates of transition costs of moving Y-12 were outside the scope of this study.

Some cost savings would accrue from closing Y-12. We estimated that security costs would be reduced by $110 million per year. Transportation of weapons components would be reduced by $10 million per year if secondary production were relocated to LANL or Pantex. Finally, we estimated a savings of $22 million per year in indirect costs due to co-locating two activities. In all, our study estimated that closing Y-12 would yield savings of $142 million per year, beginning in 2025.

Table 16 shows the break-even data for relocating Y-12 for a range of transition costs, calculated at a 3 percent discount rate.

---

[32] Y-12 plans to reduce its high-security area from approximately 150 acres to about 15 acres over the next 10 years. This reduction, in addition to reductions in technical support operations, waste management operations, and support facilities, entails decontaminating and decommissioning roughly 3.4 of the 4.7 million square feet in the current site footprint.

Table 16. Relocation of Y-12 Break-Even Analysis

	Additional Construction	Transition Cost	Total Cost	Break-Even Year	Net Present Value
Low Transition Cost	$1.0B	$0.5B	$1.5B	2040	$1.8B
Middle Transition Cost	$1.0B	$1.0B	$2.0B	2046	$1.5B
High Transition Cost	$1.0B	$2.5B	$3.5B	2079	$0.6B

Our analysis for relocating the secondary production function shows a positive net present value, although the break-even year is 3 decades away at the earliest. For Y-12, most of the production facilities are already planned to be replaced. The marginal cost of rebuilding the HEUMF and the plant support buildings is not an overwhelming hurdle to overcome.

For relocating Y-12, the transition costs have the largest uncertainty. The HEUMF is a recent actual cost and plant support construction is straightforward. However, there is some risk that the transition costs could be even higher than shown in Table 16. Other considerations involving transition include the availability of a suitable work force at the receiving site as well as numerous environmental and political issues. A detailed site-specific study would be required to understand fully the likely transition costs and risks associated with relocating the Y-12 mission.

VI. SUMMARY OF FINDINGS

We conducted an economic comparison of two modernization alternatives for the NNSA production complex: the Consolidated Nuclear Production Center (CNPC) approach and the Distributed Centers of Excellence (DCE) approach. Although both alternatives require substantial investments, we found the CNPC alternative would cost significantly more than the DCE alternative. We found no cost reductions sufficient to offset the additional investment costs associated with the CNPC alternative.

We found that the least-cost option is the DCE alternative with pit production at Los Alamos National Laboratory (the TA-55 facility). We estimated the CNPC alternative would cost at least $7 billion more than the least-cost DCE alternative. To justify the additional costs, the CNPC would have to either achieve sufficient operations and maintenance cost savings or be judged to be better at achieving mission goals.

Our analysis found the likely savings from security, transportation, and improved efficiencies directly attributable to the consolidation of production functions at a CNPC would not offset the large, additional up-front expenditures.

Note that the alternatives were not well enough defined at the time of this study to construct budget quality estimates, and thus there is considerable uncertainty with respect to both our cost and savings estimates. The uncertainty is not symmetrical; in particular costs are more likely to increase and savings are more likely to decrease (or be delayed by schedule growth in the new construction, for example).

However, much of the uncertainty is for the cost of new investments (e.g., UPF) common to both alternatives. Changes in the cost of common investments would influence the affordability of the modernization but would have no effect on the economic comparison between the two alternatives.

Increases in costs for investments not common to both alternatives or decreases in savings are more likely to strengthen the economic case for the DCE alternative. Furthermore, the magnitude of the cost difference between the two alternatives (at least $7 billion) is such that we could not make an economic case for choosing the CNPC alternative, even using assumptions that are most favorable to the CNPC alternative.

A. COMPARISON WITH THE SEAB TASK FORCE CONCLUSIONS

We note that our conclusions differ significantly from the conclusions of the SEAB Task Force. The SEAB Task Force did not do a detailed cost analysis,[33] but concluded that:[34]

> The accumulated budget for the "revolutionary Complex transformation" option from 2006 to 2030 sums to about $15 billion dollars less than the flat budget "baseline" case, in 2005 dollars. These "savings" are the result of accelerated expenditures during the period up to 2015, about $10 billion dollars above the flat "baseline" budget, combined with a total reduction of about $25 billion dollars during the period from 2016 to 2030, in 2005 dollars. In other words, some $10 billion dollars of additional expenditures are used to generate $25 billion dollars in savings.

The SEAB report goes on to state:[35]

> [T]he accelerated dismantlement program is considered to represent half of the $10 billion accelerated expenditures from 2006 to 2015, while the other half is largely represented by the accelerated schedule for siting, construction and early *operation of* the CNPC. [Emphasis added.]

The SEAB report asserts that an investment of $5 billion for a CNPC, operational in 2015, would generate $25 billion in savings over the period from 2016 to 2030. Our estimates of both the costs of and resulting savings from a CNPC differ greatly from the numbers in the SEAB report. As shown in Chapter IV, we estimated the total investment required to achieve a CNPC to be $13.5 billion to $17.5 billion, depending upon the site. Additionally, we estimated the cost to transition a mission from one site to another to be on the order of $1 billion per move, possibly substantially more. This brings the total cost of a CNPC to between $15.5 billion and $20.5 billion, depending upon the site chosen.

As discussed in Chapter IV, the savings attributable to the CNPC begin to accrue only after the facility is operational and the sites that are to be closed have been de-inventoried of special nuclear material. The NNSA's current assumption is that this could be accomplished in the 2022–2025 timeframe, which, unlike the SEAB assumption of an operational CNPC in 2015, seems reasonable given the NNSA's historical construction timelines. We estimated the total savings attributable to the CNPC from security,

---

[33] U.S. Department of Energy, Secretary of Energy Advisory Board, "Recommendations for the Nuclear Weapons Complex of the Future: Report of the Secretary of Energy Advisory Board Nuclear Weapons Complex Infrastructure Task Force," Final Report, July 13, 2005, p. E-1.

[34] Ibid, p. E-2.

[35] Ibid, p. E-2.

transportation, and efficiencies to be $138 to $270 million per year, depending upon the site. By these estimates, the total accumulated savings would not exceed $1.7 billion by 2030 and would be between $2 and $4 billion over a 15-year period from 2025 to 2040. We could find no other categories of savings attributable to a CNPC.

In summary, we found that the CNPC would cost significantly more, take significantly longer to implement, and the savings would be significantly lower than the SEAB anticipates.

B. IMPLICATIONS OF PIT REQUIREMENTS

As an excursion, we analyzed the implications of relaxing pit requirement assumptions. Both alternatives propose building a new Consolidated Plutonium Center (CPC) to increase pit production capacity to 125 pits per year. Alternative stockpile assumptions imply that there may be a lower requirement for pit production in the future.

We found, for a pit requirement of 125 pits per year, no cost basis for moving out of TA-55 at Los Alamos National Laboratory. If the pit requirement is lower than 125 pits per year, there is an even a stronger case for keeping pit production at Los Alamos.

For assembly/disassembly, we found no cost basis for moving the assembly/disassembly mission from Pantex Plant. We found that Pantex is functional and has sufficient capacity to meet planned requirements. Replicating the required assembly/disassembly capabilities elsewhere would require substantial investment. The resulting savings from closing Pantex, primarily in reduced security costs, would not justify this expenditure.

Finally, we also examined the cost implications of moving the secondary production mission from Y-12. Relocating the Y-12 mission would require an estimated investment of $5.0 billion; however, much of this investment is already required to modernize Y-12. We estimated that the additional investment required to replicate the Y-12 capability elsewhere would be approximately $1 billion and the transition costs associated with relocating the Y-12 mission would be between $0.5 billion to $2.0 billion, depending on the assumptions made. The transition costs depend in part on the amount of mission risk (associated with a potential gap in production) that would be undertaken during any transition period.

Savings estimates for relocating Y-12 result in a positive net present value for the extra expenditures required. However, savings wouldn’t start to accrue for at least three decades. The break-even year varies from 2040 to 2079, depending on the magnitude of the transition costs, and could vary further depending on when savings actually begin to accrue.

A more detailed analysis would be required to understand fully the likely transition costs and risks associated with relocating the Y-12 mission.

APPENDIX A:
THE NNSA NUCLEAR ENTERPRISE MODEL

In addition to the economic analysis of the modernization alternatives discussed in the main body of this report, IDA was also tasked to evaluate the NNSA Nuclear Enterprise model ("the model"). In particular, IDA was asked to provide an evaluation of the model's suitability for estimating the cost of the nuclear weapons complex modernization approaches.

To accomplish this task, the study team met with and had several discussions with the model developer, Cliff Shang from Lawrence Livermore National Laboratory (LLNL). Shang reviewed the model's structure and data and illustrated its use by describing several analyses performed using the model. IDA was not supplied with the model code or provided with the details of the model structure, so the following assessment is not a validation of the model. Rather, we assess what may be considered some of the strengths as well as some of the weaknesses of the modeling approach.

In summary, we found that the model is not a cost model. Estimates of costs for new facilities and for modernization of existing facilities are inputs to the model. The model does not produce independent estimates for the cost of new buildings.

The NNSA Nuclear Enterprise Model is a process model of the entire nuclear weapons complex. Work on the model began in April 2004 at the initiative of Victor Reis, an advisor to the Secretary of Energy and a former Assistant Secretary for Defense Programs. The idea was to develop a modeling tool to evaluate options for transforming the nuclear enterprise and to understand the implications of different stockpile strategies on the production complex. Shang and his team, drawn from staff of LLNL, began work on the model to describe the operations of the complex.[1]

---

[1] The NNSA Nuclear Enterprise Model has not been formally documented and described. The description that follows is based on a meeting and discussion with Cliff Shang, notes on simulations provided by Cliff Shang, and an article describing the model (Arnie Heller, "Modeling the Future," *LLNL Science and Technology Review*, December 2005, pp. 4–10).

The model may be used to analyze options and simulate proposed changes in the operations of the NNSA enterprise and can project the effects of different policy choices forward for decades. The model pairs stockpile policies, plans, and assumptions with the functioning of the nuclear weapons complex to capture how the entire enterprise works. Designed for portability and expandability, the model can be modified easily and the results viewed almost instantaneously on a desktop computer. At the top level, the model can be used to (1) view how fast the enterprise could respond, and in what ways, if requirements changed; (2) predict the effect that a severe technical problem might have on an NNSA program; or (3) see how different levels of investments in facility infrastructure would affect the responsiveness of the nuclear weapons complex as a whole.

At the lower level, the model can help managers look at building maintenance schedules, compute staffing projections, or compute transportation schedules for delivering dismantled warhead components to the appropriate sites. In one example, the model showed that consolidating nuclear material in a few sites might streamline production operations and simplify security requirements for the sites.[2]

MODEL FORM AND STRUCTURE

The NNSA Nuclear Enterprise Model belongs to a class of models variously styled as “process,” “flow,” “activity,” or “systems dynamics” models. We use the term “process” to describe the modeling technique. A process model is one that seeks to identify and capture the key relationships among variables by characterizing the way items move and/or transform as they pass through a system. Process models are an often-used tool of systems engineers seeking to analyze manufacturing activities, but they are not limited to those activities. Indeed, some applications of process modeling have dealt with such issues as limits to growth (the Club of Rome study in the 1970s), climate change, biological and ecological systems, political systems, and economic systems. The model is implemented using a software package called STELLA, distributed by isee systems.[3] Members of IDA’s staff have experimented with simple applications using STELLA and find it an appropriate tool for the purpose at hand. While one might wish

---

[2] Staffs at NNSA sites and the Service Center operate a number of models to support operations and planning. An example is the TRIPS model used to analyze operations of the Office of Secure Transportation. Those models are generally more detailed and probably better at their specific tasks than the corresponding module of the Enterprise Model.

[3] Go to the isee systems Web site (www.iseesystems.com) for more information about process modeling using STELLA.

for a more sophisticated modeling technique, such as a discrete event simulation or an optimization model, the sheer scale of activities represented in the model may have ruled out such an approach.

Why is the model called an "enterprise" model? The term "enterprise model" refers to process (or other) models whose scope and scale is larger than a single plant or facility. Such tools attempt to model the entire enterprise—in the present instance, the entire nuclear weapons complex.[4]

The choice to attempt to model the entire enterprise has consequences. It would normally mean depicting activities within the complex at a higher level of abstraction, or with less detail than would a model of, say, the assembly of a nuclear weapon at the Pantex Plant. We will discuss the level of detail presented in the model as we describe its components and data sources.

Model Structure

The model may be thought of as a series of interrelated modules dealing with different activities of the nuclear weapons complex. The following is a list of key activities represented in the model:

- Production of nuclear components
- Procurement of non-nuclear components
- Assembly and disassembly of weapons
- Research and development efforts
- Stockpile management
- Surveillance and testing
- Transportation of nuclear materials and weapons
- Facility management:
  - Construction of new facilities
  - Maintenance of facilities
  - Demolition and decontamination of facilities
  - Security and safety

---

[4] The activities at the design laboratories that are modeled are those funded and supported by NNSA. The laboratories do research for many Department of Energy and other customers beyond the NNSA Defense Program.

Model Input

The model draws extensively from data provided by the various NNSA sites. Those data include information about their key functions and activities, their capabilities, and their required resources, including:

- Current and long-term costs for construction
- Comprehensive 10-year site plans
- Recapitalization, demolition, and decontamination schedules
- Direct and indirect employee payrolls and related expenses
- Costs for production and other activities, by facility within sites
- Security and safety costs, by site

In addition, the model requires information from NNSA Headquarters, including:

- Nuclear stockpile plans and policies:
  - Surveillance requirements by weapon
  - Testing requirements by weapon
- Weapons production plans
  - Requirements for newly build weapons
  - Life extension programs
  - Modernization programs
- Weapons retirement plans
- Programmatic data on research and development activities, including
  - Directed stockpile work;
  - Science and engineering campaigns
- Costs to transport nuclear materials and weapons
- Budget data

The model has the capability to “shred out” NNSA budget categories to the various sites and the activities they conduct. It can also “roll-up” costs from the detailed level back into the budget categories used by NNSA Headquarters, to assess the budgetary costs of programmatic alternatives.

For each of the key activities listed above, there is a module consisting of a number of equations, variables, and constants. The weapons assembly/disassembly module, for example, would identify key Pantex facilities that perform assembly and disassembly. Subject to the overall throughput constraints imposed by the size of that facility and safety policies in place, a detailed workload requirement would be imposed based on

NNSA planning documents. Resources (labor, parts, and materials) would be drawn upon to perform the required tasks. Some parts and materials would be obtained from other sites—non-nuclear parts from Kansas City, secondaries from Y-12, primary pits from Los Alamos—generating requirements for those sites as well. Disassembly of weapons retired from the stockpile would compete for space and resources with assembly of new weapons or those undergoing modernization or life extension programs. Operation of the facilities would generate annual maintenance requirements. Finally, all of the activities described would generate costs that could be assembled into the appropriate NNSA budget categories.

USES OF THE MODEL

There are many potential uses for the model. Two significant applications for which the model has already been put to use were the SEAB Task Force analysis of the nuclear weapons complex and the Complex 2030 analysis by NNSA staff. Here are some other possible questions that the model might be used to address:

- The Reliable Replacement Warhead is expected to be easier to manufacture than current weapons. How might those efficiencies translate into effects on capacity utilization throughout the complex? Will they allow increases in other activities, such as weapons dismantlement at Pantex?
- What are the life-cycle costs of selected warheads? Does it make sense to retire first those that are most expensive to maintain?
- What are the steps needed to surge production capacity in a breakout stockpile scenario?
- What delays might occur if key facilities go down or must operate at reduced capacity?

OVERALL APPRAISAL OF THE NNSA NUCLEAR ENTERPRISE MODEL

How should one judge the performance of a model like the NNSA Nuclear Enterprise Model? What criteria should be applied to that assessment? Is it possible to define “success” or “failure” with a model of this scope? The following assessment is necessarily highly subjective. It is not a validation of the model. As was previously mentioned, IDA was not supplied with the model code or provided with the details of the model structure; we could not “validate” the model. Rather, we assessed what may be considered some of the strengths as well as some of the weaknesses of the modeling approach.

Strengths

The first strength of the model is its comprehensiveness. It is a bold step to set out to build a model of an enterprise such as the nuclear weapons complex. That Shang and his team have succeeded in developing a functioning tool that includes all the key activities that go on in the complex—including research and development work as well as production—is a significant step. That the modelers have been able to include so much of the details of site-specific facilities and activities is really remarkable.

The second strength is the incorporation and use of budget data and the linkage between "macro"-level budget concepts and the detailed description of activities at each site. Linking production and stockpile policies to budgets insures that the model's outputs are fiscally constrained and focus attention on possible trades to maintain the affordability of policy alternatives.

Fidelity is a third strength, albeit one with a caveat. Shang represents that the model's details were created through interaction with other analysts throughout the complex. They therefore should be considered representative of "how the system works." It was impossible for IDA staff to independently verify this claim, since we had neither the model code nor the detailed knowledge of the complex needed to do so.

Adaptability is another strength. The process model framework is easily changed and lends itself to an evolutionary approach to model specification; start small and create more elaborate representations of systems as you go.

Weaknesses

One significant weakness of all process models is that they are data "hogs." Because the models rely on specification rather than parametric estimation, all of the model information (both structure and data) must be supplied before the model can be run. Another way to say this is that there is nothing more to the model than what its developer puts into it. Model maintenance is costly and time-consuming. Data must be updated constantly. And failure to do so risks criticism that the results are not "up to date," even if the differences might have no material effect on the model's conclusions.

Another issue is how to validate the model. One exercise Shang has performed in the way of validation is to see if, given the NNSA programmatic and stockpile data and assumptions, the model can duplicate the Future Years Nuclear Security Program (FYNSP). This exercise is of limited value in building confidence in the model. Success in duplicating the FYNSP would establish only that the model is locally valid; that is, that the model will closely approximate reality as long as the assumptions do not wander far from past history. However, some of the cases being examined represent major policy changes—especially the introduction of the Reliable Replacement Warhead and the creation of a Consolidated Nuclear Production Center. Can the model "stretch" to accurately represent the results of such changes? And does historical data from the 1990s and 2000s give us any basis for confidence in the model's results?

COST AND BUDGET ANALYSES USING THE NNSA NUCLEAR ENTERPRISE MODEL

The model has been used by both the SEAB Task Force and the Complex 2030 authors to examine the costs as well as the benefits of alternative approaches to transforming the nuclear weapons complex and stockpile. IDA was asked to provide an evaluation of the model's suitability for estimating the cost of the nuclear weapons complex modernization approaches. This section looks at how best to judge its appropriateness to that task.

The first point to make is that the model is not a cost model, as cost analysts would define it. That is, the model contains no information that gives any insight into what any given facility is likely to cost. In fact, estimates of costs for new facilities, for modernization of existing facilities, and for nuclear weapons complex activities such as the Life Extension Program or building a new weapon such as the Reliable Replacement Warhead, must all be input into the model before it is run.

The same is true for budget information. The model has the capability to take data expressed in NNSA budget categories and "shred" or allocate it to individual sites and activities. It can also reverse the process, rolling up detailed costs into their appropriate budget category. This is a useful capability. But one must be mindful of its limitations. The data used for this process reflect historical allocation patterns. They cannot be expected to accurately mirror future initiatives for which no history exists.

So what should one expect from the cost and budget results of running the model? Put simply, they will be at best as good as the cost and budget information that are part of the model's inputs.

The model is calibrated to approximate the budgetary levels of the FYNSP when using assumptions based on the program of record. One would expect that the error in model projections of costs for a given alternative would increase in proportion to the extent that the alternative’s assumptions deviate from the program of record. This is not particularly encouraging, given that some alternatives are producing an entirely new family of weapons, and others assume the closure of major facilities and their replacement with new, and different, greenfield facilities.

APPENDIX B:
CONSTRUCTION OUTLAYS AND AFFORDABILITY

This appendix shows the estimated funding profiles required for the DCE and CNPC alternatives. In order to estimate the funding profiles of potential major investments, such as a Consolidated Plutonium Center (CPC) or Uranium Processing Facility (UPF), we used historical examples of NNSA construction projects. The specific examples (because year-by-year funding data were available) were the Criticality Experiments Facility, the Tritium Extraction Facility, National Ignition Facility, and the Beryllium Capability Project. Figure B-1 displays the cumulative percentage of funding received versus the cumulative percentage of schedule completed for these projects.

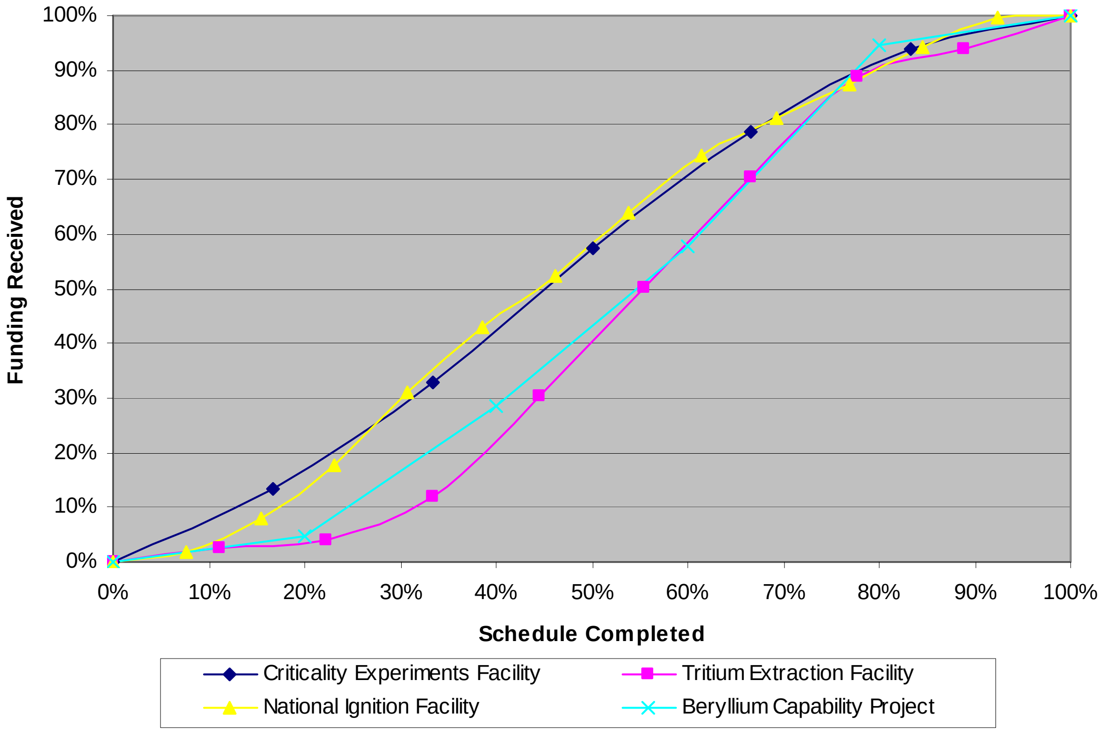


Figure B-1. Cumulative Percentage of Funding Received Versus Schedule Completed

To construct an average funding profile, we used the available data on annual funding expenditures. For each project, we interpolated between actual data points to create an estimate for the percentage of funding expended for each 10 percent increment in schedule. We took the average of these values to compute the typical funding profile in Figure B-2.

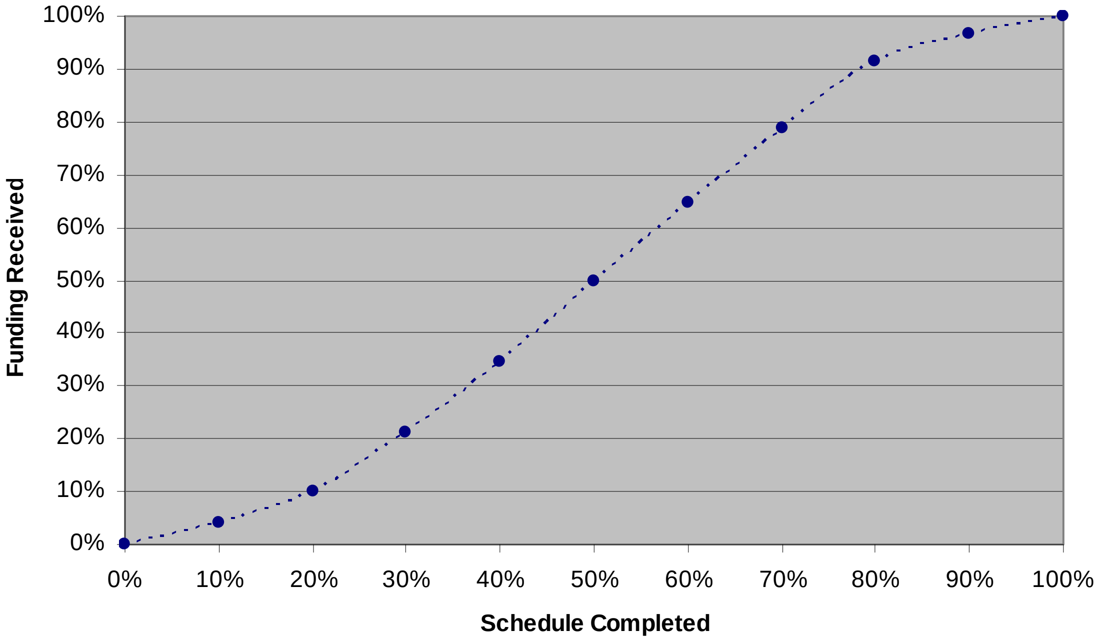


Figure B-2. Average Construction Outlay

For either the DCE or CNPC alternative, the major investments we considered were a CPC, TA-55 upgrades, secondary facilities, an assembly/disassembly facility and any transition costs. Table B-1 gives the timeframe for each of these investments.

For the DCE alternative, the major investment costs are the TA-55 upgrade ($2 billion), a CPC ($2 billion at Los Alamos or $6 billion elsewhere), modernizing secondary production at Y-12 ($4 billion), modernizing the assembly/disassembly facility at Pantex ($0.5 billion) and any transition costs ($1 billion if the CPC is not at Los Alamos). For each major investment, we took the total estimated cost, the expected completion date and our construction outlay percentages to get the funding profile in Figure B-3 for CPC at LANL and Figure B-4 for CPC not at Los Alamos.

Table B-1. Timeframes of Major Investments

Investment	Start Date	End Date
TA-55 Upgrade		
Maintenance/PF-4 upgrades	2007	2010
CMRR-NF	2008	2015
2nd CMRR-NF + RLUOB	2015	2022
CPC	2013	2022
Secondaries		
UPF, HEUMF, and Plant Support	2009	2018
CMC	2018	2022
Assembly/Disassembly	2013	2022
Mission Transition		
Moving out of Y-12	2018	2020
Moving out of Pantex	2022	2024
Moving out of Los Alamos National Laboratory	2022	2024

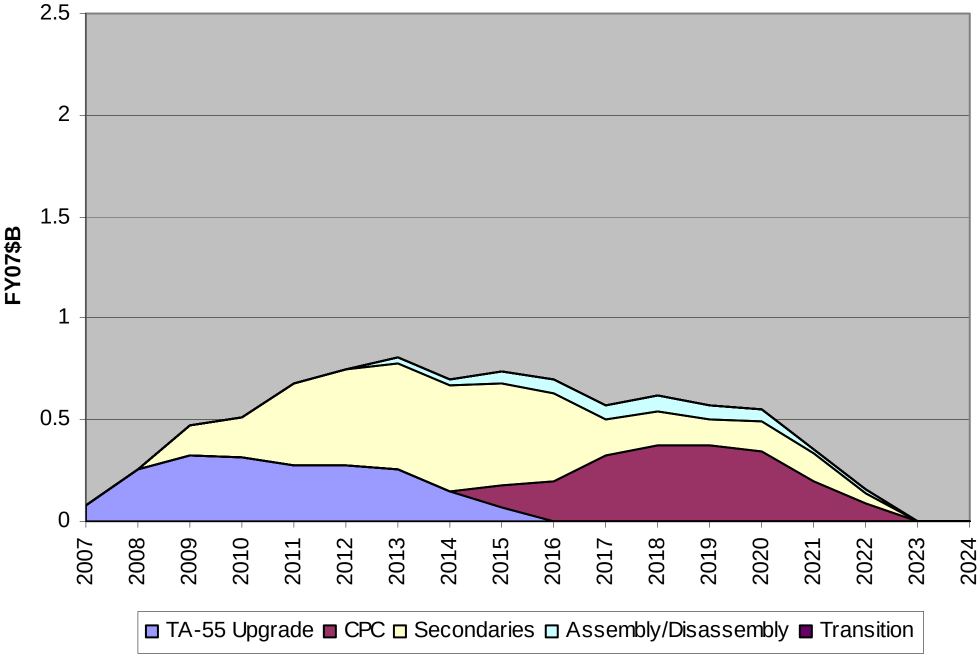


Figure B-3. Estimated Spending for DCE (CPC at Los Alamos National Laboratory)

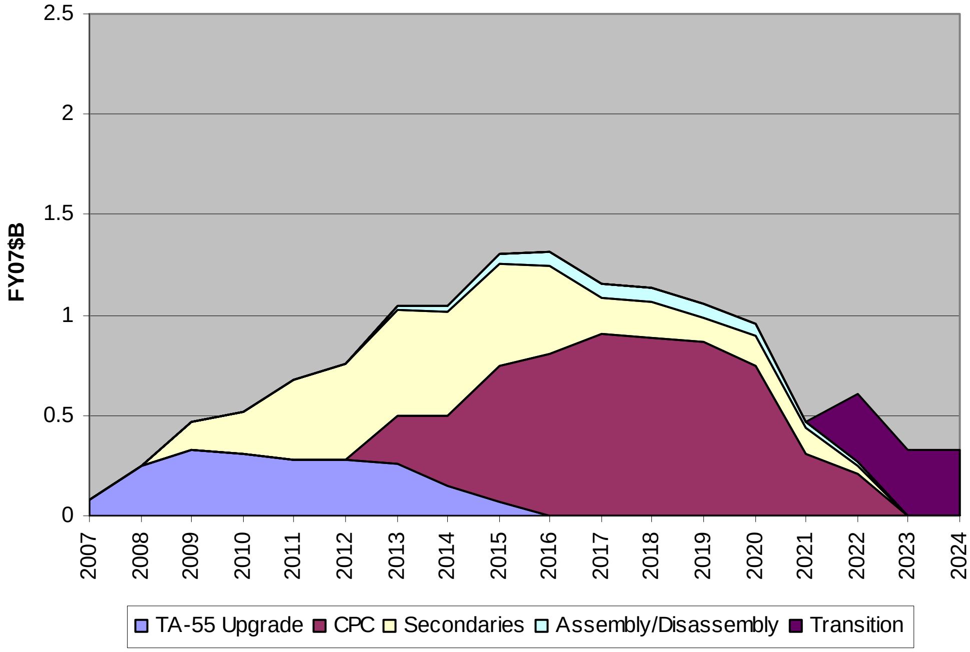


Figure B-4. Estimated Spending for DCE(CPC Not at Los Alamos)

For the CNPC alternative, the major investments were the TA-55 upgrade ($2 billion), a CPC ($2 billion at LANL or $6 billion elsewhere), secondary production ($4 billion at Y-12, $5 billion otherwise), an assembly/disassembly facility ($0.5 billion at Pantex, $4.5 billion otherwise) and any transition costs ($1 billion per move). Following the same procedure used for the DCE estimates yields Figures B-5 through B-8 for each CNPC location.

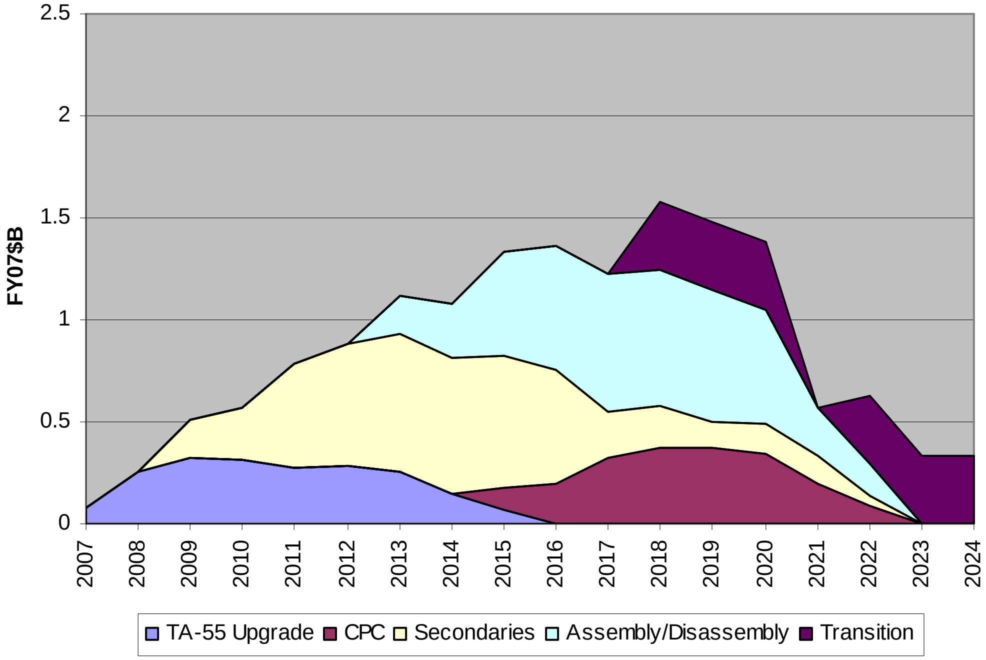


Figure B-5. Estimated Spending for CNPC (Los Alamos National Laboratory)

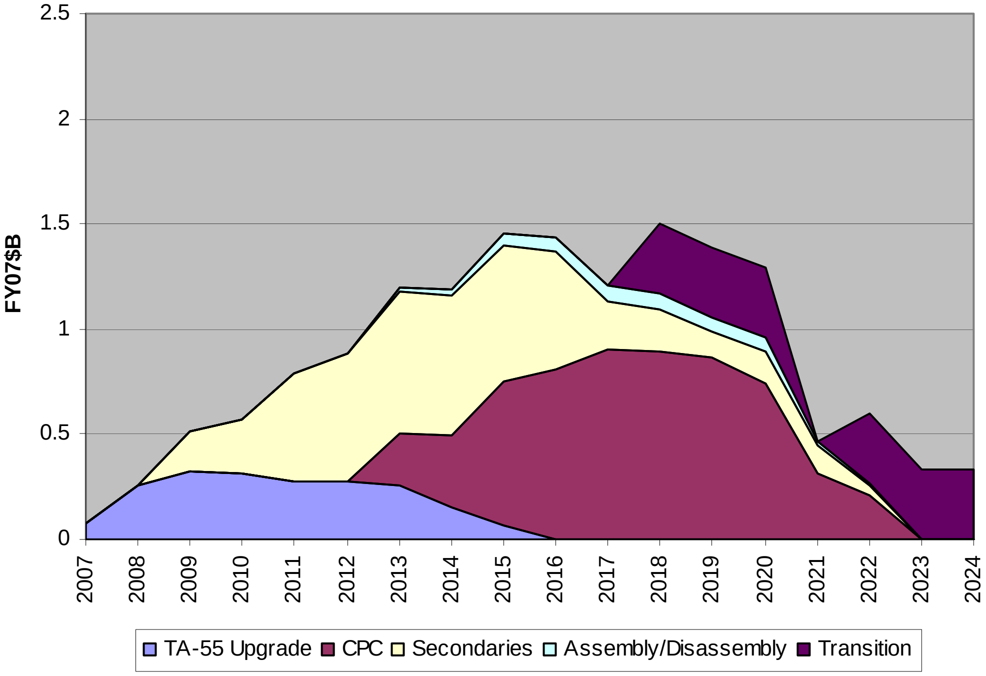


Figure B-6. Estimated Spending for CNPC (Pantex Plant)

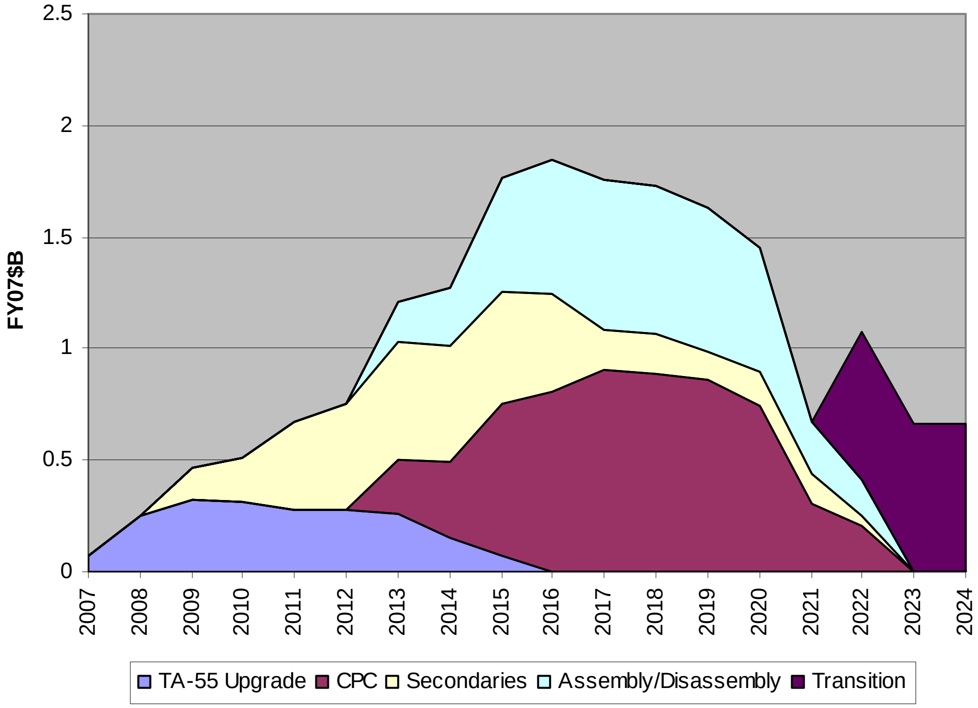


Figure B-7. Estimated Spending for CNPC (Y-12 National Security Complex)

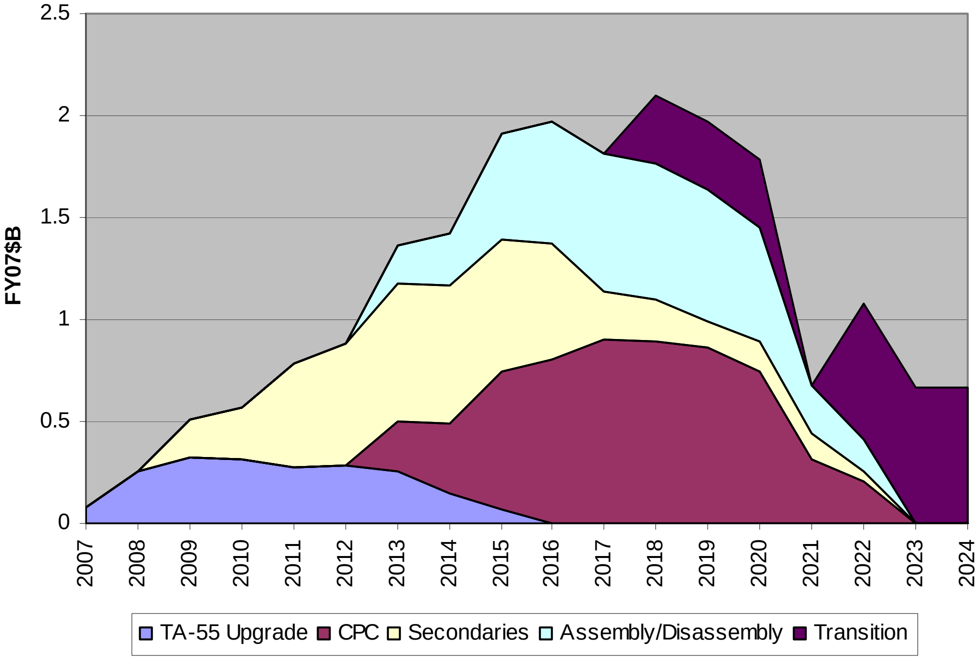


Figure B-8. Estimated Spending for (Savannah River Site or Nevada Test Site)

ABBREVIATIONS

AC/MC	actinide chemistry/materials characterization
B	billion
B&W	Babcock & Wilcox
BRAC	Base Realignment and Closure
BWXT	BWX Technologies
CAIG	Cost Analysis Improvement Group
CD	Critical Decision
CHE	conventional high explosives
CMC	Consolidated Manufacturing Complex
CMR	Chemistry and Metallurgical Research
CMRR	Chemistry and Metallurgical Research Replacement
CMRR-NF	Chemistry and Metallurgical Research Replacement Nuclear Facility
CMRR-RLUOB	Chemistry and Metallurgical Research Replacement Radiological Laboratory/Utility/Office Building
CMRR-SFE	Chemistry and Metallurgical Research Replacement Special Facility Equipment
CNPC	Consolidated Nuclear Production Center
CPC	Consolidated Plutonium Center
DBT	Design Basis Threat
DCE	Distributed Centers of Excellence
FIMS	Facilities Information Management System
HE	high explosive
HEUMF	Highly Enriched Uranium Materials Facility
ICPP	Integrated construction Program Plan
IDA	Institute for Defense Analyses
IHE	insensitive high explosives
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory

LLNL	Lawrence Livermore National Laboratory
M	million
M&O	Management and Operating
MPF	Modern Pit Facility
NNSA	National Nuclear Security Administration
NTS	Nevada Test Site
O&M	operations and maintenance
OSD	Office of the Secretary of Defense
OST	Office of Secure Transportation
PA&E	Program Analysis and Evaluation
PEIS	Programmatic Environmental Impact Statement
PIDAS	Perimeter Intrusion Detection and Assessment System
RRW	Reliable Replacement Warhead
SEAB	Secretary of Energy Advisory Board
SNL	Sandia National Laboratories
SNM	special nuclear material
SRS	Savannah River Site
STARS	Standard Accounting and Reporting System
TA	Technical Area
UPF	Uranium Processing Facility

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
11-2007

2. REPORT TYPE
Final

3. DATES COVERED *(From - To)*
Oct 2006-Nov 2007

4. TITLE AND SUBTITLE
Economic Analysis of National Nuclear Security Administration (NNSA) Modernization Alternatives

5a. CONTRACT NUMBER
DASW01-04-C-0003

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S), Last Names First
Hunter, David E.
Bittle, Christina S.
Celec, Frederick S.
Helwig, Michael S.
Davis, Gregory A.
Mahoney, Rob
Minix, Joshua A.
Nicholls, David J.
Richanbach, Paul H.
Thomas, Robert W.
Williams, Laura M.

5d. PROJECT NUMBER

5e. TASK NUMBER
BA-7-2784

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NUMBER
R-411

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of the Director
Program Analysis and Evaluation
1800 Defense Pentagon, Room BE829
Washington, DC 20301-1800

10. SPONSOR/MONITOR'S ACRONYM(S)
OSD(PA&E)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
IDA conducted an economic analysis of two NNSA approaches to transforming and modernizing the U.S. nuclear weapons production complex. One approach envisions consolidating all nuclear weapon production functions into a single site, called a Consolidated Nuclear Production Center (CNPC). The other approach, Distributed Centers of Excellence (DCE), proposes modernizing the current complex in place. The IDA study team estimated the likely investment costs associated with each modernization alternative and the recurring savings that would result from the CNPC versus the DCE approach. We found that the CNPC proposal requires substantially greater investments and the savings are insufficient to justify the extra expenditures. In addition, we found no cost basis for moving either pit production or assembly/disassembly from their present locations. We found a positive net present value for moving secondary production from its present location; however, the break-even point for the investment is at least 30 years away. In addition, IDA reviewed the suitability of using the NNSA Nuclear Enterprise model for cost estimating.

15. SUBJECT TERMS
National Nuclear Security Administration; Nuclear Complex; Consolidated Nuclear Production Center (CNPC); Distributed Centers of Excellence (DCE); Consolidated Plutonium Center; Nuclear Weapons Production

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON (Last Name First)**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Henry, Tom
Unclassified	Unclassified	Unclassified	Same as Report	92	**19b. TELEPONE NUMBER (*Include area code*)** 703-692-8037

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI-Std Z39-18