INDEPENDENT BUSINESS CASE ANALYSIS
FOR THE CONSOLIDATION OF
NNSA HIGHLY ENRICHED URANIUM OPERATIONS

National Nuclear Security Administration

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
NATIONAL NUCLEAR SECURITY ADMINISTRATION
OFFICE OF STRATEGIC PLANNING AND COMPLEX TRANSFORMATION

SEPTEMBER 2008

TECHSOURCE INCORPORATED

LMI GOVERNMENT CONSULTING

TechSource
Incorporated
Scientific and Engineering Consultants

September 12, 2008

Dr. George C. Allen, Jr.
Director, Office of Strategic Planning and Complex Transformation
National Nuclear Security Administration
U.S. Department of Energy
Washington, DC 20585

CONTRACT NO: DE-AM52-06NA27683/TASK ORDER NO: DE-AD52-08NA28813

Subject: Independent Business Case Analysis for the Consolidation of NNSA Highly Enriched Uranium Operations

Dear Dr. Allen:

At your request and under the terms and conditions of the referenced contract between TechSource and the Department of Energy, National Nuclear Security Administration, TechSource formed a team of subject matter experts to provide an independent assessment of the consolidation options for Defense Programs uranium operations.

The team developed cost and qualitative data for three alternatives: modernization at Y-12, relocation to Pantex and relocation to the Savannah River Site. In order to establish an appropriate baseline, the team also developed a fourth alternative, staying at Y-12 without construction of the Uranium Processing Facility, or UPF. The alternatives are thoroughly described in the accompanying report.

In order to complete this task in the time allowed, the team worked quite closely with the NNSA Integrated Project Teams (IPT) for Uranium Operations and with the three sites, especially during the phase of the report focused on data collection for the various options. Members of the team also participated with NNSA and the Cost Analysis Improvement Group (CAIG) of the Department of Defense in the review of the transition plans from the three sites; we provided our insights and suggestions as part of that process. Finally, the team presented briefings to NNSA leadership, culminating with a briefing of the Administrator on July 21, 2008. The findings in this report are consistent with the preliminary conclusions reached in our briefing, though, as expected, the additional time has resulted in some subtle refinements and slight changes in calculated values.

Following the July briefing the team further refined the cost estimates, held team meetings to assure consensus, reviewed our findings with the CAIG, and submitted the report to the three sites and NNSA staff for a review for factual accuracy. This report takes into account all comments received. We thank everyone who took the time to review this report; it increases our confidence in its accuracy and completeness.

In addition to support from the sites, the team is very appreciative of the direct support it received from the Systems Integration Technical Support (SITS) group, the nuclear weapons complex integration group located at Sandia National Laboratories. SITS provided membership on the team as well as infrastructure support and valuable background material to assist in our study. We also thank you, Ted Wyka and the rest of the NNSA staff who have provided the support, direction and background that were essential for our success.

Finally, while the team did receive tremendous support from all involved, the report represents the consensus opinion and independent findings of this team. Comments received were thoughtfully considered, but, as requested by you and as provided in our contract and charter, the team, alone, is responsible for all observations, conclusions and recommendations in this report.

Thank you for the opportunity to be of service in support of a critically important national initiative. We look forward to the opportunity to work with you in the future.

Sincerely,

Donald G. Trost
Executive Vice President

Independent Business Case Analysis for the Consolidation of NNSA Highly Enriched Uranium Operations

SEPTEMBER 2008

Executive Summary

The National Nuclear Security Administration (NNSA) is proposing a *Complex Transformation Supplemental Programmatic Environmental Impact Statement* (SPEIS), which envisions a modernized, consolidated nuclear weapons complex. One element of the consolidation study is the future location of the highly enriched uranium (HEU) operations. This report documents the results of the TechSource/LMI independent business case analysis, which evaluates options for relocating the HEU operations.

Currently, all operations involving the manufacture of canned subassemblies (CSAs) and the processing of HEU are carried out at NNSA's Y-12 National Security Complex (Y-12) in Oak Ridge, TN. The total operation includes the weapons work for NNSA Defense Programs, material processing for Department of Energy Nuclear Energy and for Naval Reactors, and reimbursable work for Oak Ridge National Laboratory and others.

The facilities at Y-12 are old and need substantial refurbishment. Many of the processing facilities were constructed in the 1950s and have been operating continuously for almost 50 years. The nation has a long-term, continuing need for the capability to process HEU. This study evaluates the costs, risks, and benefits of either modernizing HEU operations at Y-12 or moving them into new facilities at Savannah River Site (SRS) or Pantex. Modernization would include completing the HEU materials facility (HEUMF) and constructing the Uranium Processing Facility (UPF) and Consolidated Manufacturing Complex (CMC) at Y-12, or constructing an HEU storage facility, UPF, and CMC at either SRS or Pantex.

To evaluate the three location options involving the future of HEU operations, the team examined five base cases.

- *Case 1a*. HEU operations remain at Y-12, construction of HEUMF is completed, but there is no further new construction. This case is included, not because it is a serious planning option, but because it represents the default path of delayed strategic decisions.

- *Case 2a*. HEU operations remain at Y-12, construction of HEUMF is completed, and UPF and a new CMC are constructed.

- *Case 3a*. HEU operations are moved to SRS. Y-12 is decommissioned, remediated, and closed.

- *Case 4a*. HEU operations are moved to Pantex, and an HEU storage facility and a UPF are constructed inside the current Perimeter Intrusion Detection and Assessment System (PIDAS). Y-12 is decommissioned, remediated, and closed.

- *Case 4b*. The same as Case 4a, except the HEU storage facility and UPF are constructed outside, but adjacent to, the current PIDAS.

Given the uncertainty of nearly all future costs, especially those for construction and decommissioning and remediation, probabilistic risk analysis techniques were incorporated in the financial model to develop more realistic cost estimates and more insightful assessments of the relative rankings. The analysis concentrated on estimating the stream of annual costs of each alternative. Because of the uncertainty associated with these future costs, the estimates were developed primarily as probability distributions—or uncertainty distributions. Each uncertainty distribution describes the range of values within which the cost parameter lies, as well as the level of confidence that the parameter will be any particular value. Monte Carlo techniques were used to determine year-by-year cash flow and the associated uncertainties. For each alternative's set of annual cash flows, the team determined a single measure of equivalent worth. The measures of equivalent worth, synonymous with present worth or net present value (NPV), were then compared to determine each alternative's relative ranking with respect to costs from NNSA's perspective.

The model was used to evaluate the financial consequences of each of the five cases in terms of the NPV in 2008–60, as well as the year-by-year budget requirements (escalated) for each case. Figure ES-1 shows the NPV for each of the five cases for the 5–95 percentile range and the mean NPV (triangle).

These results show that keeping the HEU operations at Y-12 and constructing UPF and CMC (Case 2a) is the alternative with the lowest NPV. Moving the HEU operations to either SRS or Pantex increases the mean NPV by approximately $8 billion. If the HEU operations remain at Y-12, and UPF and CMC are not constructed (Case 1a), the mean NPV will increase (compared with 2a) by approximately $7 billion. The higher NPV of Case 1a is driven by the extraordinarily high cost of refurbishing the current HEU and non-HEU operational facilities to meet current standards.

Figure ES-1. Model Results Base Cases NPV ($ billion)

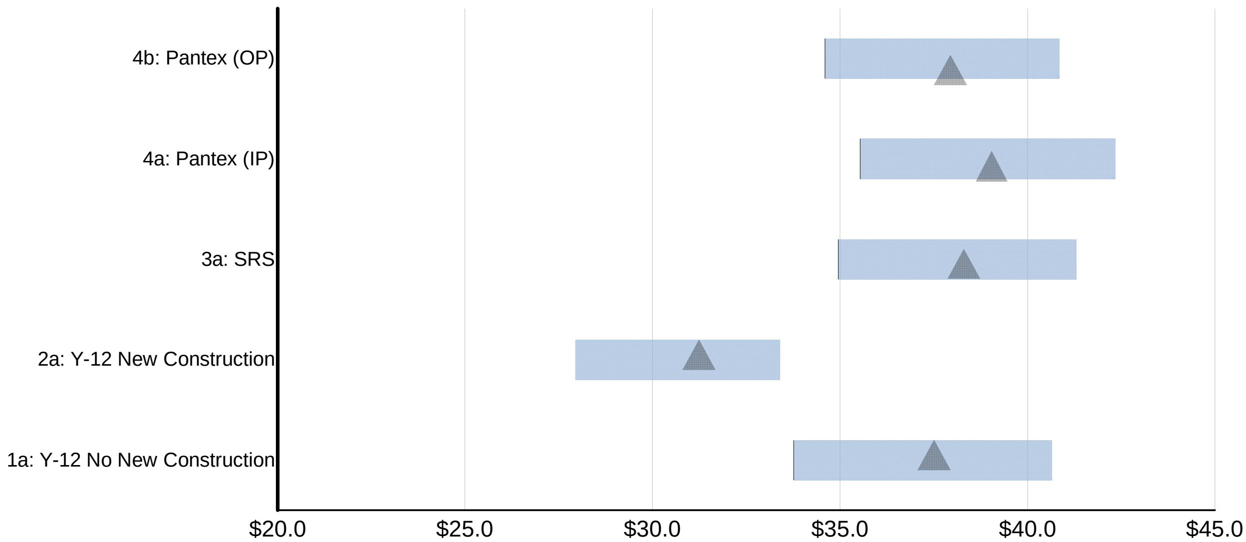
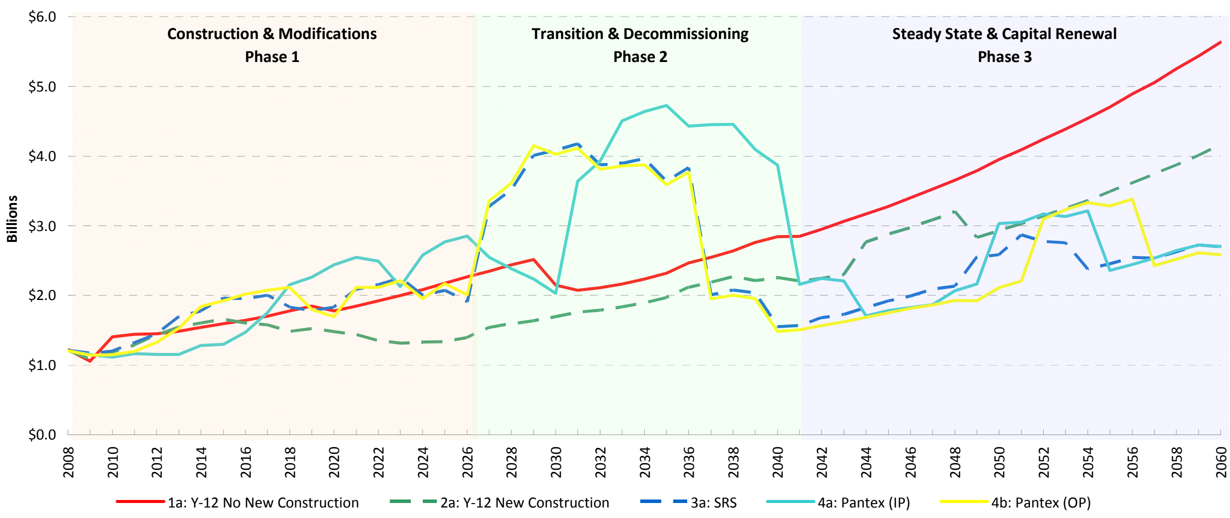


Figure ES-2 shows the year-by-year budget requirements (escalated) for each of the five base cases.

Figure ES-2. Budget Requirements for Base Cases



Modernization of the HEU enterprise involves three phases: (1) the new facilities (HEUMF, UPF, and CMC) are constructed, or the existing facilities are renovated; (2) the transition is made to new facilities, and the Y-12 site is decommissioned and remediated (if the operations are moved to a new location); and (3) the new HEU enterprise begins steady state operation at the location chosen. Included in the steady state phase is capital renewal of the new construction facilities.

Moving the HEU operations to either SRS or Pantex requires two major investments, as shown in the peaks of the budget curves:

- Construction of HEU storage facility, UPF, and CMC (in 2015–26, Phase 1)
- Decommissioning and remediation of Y-12 (in 2026–41, Phase 2) after site shutdown.

Remaining at Y-12 reduces the first and eliminates the second from consideration. However, the maximum savings in operating costs after transition, compared with current costs, are realized by moving to SRS or Pantex. Moderate savings are realized at Y-12 if UPF and CMC are completed. Minimal savings are realized with Case 1a. Case 2a appears to be the most viable from a budget requirements point of view in the early years and in terms of total cost, but it does not maximize the savings in long-term operating costs.

Each case evaluated requires substantial investment (in FY08 dollars) for new construction, modifications, and capital renewal. Even though Case 1a involves no new construction, it requires a major investment of more than $5 billion to refurbish the current facilities up to current requirements. Case 2a (Y-12) requires approximately $4.3 billion to construct UPF and CMC and modify other facilities for consolidated operations. Moving HEU operations to SRS or Pantex requires approximately $5 billion for new construction, modifications, and capital renewal. Moving the operations from Y-12 will also require approximately $7 billion to decommission and remediate Y-12 after plant shutdown. These investments are spread over 20–30 years.

The majority of facilities currently used for the HEU and CSA operations at Y-12 are 40–50 years old. Case 1a assumes no additional new construction; thus, these facilities would have to be brought up to current standards at a cost of more than $5 billion, starting in 2010. For Cases 2a, 3a, 4a, and 4b, these aging facilities would not be renovated but have to remain operable until the transition to new facilities is complete in 2023–27 with a minimum of refurbishment to keep them operational. Most of the existing facilities have deteriorated to a marginal state. Keeping these existing facilities operating for the next 15–20 years is a key to consolidating to new and more efficient facilities, regardless of the location, and represents a high risk to the program.

Transportation of HEU is an important element of the HEU enterprise, and is specifically included in the model, but the costs are not high enough to be a determining factor in the decision on a preferred location. The routine day-to-day movement of HEU and CSAs costs $10 million to $30 million annually (unless the operations moved to Pantex, which would substantially reduce these costs). Moving HEU operations to SRS would involve a one-time cost of $145 million to move all the material from Y-12 to SRS. Relocation to Pantex would involve a one-time cost for moving the stored material of $450 million due to the longer distances. The transport requirements for each of the cases are within the current Office of Secure Transportation capability so long as at least 5 years are allowed for moving the stored HEU to a new location.

Except for Case 1a, all cases generate security cost savings through consolidation of operations. Currently, Y-12 is spending $117 million on security. Consolidation at Y-12 would reduce these costs by $37 million (in FY08 dollars). Moving the operations to SRS or Pantex would reduce security costs by $40 million or $32 million, respectively. All security options would meet the 2005 design basis threat requirements.

The results of this study were tested against the sensitivity of several important parameters:

- *Constrained budget*. Future budget constraints are likely to limit the rate at which major nuclear construction can be accomplished. If annual construction and modification budgets for HEU operations are limited to $350 million in FY08 dollars (FY08 expenditures are $320 million), and annual decontamination and decommissioning (D&D) budgets are limited to $500 million (in FY08 dollars), the programmatic delays will be 1–3 years. The NPV (through 2060) does not change appreciably. Case 2a remains the least costly option.

- *Decommissioning*. The team considers the costs of D&D and environmental restoration (ER) an integral part of the business case analysis. However, the model was used to calculate the costs of each case without D&D and ER to determine whether the conclusions differed greatly. Without D&D and ER, the mean NPV of moving to SRS or Pantex decreases by approximately $5 billion, but remaining at Y-12 still has a lower mean NPV by about $3 billion. Case 1a becomes the highest NPV option if D&D/ER costs are excluded.

- *Site surveillance and maintenance (S&M)*. If HEU operations are moved from Y-12, and no D&D and ER of the site is assumed, then long-term site S&M is included in the analytical model. The baseline data from Y-12 estimated a staff of 1,000 people would be required for long-term site S&M after shutdown, and that value was used in the “no decommissioning” sensitivity analysis. Decreasing the staff size to 100 people reduces the mean NPV of moving to either SRS or Pantex to approximately equal to Case 2a where operations remain at Y-12. Therefore, even a drastic reduction in site surveillance and disregarding D&D and ER cost do not alter the previous conclusion that moving HEU operations from Y-12 holds no NPV advantage over the study period (2008–60).

In addition to the cost modeling, a qualitative review was done to examine factors that were not quantifiable in the cost model. The current facilities are old and have been allowed to deteriorate to the point where something must be done to preserve the long-term capability to process HEU. The lowest risk option is to complete HEUMF, construct UPF and CMC, and consolidate all uranium mission manufacturing operations into these three facilities at Y-12. A skilled and experienced staff is already in place, and a transition to new facilities in the same geographic location is much simpler than moving an entire operation to a new site. The mission risk of staying at Y-12 is comparatively low.

Although the team identified no factor that would preclude a move from Y-12 to SRS or Pantex, such a move would pose higher mission risks. The risk involved in a move to SRS is moderate. SRS has staff and existing facilities experienced in the processing of HEU and handling the associated waste products. Pantex has no such experience, so the HEU processing operation would be entirely new. Therefore, moving to Pantex poses a higher mission risk.

The bottom line: the team identified no cost or risk advantages in moving the HEU operations to either SRS or Pantex. Staying at Y-12 requires significant modernization of production facilities, best accomplished by building new, replacement facilities. The move to SRS or Pantex results in significant annual operational savings, but these savings are insufficient to compensate for the required investments. However, the team identified no factor that would preclude moving HEU operations from Y-12 to SRS or Pantex, if that move were part of some larger overall strategy.

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Chapter 1
Introduction

1.1 PURPOSE

In late 2006, the National Nuclear Security Administration (NNSA) selected TechSource and LMI (the team) to support its decision-making process regarding alternatives in the proposed *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement—Complex 2030 (SPEIS)*, announced in the *Federal Register* on October 19, 2006 (71 FR 61731). The team performed independent business case analyses (IBCAs) to help decision makers understand the life-cycle costs, investment costs, and benefits and risks of different consolidation options under consideration as part of the NNSA vision for infrastructure transformation.[1]

In one of these business case analyses, the team examined the options of consolidating all NNSA special nuclear material (SNM) operations at a single site. It presented the results to NNSA in the report, *Independent Business Case Analysis of Consolidation Options for the Defense Programs SNM and Weapons Production Missions*, December 2007.

The original study (now known as Phase I) included options for consolidating the highly enriched uranium (HEU) operations including manufacturing canned subassemblies (CSAs), which showed some indications of long-term economy. The team then focused special attention on these options in a short review of HEU operations (Phase Ia).

NNSA asked the team to carry out a Phase II study considering the movement of HEU operations from Y-12 to an alternative NNSA site. The purpose of this study is to analyze the geographic location of NNSA HEU operations in more detail with refined data and second-generation analytical model.

1.2 PROBLEM DEFINITION

Currently, all operations involving the manufacture of CSAs and the processing of HEU are carried out at NNSA's Y-12 National Security Complex (Y-12 site) in Oak Ridge, TN. The total operation includes the weapons work for Defense Programs (DP), material processing for the Office of Defense Nuclear Nonproliferation (NN), the Naval Reactors (NR) program for Naval Nuclear Propulsion, and

[1] U.S. Department of Energy (DOE), NNSA, *Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century*, DOE/NA-0013, October 2006.

Nuclear Energy (NE), and reimbursable work for Oak Ridge National Laboratory (ORNL).

The facilities at Y-12 are aging and in need of substantial refurbishment. Many of the processing facilities were constructed in the 1950s and 1960s and have been operating continuously for over 50 years. The nation has a long-term, continuing need for the capability to process HEU.

The basic question of this study is whether HEU operations should remain at Y-12 or relocate to either the Savannah River Site (SRS) or Pantex Plant. The competing priorities are the high cost of new construction and the expected savings from a modern consolidated uranium center (CUC) at Y-12 compared with the costs to relocate and build a totally new CUC and the expected savings from closing Y-12.

Should HEU operations remain at Y-12, substantial new construction will be required to replace the aging facilities. The newer facilities at Y-12 or another site are expected to result in more efficient operations. In addition, economies of scale may result from combining the HEU operations with the ongoing operations at another site.

This report documents the team's analysis of the costs, risks, and benefits of retaining HEU operations at Y-12 or moving them to either SRS or Pantex. All options are within the environmental envelope of the alternatives described in the current SPEIS.[2]

1.3 TEAM COMPOSITION

The team is comprised of professionals with extensive experience in the weapons complex, facilities management, construction, cost estimating, and financial analysis. Two members participated in the Secretary of Energy Advisory Board (SEAB) study that examined consolidation alternatives in 2004 and 2005.[3] Seven of the eight members participated in the Phase I study, and one participated in the writing of the SPEIS. In addition to representatives from TechSource and LMI, the team includes technical staff from the Systems Integration and Technical Support group at Sandia National Laboratories (SNL). (Appendix A contains short biographies of team members.)

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[2] NNSA, *Draft Complex Transformation Supplemental Programmatic Environmental Impact Statement*, December 2007 (predecisional draft). Unless otherwise noted, all references in this report to the SPEIS are to the December draft.

[3] *Recommendations for the Nuclear Weapons Complex of the Future*, report of the Secretary of Energy Advisory Board, Nuclear Weapons Complex Infrastructure Task Force, July 13, 2005.

1.4 APPROACH AND SCHEDULE

Starting with the Phase I financial model, the team developed a second-generation model, which provided the basis for a data call to the three sites under consideration: Y-12, SRS, and Pantex. Close cooperation with the NNSA integrated project team (IPT) permitted only one data call to the sites and one database for the NNSA evaluation, as well as this IBCA. The IPT included federal personnel from headquarters, support organizations, candidate sites, and site contractor subteams. Transition data (cost and schedule) modeling is based on the strategies developed by each of the three sites.

The team was formed in January 2008 and met with the NNSA IPT. The team developed an extensive data matrix to organize and display the cost data in a way that could be directly linked to the financial model. The team and the IPT agreed to use the same data provided by the three sites. The data call and the data matrices were sent to the three sites—Y-12, SRS, and Pantex—in March 2008, and the team received data from the sites in May. The team personnel worked directly with the site personnel during the data generation to explain the data matrices and immediately answer questions.

The first data return from the sites in May was quite good, requiring minimal clarification and change. During May and June, the team analyzed the data, refined the model, and evaluated various sensitivities. It presented initial results to NNSA on June 18 and final results on July 21.

The team analyzed the data using an LMI financial model developed specifically for this purpose. The model uses point estimates of future costs provided by the sites, assigns uncertainty bands to each cost category, and then calculates the range of future cost profiles, as well as the net present value (NPV) of total costs. These costs are then compared among the various options and combined with the risks and benefits for the use of NNSA decision makers. (Chapter 7 details the analytical model.)

Concurrent with the preparation of the site data and completion of the data matrixes, the IBCA team developed independent construction cost estimates for the three primary facilities that comprise HEU operations, namely HEU storage, the uranium processing facility (UPF), and the consolidated manufacturing complex (CMC). These estimates were used in the team financial model to compare with results obtained from the site-generated estimates.

Throughout the study, the team continuously coordinated with the NNSA IPT to maintain currency with the rapid evolution of the SPEIS and its associated assumptions. In this report, the team does not attempt to duplicate all the information in the draft SPEIS,[4] but furnishes sufficient detail to allow an understanding of the facility concepts and their use by the team for this IBCA.

[4] See Note 2, this chapter.

Chapter 2
Background and Scope

2.1 HISTORY

Over the past decade, multiple studies and documents have proposed transforming the NNSA weapons complex into a smaller, more responsive organization. In addition, the NNSA strategic plan calls for consolidation of its future operations across the complex.

The 2001 Nuclear Posture Review addressed the role of nuclear weapons in the post-Cold War era.[1] In particular, it identified the need for a "New Triad" composed of defenses, nuclear and nonnuclear strike capabilities, and a responsive infrastructure.

In January 2005, the Secretary of Energy asked the SEAB to form a Nuclear Weapons Complex Infrastructure Task Force (NWCITF) to advise DOE on the infrastructure changes needed to respond to the Nuclear Posture Review. In July of that year, the NWCITF recommended initiatives for change, including consolidation, to aid in the long-term transformation to a more responsive and cost-effective complex.[2]

In December 2006, the Defense Science Board (DSB) Task Force on Nuclear Capabilities issued a comprehensive review of U.S. nuclear facilities and capabilities.[3] In this study, the task force recommended substantial changes to the structure and management of the nuclear weapons complex, in particular, consolidation into a smaller, more efficient footprint, as well as a more concentrated contractual arrangement.

In January 2006 and again in January 2007, NNSA assembled its leadership from throughout the complex to address the challenges posed by the Nuclear Posture Review, SEAB report, DSB study, and numerous other studies that dealt with the complicated issue of how to manage and transform the nuclear weapons complex. This internal review, which identified a series of initiatives for transforming the weapons complex, resulted in the October 2006 *Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of*

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[1] DoD, Nuclear Posture Review, January 8, 2002.

[2] NWCITF, *Recommendations for the Nuclear Weapons Complex of the Future*, July 2005.

[3] DSB, *Report of the Defense Science Board Task Force on Nuclear Capabilities*, December 2006.

the 21st Century, known for the remainder of this report as the “complex transformation planning scenario.”[4]

In December 2007, the TechSource/LMI team published the Phase I results of a NNSA-sponsored study comparing the various options for consolidating the NNSA SNM operations.

2.2 PRIOR IBCA RESULTS

In Phase I, the team analyzed five different levels of consolidation and 20 specific options for SNM operations within the NNSA. The options ran the gamut from the current configuration to full consolidation in a single Consolidated Nuclear Production Center (CNPC) at any one of five different geographic locations. The results showed that consolidation was economically attractive only in the very long term, 2060. The very high cost and long duration of nuclear facility construction extended the economic payoff out many years. The low-cost options tended to center on consolidating operations with the existing plutonium facilities at Los Alamos National Laboratory Technical Area-55 including the construction of a new Chemistry and Metallurgy Research Replacement-Nuclear Facility (CMRR-NF). In addition, moving HEU operations from Y-12 to either SRS or the Pantex appeared to reduce 2060 NPV somewhat. These HEU options were further evaluated in a quick interim review (Phase Ia), which tended to confirm the conclusion of slight savings by moving HEU operations and closing Y-12. These early studies were essentially scoping studies to examine a wide range of alternatives. They lacked the detailed data and reduced uncertainties to clearly differentiate between some of the options. To support the pending SPEIS record of decision (ROD), this study analyzes three specific options for future HEU operations in more detail.

2.3 SCOPE AND LIMITS

This report provides the results of the team’s evaluation of future options for the location of all HEU operations, including material processing, HEU storage, CSA manufacturing, and the non-HEU parts processing and manufacture necessary for CSA manufacturing. HEU operations include the weapons work done for DP, material processing for NN, NR, and NE, and reimbursable “work for others” (WFO) done for ORNL and other entities. The options include HEU operations

- remaining at Y-12, or
- moving to
  - SRS, or
  - Pantex.

[4] See Note 1, Chapter 1.

The financial evaluation includes all costs directly related to the manufacturing, dismantlement, and transportation of CSAs, as well as the cost for all HEU processing independent of the funding source. The analysis includes the cost of new facilities necessary to consolidate and modernize the operations to realize a more efficient complex.

This study is limited to evaluating the relocation alternatives on the basis of Stockpile 5a; it does not consider other stockpile scenarios or address sizing and capacity alternatives. In addition to performing economic analysis, the team performed a qualitative analysis to capture risks and benefits.

To evaluate the three location options involving the future of HEU operations, the team examined five base cases:

- *Case 1a*. HEU operations remain at Y-12, the HEU Materials Facility (HEUMF) is completed, but no further new construction is done. Therefore, future operations at Y-12 depend on the refurbishment of current facilities to bring them up to current standards. This case is included, not because it is a serious planning option, but because it represents the default path of delayed strategic decisions.

- *Case 2a*. HEU operations remain at Y-12, HEUMF is completed, a Uranium Processing Facility (UPF) is constructed, a new consolidated manufacturing complex (CMC) is constructed, and the perimeter intrusion detection and alarm system (PIDAS) area is significantly decreased. This represents the current baseline plan at Y-12, which NNSA has yet to approve.

- *Case 3a*. All HEU operations are moved to SRS. HEUMF is completed at Y-12, and UPF, a new HEU storage facility, and CMC (together the consolidated uranium center [CUC]) are constructed at SRS. HEU operations continue at Y-12 until the new CUC is functional at SRS, and then all HEU operations move to SRS. Y-12 is de-commissioned, environmentally restored, and closed. Delivery of qualified CSAs are expected to continue during the transition by either overlapping operations at both sites or prebuilding product at Y-12 to cover the time of transition.

- *Case 4a*. HEU operations move to Pantex. HEUMF is completed at Y-12, and UPF, an HEU storage facility, and CMC are constructed at Pantex. HEU operations continue at Y-12 until the new CUC is functional at Pantex, and then all HEU operations move to Pantex. Y-12 is decommissioned, environmentally restored, and closed. Delivery of qualified CSAs are expected to continue during the transition by either overlapping operations at both sites or prebuilding product at Y-12 to cover the time of transition. This case considers UPF and the HEU storage facility to be constructed inside the existing Zone 12 PIDAS at Pantex, so the resulting size of the protected area does not increase.

- *Case 4b*. The same as case 4a except the team considers constructing UPF and HEUMF outside, but adjacent to, the Zone 12 PIDAS. The team assumed that this approach may result in more efficient and timely construction, but a net increase in the final PIDAS area.

2.4 KEY ASSUMPTIONS

To bound the problem, the team made certain assumptions necessary to determine boundary conditions for this business case. This section lists and concisely discusses the key assumptions used in the study.

2.4.1 Overall Assumptions

The overall assumptions are as follows:

- A SPEIS record of decision (ROD) is published in early FY09, which provides the strategic direction for immediate actions.
- Stockpile Scenario 5a is the DP programmatic demand for all the cases presented in this report. Scenario 5a is dominated by reliable replacement warhead (RRW) manufacture and a high dismantlement rate. The workload demands of Scenario 5a are expected to bound the demands from other stockpile options.
- All environmental issues are covered in the current SPEIS, and the five cases for this evaluation are within the SPEIS envelope.
- The model includes all costs of the HEU enterprise and all operations at Y-12, including WFO, NNSA site office operations, and all transportation of HEU.
- The team used the current sizing of UPF, CMC, and HEUMF for all locations. Although a new HEU storage facility would not be operational at SRS or Pantex until around 2020, the requirement for HEU storage remains high through the transition period with the projected Stockpile 5a dismantlement workload. An independent validation of the required capacity of HEU storage is beyond the scope of this study. Because this study is a comparative analysis, the results are not particularly sensitive to the sizing assumptions of HEU storage, UPF and CMC.
- For transitions to SRS or Pantex, all Y-12 functions would move to the new location, and the site would be completely closed down and remediated.
- Deactivation, decontamination, decommissioning, and dismantlement and environmental restoration (ER) costs are included in the analyses if those costs are a direct result of the decision to consolidate. Current D&D ac-

tivities, current legacy D&D liabilities, and D&D costs occurring after 2060 are not included. (Chapters 7 and 9 discuss the analysis sensitivity with and without D&D costs.)

- All inputs to the model are in 2008 dollars.
- For Case 1a, refurbishment of the current HEU manufacturing facilities would start immediately after a decision is made to remain in the facilities rather than build UPF and CMC at Y-12. These refurbishments would bring the facilities up to current standards for nuclear operations.
- Cases 2a, 3a, 4a, and 4b assume that the Y-12 HEU manufacturing facilities would be operated with a minimum of refurbishment until the new facilities are completed (2023–27).
- New facilities would require recapitalization (20 percent of total construction cost) at 25-year intervals consistent with DOE and commercial practices.

2.4.2 Site-Specific Assumptions

Each site made additional assumptions during the development of its transition strategy. These assumptions are recorded in the individual site transition plans.[5] The team modified some of the site-specific assumptions as discussed in the individual site discussions in Chapters 4 and 7. Table 2-1 compares the assumptions the IPT used for its analysis and the assumptions the team used.

Table 2-1. Comparison of Assumptions

Assumption	IPT	IBCA
Inflation	Excluded	Included in base case; excluded in sensitivity case
Construction time	Site input	Developed independent estimate (1–2 year adjustment)
Construction cost	Site input	Developed independent estimate for HEU storage and CMC
Site closure surveillance and maintenance (S&M) costs	Site input	Major reduction for sensitivity analysis
No new construction at Y-12 (Case 1a)	Excluded	Included
Construction outside PIDAS at Pantex (Case 4b)	Excluded	Included
Indirect costs	Site input	Adjusted indirect for increased construction support and reduced legacy costs

[5] NNSA, *Uranium Operations Mission Transformation Integrated Project Team Report*, Appendixes A, B, and C, July 18, 2008.

Chapter 3
Current HEU Facilities, Operations, and Costs

3.1 OVERVIEW

NNSA HEU facilities and operations are currently located at the Y-12 plant in Oak Ridge, TN. Many of the facilities are of 1950s construction, oversized for the current and future missions, and nearing the end of their useful lives. Relying on these facilities much beyond 2020 will be very costly due to the upgrades and maintenance required to meet increasingly stringent building safety and security requirements.

Table 3-1 lists the current HEU operations missions and functions. Y-12 is the only production source of CSAs, cases, and certain other nonnuclear weapons components within the NNSA nuclear weapons complex.

Table 3-1. Major Missions at Y-12

Mission	Description	Sponsor
Weapons components	Fabricate uranium and lithium components and parts for nuclear weapons and test hardware	NNSA
Stockpile surveillance	Evaluate components and subsystems returned from the stockpile	NNSA
Uranium and lithium storage	Store enriched uranium, depleted uranium (DU), and lithium materials and parts	NNSA
Dismantlement	Dismantle nuclear weapon CSAs returned from the stockpile	NNSA
Environmental restoration and waste management	Waste management and decontamination activities	ER, EH, NE, EM, and NNSA
WFO	Provide specialized medical emergency, security, technology, and protection strategy expertise	DoD and various other agencies
Arms control and nonproliferation	Conduct security technology research and development (R&D) and render technical support for material disposition, global threat reduction, fissile material control, and nonproliferation analysis	NN
Naval reactors	Supply HEU for use as fuel in naval reactors	NNSA

Source: Adapted from the draft SPEIS, DOE/EIS-0236, December 2007, Table 3.2.9-1, page 3-14.

Note: ER = Environmental Restoration; EH = DOE Office of Environmental, Safety, and Health; NE = Office of Nuclear Energy; EM = Office of Environmental Management.

Table 3-2 shows the cost elements of the uranium operations at Y-12 and costs or cost estimates in FY07–11. For this table, the team assumes that the new HEU (UPF) and non-HEU (CMC) processing facilities are not built and the existing facilities must be refurbished to current standards. This is the team's Case 1a.

Table 3-2. Total Costs Uranium Operations—Case 1a ($ million)

Category	Description	FY07 actual cost	Estimated cost[a]			
			FY08	FY09	FY10	FY11
Construction	Complete HEUMF; close out UPF design	109	246	51	32	—
Modifications	PIDAS, DBT projects, FIRP, Be, CCC, steam plant, potable water	46	77	70	70	71
Modifications	HEU facility refurbishment[b]	—	—	—	270	270
Operations	Direct production labor and materials	377	375	373	372	372
Indirect costs	Legacy computing, infrastructure, ESH, M&A, fee	309	314	328	322	349
Security	Security, direct and indirect	106	118	110	115	115
Transportation	HEU transportation	N/A	41	37	33	36
Y-12 site office	—	14	15	15	15	15
Total		960	1,186	984	1,228	1,217

Note: Be = Beryllium, CCC = Complex Command Center, DBT = design basis threat; FIRP = Facilities and Infrastructure Recapitalization Program; ESH = environment, safety, and health; M&A = management and administration; N/A = not available.

[a] FY09 president's budget submittal and B&W Technical Services Y-12, LLC (B&W Y-12), input in FY08 dollars.

[b] Upgrades and modifications to existing HEU facilities.

Table 3-2 includes $270 million (FY08 dollars) per year for modifications of existing HEU facilities, starting in FY10 and assuming UPF is not constructed. This cost, estimated at a total of $2.7 billion, is to upgrade the existing HEU operations facilities to meet current standards. Likewise, a similar expense of $1.7 billion is estimated for the non-HEU operations facilities. These major refurbishment costs are not in the current budget planning because the budget submission assumes UPF will be authorized. Table 3-2 shows these modification costs starting in FY-10.

3.2 Y-12

Currently all HEU processing and manufacture of CSAs for NNSA are carried out at the Y-12 site, primarily in buildings constructed in the 1950s and 1960s. The site contains about 800 acres of land, and 600 acres are enclosed within the perimeter fence. Approximately 150 acres are enclosed within the high-security PIDAS protected area, including the facilities for HEU operations, which are housed in five separate facilities totaling approximately 1 million square feet. The consolidation of storage activities in the newly constructed HEUMF will reduce the operational footprint to four facilities, including HEUMF. The site's current workforce is approximately 4,500.

3.2.1 HEU Storage

The nation's stockpile of HEU is currently stored in multiple buildings at Y-12. It is a dynamic inventory resulting from manufacture and dismantlement of nuclear weapon components over more than 50 years and is stored in various forms and configurations. The Y-12 inventory includes national strategic reserve and other national security materials and is used to supply NNSA DP, NR, and NN and various DOE NE research programs. HEUMF is scheduled to be operational by the end of FY10, at which time Y-12 will begin the process of transferring material from existing facilities. Some material will need to be converted to a long-term storage form in the existing HEU processing facilities. The consolidation of all Y-12 HEU inventory to HEUMF is projected to be completed by 2020. The total project cost (TPC) for HEUMF construction is estimated at $550 million. Once the HEU inventory is transferred from current storage locations on site and UPF is constructed, the PIDAS will be collapsed into a much smaller footprint.

3.2.2 HEU Processing

Y-12 has ongoing processes associated with the production of HEU weapon components and CSAs, including HEU manufacturing, assembly, disassembly, dismantlement, surveillance, and storage. These processes include material characterization and processing, casting, metal working, machining, inspection, certification, and accountability. Y-12 has additional capabilities to recover HEU manufacturing scrap and production residues, including chemical recovery and oxide conversion and purification processes. These same processes are used to produce EU materials in various forms to supply other NNSA and DOE programs and contracts.

3.2.3 Non-HEU Processing and Manufacturing

Y-12 maintains capabilities and facilities for the production and processing of non-HEU components, including DU, lithium, and other special materials. Y-12 also has capabilities for processing and precision manufacturing of metal, plastic, and other general material parts. Current facilities that support these processes are located both inside and outside the PIDAS protected area and occupy approximately 450,000 square feet of aging facilities.

3.3 SRS

SRS does not have operations that directly support the HEU missions of NNSA DP or other organizations. No manufacturing is done at SRS, but the site is experienced in handling and processing of uranium and does have a current mission to recover surplus HEU for down-blending to low-enriched-uranium commercial reactor fuel. The facilities and infrastructure necessary to support the recovery and down-blending of this surplus material will remain viable through FY19. The high level waste (HLW) infrastructure to support these missions is scheduled to complete operations around the end of FY28.

SRS also has the current mission to dispose of more than 30 metric tons of weapons-grade plutonium, some of which is already stored on site in a Category I nuclear storage facility. The plutonium metal will be converted to oxide and blended with enriched uranium oxide to make mixed oxide (MOX) civilian nuclear reactor fuel, pending completion of the construction of three new facilities: the Pit Disassembly and Conversion Facility (PDCF), Mixed Oxide Fuel Fabrication Facility (MFFF), and Waste Solidification Building (WSB).

3.4 PANTEX

Pantex is the nation's only nuclear weapon assembly/disassembly and high-explosive production facility. It receives for assembly all nuclear weapon subassemblies, components, and parts from other suppliers and integrated contractor/manufacturing sites across the nuclear weapons complex, including Y-12. As such, the Pantex facility currently handles HEU only in the form of sealed CSAs and does not have processing or manufacturing facilities for handling unencapsulated HEU.

Pantex does have an on-site infrastructure for inspecting, handling, staging, and packaging of CSAs for receipt from and return to Y-12, including a trained and qualified plant workforce and site-wide nuclear safeguards and security program.

Chapter 4
HEU Consolidation Facilities

Three major new facilities are contemplated for the consolidation of HEU operations (CUC):

- An HEU storage facility (the same as or similar to HEUMF currently under construction at Y-12)
- An HEU processing and manufacturing facility (UPF)
- A non-HEU manufacturing facility (CMC).

These facilities are either under construction or proposed for construction at Y-12 to replace aging and oversized facilities and to consolidate Category I HEU storage and operations inside a greatly reduced high-security protected area.

For the IBCA, the team used HEUMF as constructed at Y-12 and UPF conceptual design as the basis for estimating the cost of consolidating HEU operations at Y-12 or relocating HEU operations to another site. Similarly, the preconceptual design for the CMC is used to estimate the cost of consolidating non-HEU manufacturing at each of the alternative sites.

4.1 HEU STORAGE

4.1.1 Assumptions

The construction of HEUMF at Y-12 is near completion, and it is expected to be fully operational by FY10. The assumption is that the HEU storage and operations will be consolidated as planned into fewer facilities at Y-12, including HEUMF, regardless of whether UPF is built at Y-12. If the decision is made to transfer HEU operations to another site, then a facility similar to HEUMF will be constructed at that site and the HEU inventory will be transferred from Y-12.

4.1.2 Requirements

The requirements (size and capacity) for a new HEU storage facility at an alternative site will depend on the size of the projected Y-12 inventory in the year of transition. Current projections are that the size of a new facility will be 75–100 percent of that of HEUMF, depending on projected DoD stockpile numbers, NNSA dismantlement rates, and HEU requirements for other NNSA, DOE, and WFO programs. For the purposes of the IBCA, the team used the 100 percent HEUMF size for a new storage facility.

4.1.3 Description

The as-designed HEUMF is a 110,000-square-foot, hardened, aboveground nuclear facility. Depending on the program and material form, HEU can be stored in HEUMF in drums or rackable cans. The HEUMF TPC is estimated at $550 million (year of performance dollars), and initial loading of the facility is projected by September 2011. Movement of material into HEUMF continues for several years, through FY20, as material is processed into storable forms.

4.1.4 Construction Schedule

The team evaluated the HEUMF construction schedule as discussed in Appendix C. The team assumed a new HEU storage facility at another site can be designed, constructed, and commissioned in 9 years (CD-0 to full operation). HEUMF (at Y-12) took slightly longer due to a number of problems during design and construction.

4.2 HEU PROCESSING AND MANUFACTURING

4.2.1 Assumptions

The new UPF will include all HEU manufacturing and processing capabilities and capacities necessary to support NNSA DP requirements (both legacy and RRW) and all other NNSA and DOE programmatic requirements. The current HEU facilities at Y-12 will be maintained and operated through the transition period until UPF has demonstrated full operational capability, that is, the capability and capacity to ship HEU product to meet program requirements.

4.2.2 Requirements

The classified UPF program requirements document describes the requirements for UPF in terms of capacity and capability consistent with the latest schedule and HEU deliverables for NNSA DP and other NNSA, DOE, and WFO programs. For purposes of this IBCA, the proposed Stockpile 5a scenario defines the requirements for DP deliverables.

4.2.3 Description

UPF will consolidate all HEU operations at Y-12 into one 388,000-square-foot facility. UPF CD-1 was approved on July 25, 2007, with a preliminary cost range of $1.4 billion to $3.5 billion. Y-12 has been conducting preliminary design activities in preparation for CD-2 approval to proceed with Title II design. For purposes of the IBCA, the team used the UPF baseline conceptual design as the basis for UPF construction at all alternative sites, with a nominal TPC of $2.2 billion (year of performance dollars), depending on the construction schedule and location, as discussed in the site-specific sections.

4.2.4 Construction Schedule

The team evaluated the UPF schedule as discussed in Appendix C. The team assumed that UPF can be designed, constructed, and commissioned in 12 years. This schedule is consistent with the current Y-12 estimate.

4.3 NON-HEU MANUFACTURING

4.3.1 Assumptions

The new CMC at Y-12 is envisioned to replace aging and oversized facilities for DU fabrication, lithium processing, special materials processing and purification, and general manufacturing with a single facility incorporating all non-HEU manufacturing. The current non-HEU facilities at Y-12 will be maintained and operated through the transition period until the CMC has demonstrated full operational capability, that is, the capability and capacity to manufacture product to meet program requirements.

4.3.2 Requirements

The requirements for the non-HEU capabilities are primarily driven by NNSA DP schedules and deliverables, specifically the proposed Stockpile 5a scenario.

4.3.3 Description

Y-12 has described a very preliminary conceptual “footprint” of a 130,000-square-foot CMC. This facility would replace existing facilities at Y-12 with a combined footprint of 450,000 square feet. For purposes of the IBCA, the team used the CMC preconceptual design as the basis for CMC construction at all alternative sites. The team performed an independent parametric cost analysis and determined a nominal cost of $437 million in FY08 dollars (a TPC of $527 million in year of performance dollars for Y-12) compared with the $1 billion preliminary estimate used by the IPT. In addition to the CMC, a purification facility, similar to the recently constructed facility at Y-12, is required for material processing.

4.3.4 Construction Schedule

The team evaluated a CMC construction schedule. The team assumed a CMC can be designed, constructed, and commissioned in 9 years.

4.4 SUPPORT FACILITIES

Support facilities necessary for implementation of the uranium consolidation alternatives include waste processing, engineering support, warehouses, analytical laboratory, modified PIDAS, and utilities including electricity, cooling and process water, fire protection, and sanitary waste. The assumptions, requirements for, and description of these facilities varies with the individual site alternatives, as described in the site transition plans prepared for the IPT.[1]

4.4.1 Secure Transportation

If HEU operations were to move to SRS, a new NNSA Office of Secure Transportation (OST) Federal Agent Facility (FAF) would need to be constructed to support secure transportation operations and maintenance in the eastern United States to replace the existing eastern command center at Y-12. This facility would cost an estimated $26 million (FY08 dollars) over approximately 5 years to design and construct. If the mission moves to Pantex, OST plans to leave the FAF at Y-12 as it is located such that Y-12 could be shut down and decommissioned without impacting the OST facility.

4.4.2 Construction Schedule

Construction schedules vary depending on the site and scope of the support facilities required. The OST eastern command would need to be operational prior to start-up of HEU operations at an alternative site.

4.5 SITE-SPECIFIC CONSIDERATIONS

4.5.1 Y-12

The construction of HEUMF will be completed in 2008. Prior year (2007 and earlier) expenditures are considered "sunk costs" and are not included in the analysis, but costs for completion and start-up (2008 and beyond) are included. This facility provides the HEU storage function for the Y-12 site through the transition period to consolidated HEU storage operations, regardless of where UPF is sited. Additional HEU storage facilities are not contemplated at the Y-12 site.

UPF design has received a CD-1 approval, and new engineering offices have recently opened. The preliminary design is specific to Y-12 and integrated with HEUMF function and design.

[1] NNSA, *Uranium Operations Mission Transformation*, predecisional report, July 18, 2008, Appendixes A (Y-12), B (Pantex), and C (SRS).

The preliminary concept CMC is included in all site alternatives, although it may be possible for Y-12 to consider other options for downsizing, consolidating, and maintaining existing facilities.

Figure 4-1 shows the current and future arrangement of the Y-12 site.

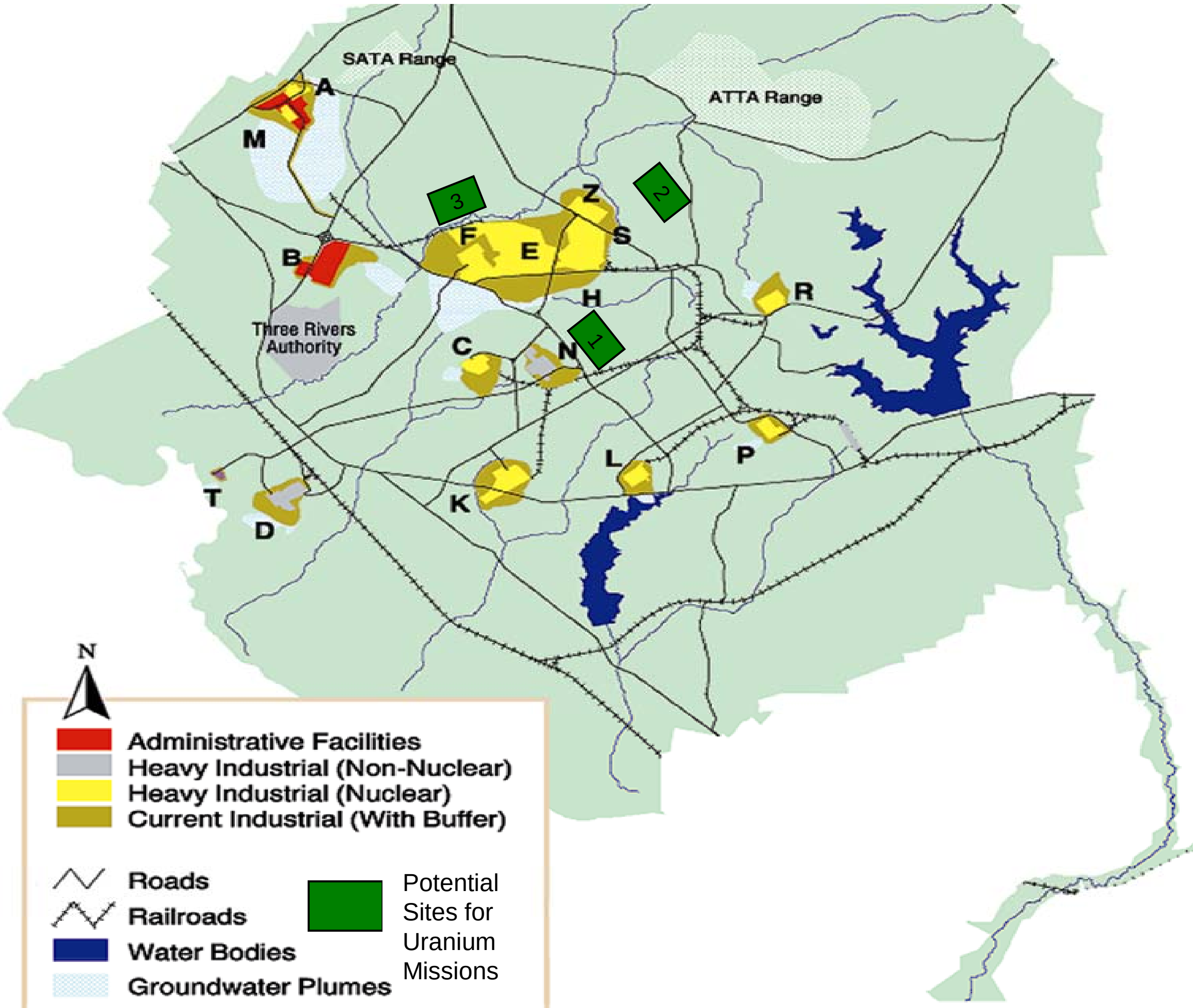
Figure 4-1. Y-12 Site Arrangement

4.5.2 SRS

Although SRS does not currently have HEU manufacturing operations that support NNSA DP, it does have other NNSA and DOE programmatic missions that involve handling, storing, and processing HEU, as well as supporting facilities and personnel. As such, some of the existing site infrastructure—analytical laboratories, engineering and administrative support facilities, utilities, and waste-handling facilities—can be utilized, along with the supporting staff.

Figure 4-2 shows the areas under consideration at SRS, should the uranium mission be sited there. Each area represented on the SRS site map by a green rectangle is large enough to accommodate the entire set of buildings associated with the CUC.

Figure 4-2. SRS Conceptual Site Locations for Uranium Mission Facilities



4.5.3 Pantex

Pantex does not currently have HEU manufacturing and processing operations, but does have the nuclear weapon assembly/disassembly mission for NNSA DP and a "customer/supplier" relationship with Y-12. As such, it has the facilities infrastructure for handling and staging CSAs, along with the safeguards and security infrastructure for protecting and accounting for Category I SNM.

Pantex does not have some of the supporting infrastructure required for HEU operations, such as analytical laboratories and waste-handling facilities.

For this IBCA, unlike Y-12 and SRS, Pantex has elected to construct the consolidated HEU facilities inside the existing protected area, which will increase the construction costs but, in its view, lower the longer-term operational and security costs.

Figures 4-3 and 4-4 show the conceptual Pantex site locations for new HEU mission facilities, inside and outside the current PIDAS in Zone 12, respectively.

Figure 4-3. Pantex Construction Concept (Inside Current PIDAS)

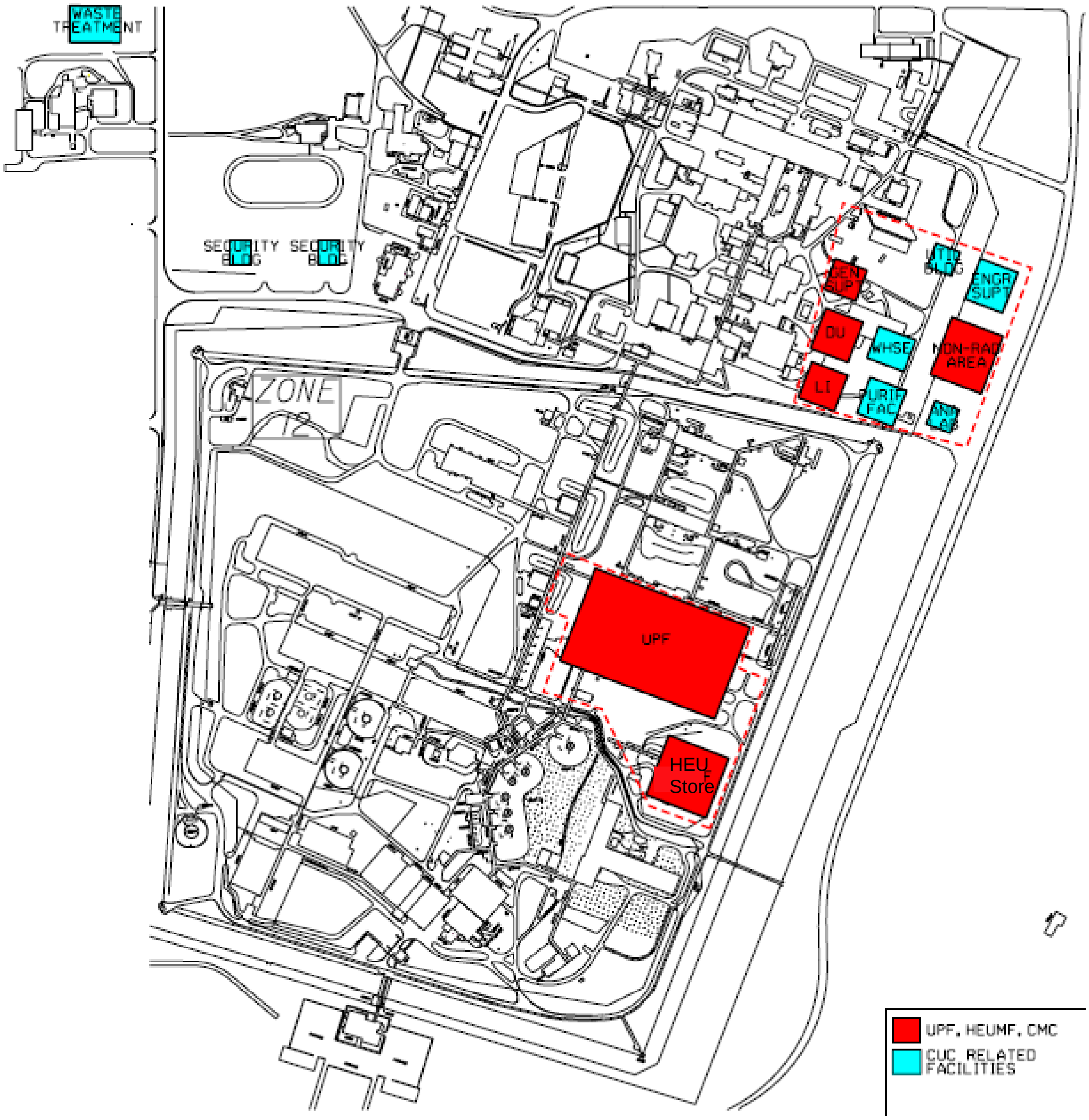
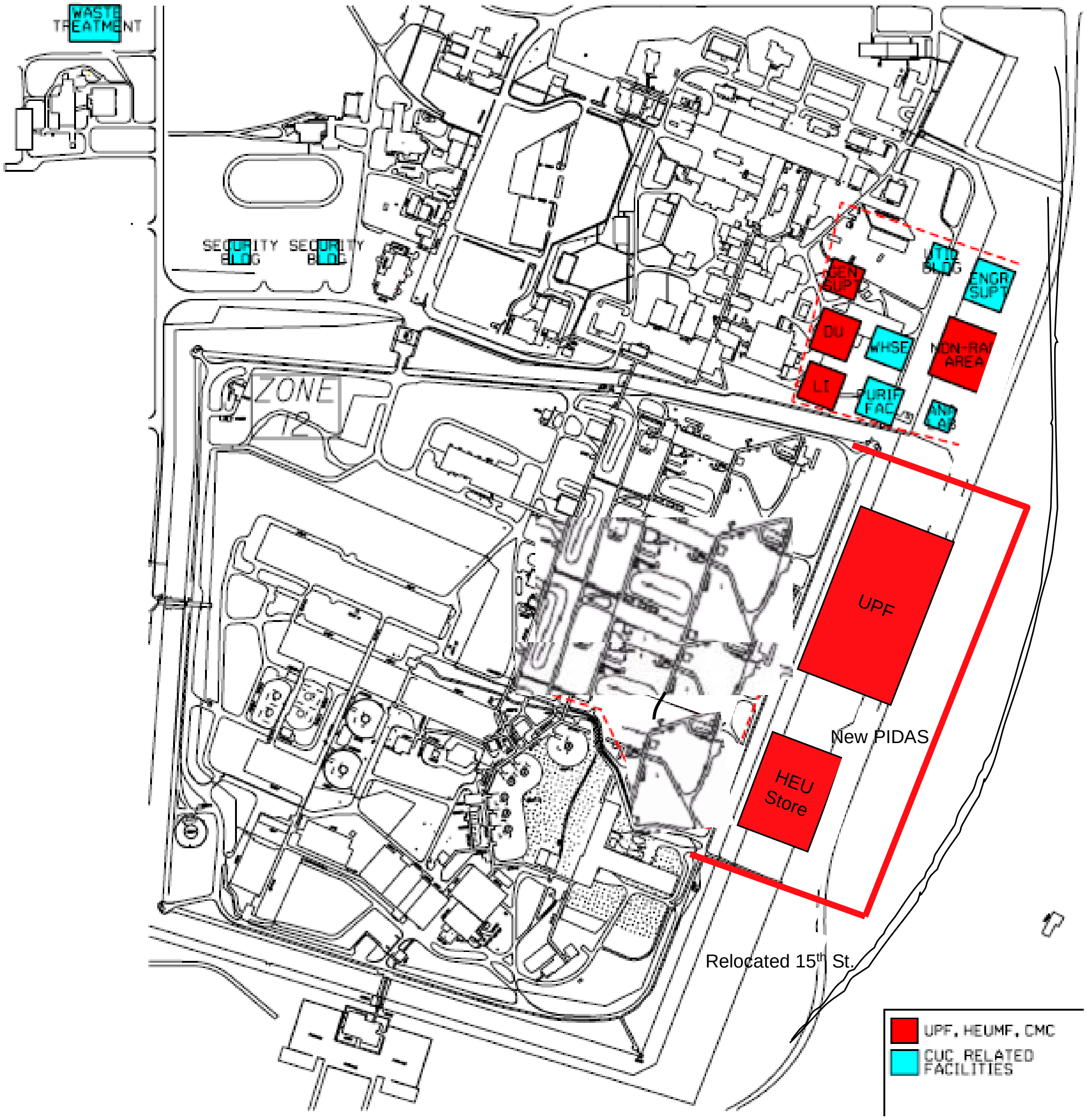


Figure 4-4. Pantex Construction Concept (Outside Current PIDAS)



Chapter 5
Alternatives and Transitions

This chapter presents an overview of the five base cases that the team evaluated. The cost data and analysis results are provided in later chapters. The team used the “a” designation with the initial cases to distinguish the cases from the IPT analysis cases 1–4. Figure 5-1 shows the relative timelines for each case and each major transition facility (HEU storage, UPF, and CMC). Chapter 4 describes the site arrangements for the three candidate sites. Appendix C details the site construction schedules the team used for cost-and-risk analysis.

5.1 Case 1a—Y-12 No New Construction (Current Configuration)

Case 1a represents the NNSA HEU operations as they exist today and includes all facilities currently under construction. For Y-12, this includes HEUMF but does not include UPF or the CMC. This case is being analyzed as a baseline for comparison with the four consolidation and modernization cases 2a, 3a, 4a, and 4b, for which modernization is assumed at each of the candidate sites. Case 1a represents the scenario in which NNSA constructs no new HEU facilities after the completion of HEUMF, but continues to produce and dismantle CSAs in existing facilities for an indefinite period. Therefore, case 1a must, by necessity, emphasize the cost and schedule of required refurbishment of existing facilities. Refurbishment of existing production buildings will be required starting in FY10, at an expected cost of $4.4 billion, and take 20 years.

The team assumed that the HEU and non-HEU refurbishment activities would not occur simultaneously due to budgetary restrictions. Support facilities will also require refurbishment, at an estimated cost of $517 million. Consolidating storage into HEUMF will reduce the security footprint somewhat, but operating costs will not decrease much. The team assumed that UPF design activities would be stopped after the ROD and the project design would be archived early in FY09.

5.2 Case 2a—Y-12 New Construction

Case 2a represents the consolidation and modernization of HEU operations at the Y-12 site. Figure 4-1 shows the transition from current to future facilities. This includes completing construction of HEUMF, construction of UPF beginning in FY11, construction of the CMC beginning in FY13, and substantial consolidation of the security footprint. The site operating costs are expected to decrease once the PIDAS perimeter has been reduced to include only HEUMF and UPF. Appendix C details the schedule for case 2a construction and transition activities.

5.3 CASE 3A—SRS

Case 3a represents moving all HEU operations from Y-12 to SRS and closing down the entire Y-12 site. A new HEU storage facility, UPF, and the CMC would be constructed at SRS. The SRS staff has suggested three possible locations for the HEU operations (Figure 4-2):

- Location 1 is in the center of SRS near the Central Shops area.
- Location 2 is east of Z area and the current Saltstone facility.
- Location 3 is behind F Area, close to the current construction site of the MOX facility.

Location 2 is the baseline location for this study. The transition would start in 2020 and would be complete and operational in 2022. This case requires the existing Y-12 facilities to continue operation until the new facilities are operating and producing certified products. A new OST East Coast FAF would be required. Appendix C contains the SRS construction and transition schedule.

5.4 CASES 4A AND 4B—PANTEX

The team evaluated two Pantex cases:

- Case 4a, Inside PIDAS (IP), is similar to that evaluated by the IPT. In this case, the construction is inside the current Zone 12 PIDAS, but must be delayed until a replacement Gas Lab is constructed and the existing facilities in the construction area are demolished. Transition does not occur until 2025.
- Case 4b, Outside PIDAS (OP), has cost and schedule implications similar to Case 3a, except the new location of HEU operations would be Pantex. The construction is outside and adjacent to the current Zone 12 PIDAS. As in Case 3a, the transition would be complete by 2023.

Both cases (4a and 4b) require the existing Y-12 facilities to continue operation until the new facilities at Pantex are operating and producing certified products. For Case 4a (IP), this continued operation date is extended about 3 years to account for the delay in Pantex construction.

A new OST East Coast FAF would not be required because the current facility at Y-12 is presumed to continue as an independent facility.

Appendix C shows construction and transition schedules at Pantex for both cases.

Chapter 6
HEU Transportation Analysis

The NNSA nuclear weapons complex has a decentralized configuration and includes operations at eight different sites across the nation, so SNM is routinely transported among at least five of the sites and between Pantex and the appropriate military bases. OST (NA-15) carries out all transportation of SNM under the custody of NNSA. The IBCA includes the cost of transporting SNM.

The OST mission includes transport of plutonium, HEU, nuclear weapons, and nuclear weapon components. For this study, the team considers only the transportation component associated with HEU and CSAs.

OST generated all data presented here using the Transportation Resource Integrated Planning System (TRIPS) computer simulation of the SNM transportation system.

6.1 SUMMARY

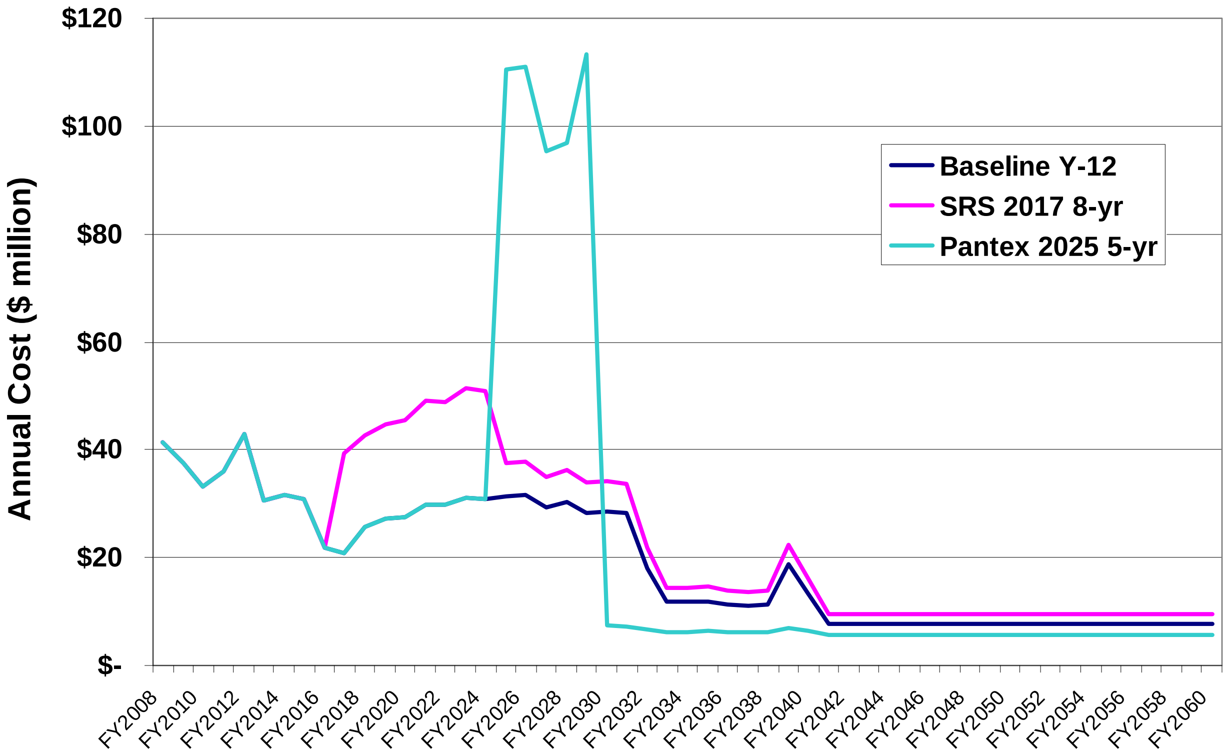
Moving HEU operations from Y-12 to an alternative site involves two components of HEU transportation cost:

- The annual costs associated with transporting HEU products
  - Defense Program weapon components between the HEU operations site and the nuclear weapons complex assembly/disassembly site, Pantex, and to the appropriate military installation
  - HEU metal and oxides for other NNSA and DOE programs, primarily to post-production processing sites, including Erwin, TN, Lynchburg VA, and SRS in Aiken, SC
- The one-time cost associated with transporting the HEU inventory stored at Y-12 to an alternative HEU operations site, either SRS or Pantex.

Figure 6-1 shows the annual cost profile for transporting all HEU products for transition Cases 2a (Y-12 new construction), 3a (SRS), and 4a and 4b (Pantex). For Case 2a, no external transport is required for the stored HEU. The proposed transition of HEU operations to SRS (Case 3a) begins in 2017 with the transfer of HEU inventory from the Y-12 site over 8 years through 2024. This is reflected in the increase in transportation costs over that period relative to the baseline Y-12 case. HEU production would commence at SRS beginning in 2025, which is reflected in a slight increase in transportation costs relative to the Y-12 baseline in

2025–60. This increase is primarily because SRS is farther from Pantex than Y-12 is.

Figure 6-1. OST Transportation Cost Profiles of Location Options (FY08 Dollars)



The proposed transition of HEU operations to Pantex (cases 4a and 4b) begins in 2025 with the transfer of HEU inventory from Y-12 over 5 years through 2029. Figure 6-1 shows this as a sharp increase in transportation costs over that period relative to the baseline Y-12 case. The difference in the deinventory peak profile for Pantex relative to the SRS alternative stems from the differences in mileage between Y-12 and those sites and the number of years proposed for the transfer of material. The lower steady-state cost post-2030 for the Pantex HEU site alternative relative to the base case (Y-12) and SRS alternatives is due to the elimination of CSA transportation within the NNSA complex.

The total cost of moving the HEU inventory does not change significantly with the duration chosen for the transfer. The team chose to evaluate an 8-year transportation campaign for Case 3a (SRS) and a 5-year transfer campaign to Pantex, consistent with the transition plans for those sites. The team chose the 5-year schedule for Pantex to be compatible with the construction and start-up schedule and as a capacity test of the OST system. OST concluded that either transfer period is within their capacity. Longer transfer times put less stress on the OST system.

6.2 TRANSPORT MODEL AND PARAMETERS

The team obtained the HEU transportation cost data using the OST TRIPS model, as provided in an OST/Sandia report.[1] The TRIPS model used as input the best projections of all of the SNM transportation requirements forecast through 2060, given the NNSA assumptions for Scenario 5a future stockpile quantities and supporting operations. The transportation requirements also included estimated future workloads for all other NNSA and DOE programs requiring SNM transportation.

The TRIPS model shows that the transportation of weapons (between DoD sites and DOE/NNSA) is the predominant annual cost. Also, considerably more weapon moves are projected in 2008–30 than in the post-2030 “steady state.” This is related primarily to the reductions in stockpile prescribed by the Moscow Treaty, that is, weapons moved to Pantex for dismantlement and the subsequent movement of subassemblies to their final destinations. The movement of CSAs between Pantex and Y-12 is the next highest activity, again with more movement projected pre-2030 than post-2030.

The OST analysis and report shows that current OST capacity is adequate for any of the four cases under consideration for this study. The average cost per convoy is an estimated $3 million for full cost recovery. The actual transportation costs differ for each program, depending on the material, form, container, and mileage to destination. The transportation costs used in the Phase II business case model were derived from the detailed TRIPS calculations and not from the average convoy cost.

The model shows that the workload projections, as illustrated in the charts that follow, have highly irregular “peaks and valleys,” on the basis of current estimates of the projected annual weapon requirements. These long-range projections would be optimized for OST operations through prioritization and workload balancing with the programmatic customers if these shipping campaigns were to be realized.

6.3 STEADY STATE HEU TRANSPORTATION (BEFORE AND AFTER TRANSITION)

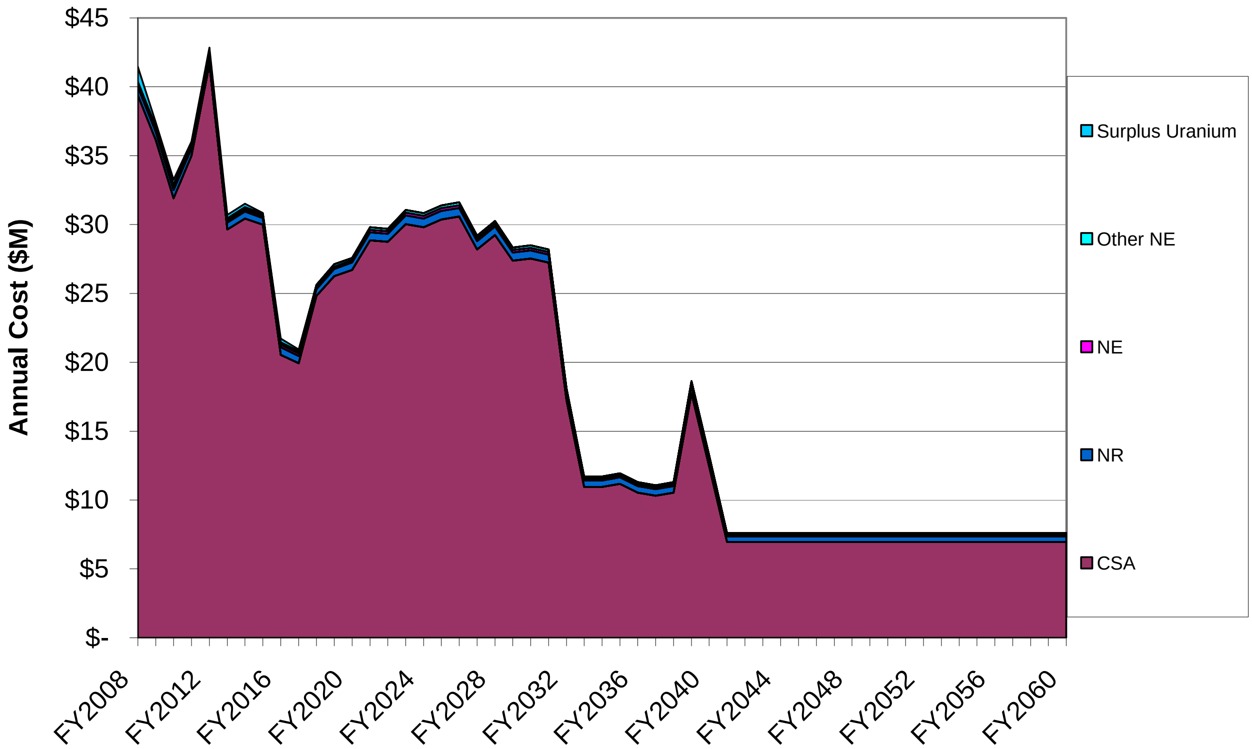
A steady state component of HEU transportation involves the movement of CSAs between Pantex and the HEU manufacturing site. The quantities are determined by the rates of weapon deliveries to the stockpile and stockpile returns from DoD, and the rates vary year to year. This steady state component also includes the

[1] OST/Sandia report, *Uranium Business Case, Transportation Analysis Using the Office of Secure Transportation’s (OST’s) Transportation Resource Integrated Planning System (TRIPS)*, May 15, 2008.

transportation of HEU to other NNSA programs, including the NR and NN programs and DOE NE research programs.

Figure 6-2 shows the estimated annual OST costs for transportation of HEU for baseline Case 2a (Y-12 new construction). (These costs are also applicable to Case 1a.)

Figure 6-2. HEU Transportation Costs (FY08 Dollars), Case 2a (Y-12 New Construction)



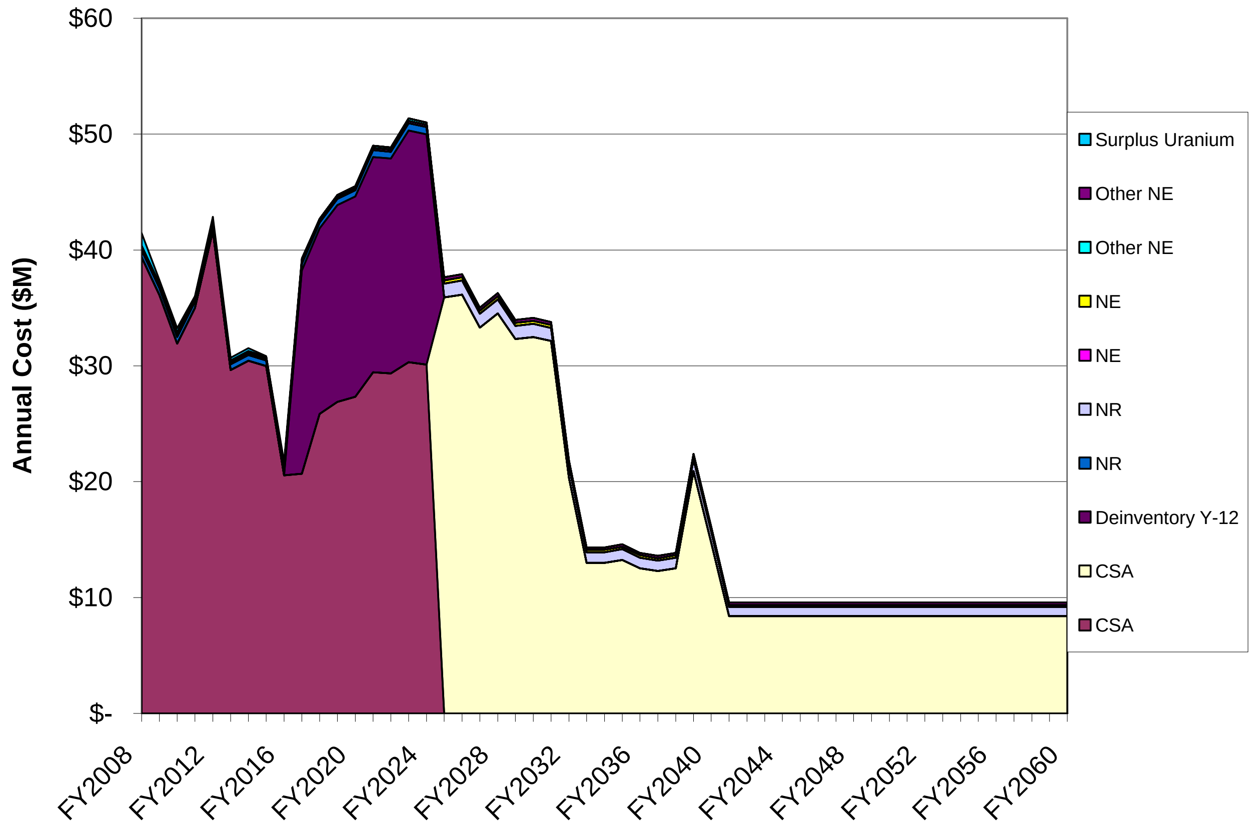
6.4 LOCATION OPTIONS—TRANSITION AND STEADY STATE TRANSPORTATION

During the transition of HEU operations to either SRS or Pantex, the HEU inventory stored at Y-12 must move to the alternative site. From the TRIPS capacity studies, the team determined that the stored material can be moved within the current OST capacity if the movement is spread over at least 5 years. The total cost of shipping the material to a specific site will be the same, independent of the number of years chosen for the transition (without escalation). The cost will differ for transfer of the same inventory to SRS rather than Pantex due to the difference in mileage from Y-12 to the alternative site.

6.4.1 SRS

Figure 6-3 illustrates the proposed transition of HEU operations to SRS (case 3a), beginning in 2017 with the transfer of the HEU inventory from Y-12 over 8 years through 2024.

Figure 6-3. HEU Transportation Costs (FY08 Dollars), Case 3a (SRS)

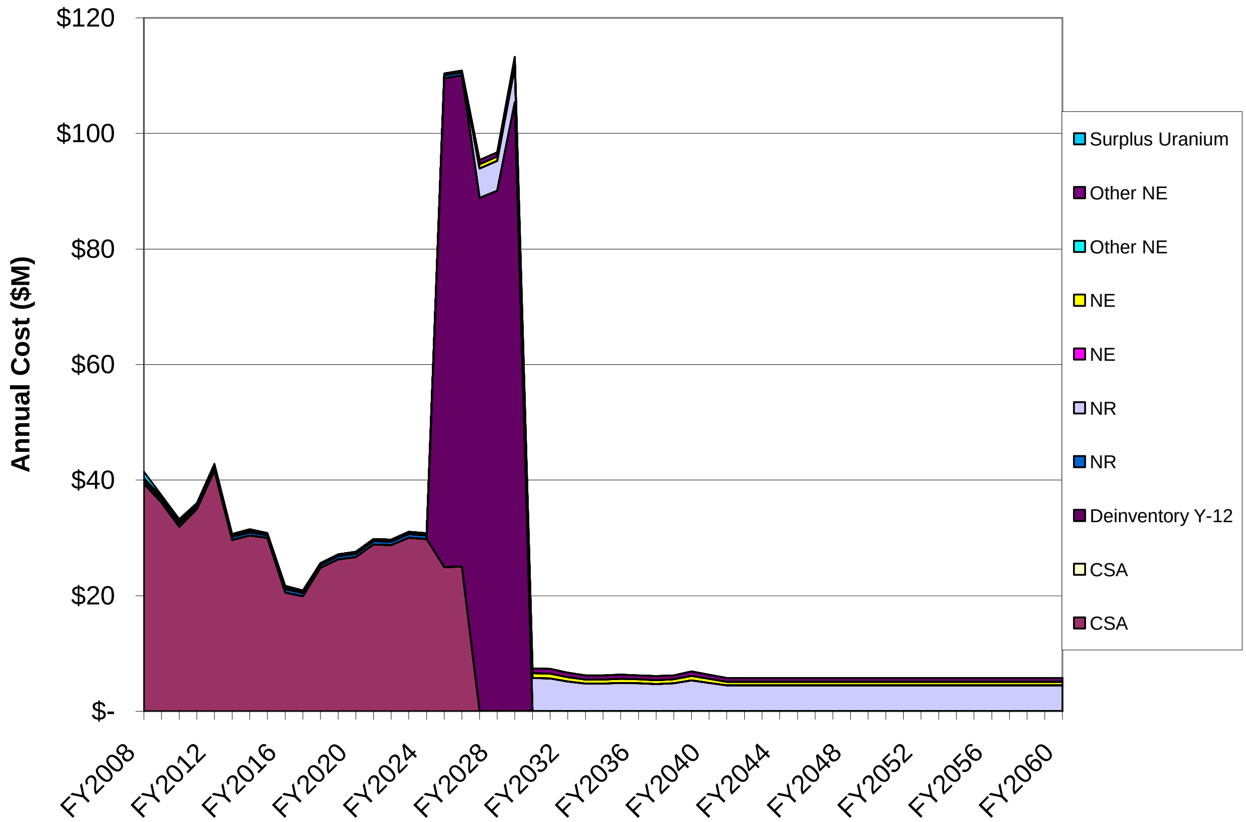


The transportation cost to transfer this inventory is reflected in the cost "bubble," shown in Figure 6-3, on top of the annual CSA transportation costs that are on-going between Y-12 and Pantex during the transition period. HEU production commences at SRS beginning in 2025, which is shown as an increase in CSA and other HEU transportation costs relative to the Y-12 baseline beginning in 2025 (about $30 million–$35 million per year). This increase is due primarily to the differences in mileage between SRS and Y-12 relative to the product receiving sites.

6.4.2 Pantex

The proposed transition of HEU operations to Pantex (Case 4a) begins in 2025 with the transfer of HEU inventory from Y-12 over 5 years through 2029. Figure 6-4 shows a sharp increase in transportation costs over that period relative to the Y-12 case (2a).

Figure 6-4. HEU Transportation Costs (FY08 Dollars), Case 4a (Pantex)



The difference in the deinventory peak profile for Pantex relative to SRS is associated with the differences in mileage between Y-12 and those sites and in the time proposed for the transfer of material (5 or 8 years). The lower steady state cost post-2030 for the Pantex HEU site alternative relative to the base case (Y-12) and SRS alternatives is due to the elimination of CSA transportation. This difference is more readily discernible in Figure 6-1, which shows the combined transportation cost profiles for all three alternatives.

For Pantex Case 4b, the team chose not to rerun the TRIPS model with the new schedule profile. The costs are the same, only the timing would change—closer to the SRS timing. The team concluded that the difference was small and would not affect the results.

6.5 CONCLUSIONS

The costs of HEU transportation for the site alternatives during the transition period significantly differ, primarily due to the transfer of the considerable Y-12 HEU inventory, including the strategic reserve and future allocations of national security program material. The post-2030 transportation costs for steady state operations also differ, as illustrated in Figure 6-1. OST has sufficient transport capacity to support any of the HEU cases.

Moving the stored HEU inventory from Y-12 to Pantex costs about $450 million and to SRS, about $145 million. Steady state HEU operations at Y-12 require about $30 million annually for transportation until about 2030, when the cost decreases to about $10 million annually as the complex completes the major dismantlement effort. If HEU operations move to Pantex, the majority of the steady state HEU transportation costs, those associated with CSA movement, are eliminated completely.

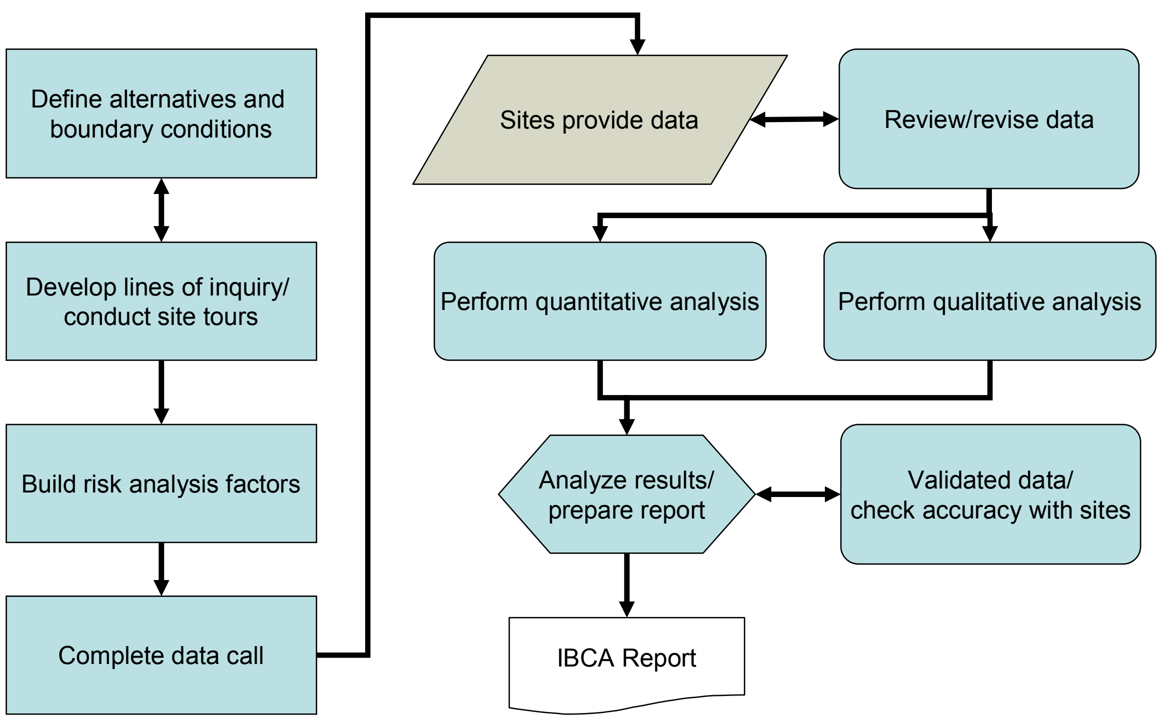
Chapter 7
Analytical Modeling Approach and Cost Analysis

The team analyzed costs for the five cases described in Chapter 5, labeled "base cases," and for a set of alternative scenarios. The team also performed sensitivity analyses. This chapter discusses the overall approach to the cost analysis and the specific method for the construction and operating cost models. The team developed these models using available data from the three sites; from similar projects that have been completed or have, when possible, completed the Critical Decision (CD)-2 (completion of preliminary design) level of definition and using the expert judgment of team members.

7.1 ANALYTICAL MODELING APPROACH

Figure 7-1 illustrates the technical approach used in developing the business cases.

Figure 7-1. Technical Approach



In the following sections, the team presents its approach for analyzing the costs, including the generic factors used in the analysis.

Given the uncertainty of nearly all costs, especially those for construction and D&D, the team incorporated probabilistic risk analysis techniques in the model. It did so to develop more realistic cost estimates and more insightful assessments of the relative rankings. This method is consistent with Office of Management and Budget (OMB) Circular A-94 guidelines for cost-benefit and cost-effectiveness analyses of federal programs.[1]

7.1.1 Guiding Principles

The cost analysis is premised on the following guiding principles:

- *Develop the alternatives*. The ultimate choice (decision) will be among alternatives. Thus, the alternatives must be identified and then defined for subsequent analysis.
- *Focus on the differences*. Only the differences in expected future outcomes among the alternatives are relevant to their comparison and should be considered in the decision. Thus, expected outcomes (whether benefits or costs) that would be (essentially) the same in all alternatives may be ignored in the analysis.
- *Use a consistent viewpoint*. The prospective outcomes of the alternatives, economic or other, should be consistently developed from a defined viewpoint (perspective).
- *Use a common unit of measurement, such as dollars*. Using a common unit of measurement to enumerate as many of the prospective outcomes as possible will simplify the analysis of the alternatives.
- *Consider all relevant criteria*. Selection of a preferred alternative requires the use of a criterion (or several criteria).
- *Make uncertainty explicit*. Uncertainty is inherent in projecting (or estimating) the future outcomes of the alternatives and should be recognized in their analysis and comparison.[2]

7.1.2 General Approach

The general approach to collecting and developing the data comprises a three-step process:

1. Develop a cost matrix that includes all the relevant business elements of the HEU enterprise.

[1] OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, October 29, 1992, www.whitehouse.gov/omb/circulars/a094/a094.html.

[2] These principles are discussed in greater depth by William G. Sullivan in his textbook, *Engineering Economy*, 13th ed. (Upper Saddle River, NJ: Pearson Prentice Hall, 2006), pp. 5–19.

2. Collect cost and descriptive data from the sites.

3. Prepare the data for input to a cost-estimating model and analyze the output.

The team developed a data call (Appendix B) to collect discrete information on a wide range of cost categories from Y-12, SRS, and Pantex. The team evaluated the data received and worked with the sites to complete the data call.

The analysis initially concentrated on estimating the stream of annual costs of each case. Because of the uncertainty associated with these future costs, the estimates were developed primarily as probability distributions—or uncertainty distributions. Each uncertainty distribution describes the range of values within which the cost parameter lies, as well as the level of confidence that the parameter will be any particular value. For each alternative's set of annual cash flows, the team determined a single measure of equivalent worth. The measures of equivalent worth (synonymous with present worth costs or present value costs) were then compared to determine each case's relative ranking with respect to costs. Net present value (NPV) is the probabilistic sum of the present values and will be use to compare alternatives (see Subsection 7.1.2.4).

7.1.2.1 Cost Categories

Before developing the cost estimates, the team determined categories of costs that needed to be estimated. For each case, it identified 11 broad cost categories that usefully capture the breadth of relevant costs that would likely be incurred at some point over the two analysis periods. These categories reflect the major activities envisioned in each case:

- *Construction*. This category comprises the costs for new construction of uranium operations and support facilities. The team relied more heavily on inputs for the design, construction, and operating costs for the specific facilities under consideration, rather than developing generic cost algorithms as was done in Phase I. The team reviewed all the cost inputs and made adjustments as needed. In some cases, it developed its own parametric estimates.

- *Modifications.* This category comprises the costs for modifying existing or planned facilities to support the uranium mission.

- *Capital renewal*. This category comprises the costs for major refurbishment of facilities needed during the life of the facility.

- *Direct production operations (labor).* This category comprises the costs for uranium mission operations, production support, and waste management.

- *Direct support material (nonlabor).* This category comprises the costs for materials necessary for production operations.

- *Indirect cost.* This category comprises the costs not directly chargeable to the production mission.

- *Security operations.* This category comprises the costs for securing the SNM and related operations.

- *Other site contractor.* This category comprises the costs attributed to the site contractor not included in the above categories.

- *Other site DOE.* This category comprises the costs for the DOE/NNSA site program office and any other DOE/NNSA costs related to the uranium mission.

- *Transportation.* This category comprises the costs to transport uranium mission components to and from the uranium operating site, including the costs to deinventory the current uranium storage facility should the mission be moved from its current location.

- *D&D and ER.* This category comprises the costs to deactivate, decontaminate, decommission, and demolish, and perform ER to clean the site to restricted release standards. These costs are directly related to the uranium mission or changes to uranium mission location. ER costs are included in the analysis when the site (Y-12) is to be closed and not included when the site continues to be used for operations.

7.1.2.2 COST ESTIMATES AND MODEL

The responses to the data call formed the initial basis for the cost estimates. Also, the team spoke at length with representatives from each site to arrive at appropriate data for input to the cost model.

On the basis of a thorough review, the team converted the data into cost estimates using discrete rules or assumptions for each site. For example, the team at times changed the input from the site to reflect the team's judgment. This was the case for some of the facilities where the team believed the input was either too optimistic or pessimistic and construction durations were adjusted (see Appendix C for a discussion of the construction costs and assumptions). Team judgment and experience, written information from the sites, observations during the sites visits, and discussions with site personnel were used to make such decisions.

The team rounded out the estimates by applying relevant parametric cost factors and its expert judgment. The primary sources of the parametric cost factors for construction and maintenance and repair costs are as follows:

- *RSMeans Building Construction Cost Data 2007*, 65th edition

- *The Whitestone Building Maintenance and Repair Cost Reference 2006–2007*
- DOE Facilities Information Management System (FIMS)
- DOE construction projects
- LMI's in-house database of construction and maintenance costs of recent projects and operations in the following federal agencies: DOE (including NNSA), DoD, and the General Services Administration.

The estimates for future costs include projected inflation. For operating costs, the team modeled inflation at a mean rate of 3.43 percent, with a standard deviation of 0.3 percent. The team derived this distribution from quarterly rates of change over the past 40 years, as measured in terms of the gross domestic product implicit price deflator.[3]

For construction costs, the team modeled inflation at a mean rate of 3.85 percent, with a standard deviation of 0.5 percent. The team derived this distribution from annual rates of change over the past 30 years, as measured in terms of a construction cost index (derived from specific construction-related categories of the producer price index).[4]

The team modeled the estimates as uncertainty distributions, rather than point estimates, in spreadsheet cost risk models. Appendix D lists these distributions. These spreadsheet "pro forma" cash flow models represent the expected flow of economic consequences of each case over time within each of the broad cost categories described above. Point values described in this chapter are the input or most likely values for the cost analysis.

To define the uncertainty about the modeled cost estimates, the team typically developed nonparametric distributions from expert opinions about the distribution parameters. For example, when the team developed estimates using (nonparametric) Program Evaluation and Review Technique (PERT) distributions, it used expert opinion and benchmarks to determine the *optimistic*, *most likely*, and *pessimistic* costs.[5]

The team accounted for this uncertainty in each of the cost categories outlined in 7.1.2.1. Furthermore, the team, when appropriate, adjusted the uncertainty in the cost categories in relation to each alternative. For example, the uncertainty assigned to the PIDAS security (construction) cost category is greater at Pantex than at SRS or Y-12, whereas the uncertainty assigned to the transportation cost category is constant across all alternatives.

[3] Source data obtained from Bureau of Economic Analysis, www.bea.gov.

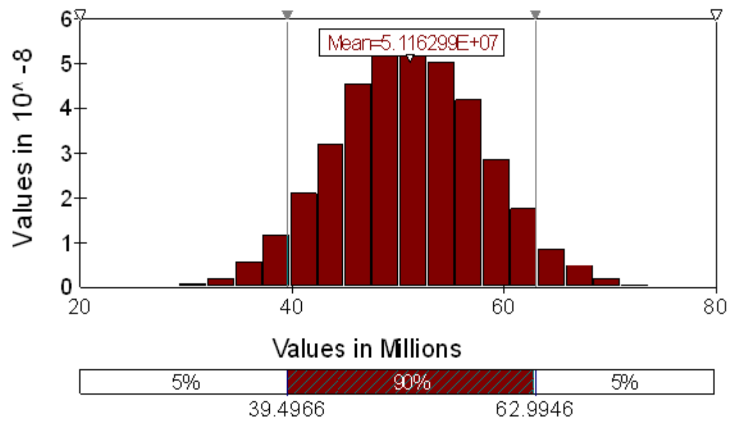
[4] Source data obtained from the industry journal, *Engineering News-Record*, www.enr.com.

[5] In a PERT distribution, "pessimistic" equates to the upper-bound parameter, "most likely" equates to the mode parameter, and "optimistic" equates to the lower-bound parameter.

7.1.2.3 DISCOUNTED CASH FLOW ANALYSIS

Once all the estimated cost distributions were modeled for each cost category, the team applied a Monte Carlo simulation to statistically sum the distributions in each year and calculate total annual costs for each alternative. Applying Monte Carlo simulation again, the team calculated the present worth of each alternative's stream of total annual cash flows. The present worth value was arrived at by discounting each year's total annual cash flow in current year dollars by the OMB Circular A-94 prescribed nominal discount rate of 4.90 percent per year and then summing those discounted annual cash flows (NPV). All present worth values are expressed in terms of 2008 dollars. The pro forma cash flow models and the results of the discounted cash flow analyses are presented in terms of distributions as depicted in the illustrative present worth cost distribution (Figure 7-2).

Figure 7-2. Present Worth Cost Distribution of Illustrative Alternative



Appendix D contains the actual estimated distributions and all relevant associated statistics of each alternative.

7.1.2.4 RANKING OF CASES

The final step in the general approach is to determine the relative ranking of the cases, with respect to the mean values of the present worth (NPV) cost distributions. The cases' relative rankings, from least to highest cost, were then presented. To both understand and evaluate the relative risk or uncertainty in the cost estimate for each case, each cost at the 5th and 95th percentiles is shown, representing the range of costs "in the middle 90 percent" of likely occurrence (excluding the least likely 5 percent tails at the low and high ends of the cost ranges). These 90 percent cost ranges can have smaller or larger differences in costs between the two end points from one case to another. These differences are proportional to the amount of cost risk or uncertainty from one alternative to another.

7.1.2.5 CASH FLOW ANALYSIS FOR BUDGETARY PURPOSES

In each year of each case, the team applied Monte Carlo simulation to the total cost of that case, resulting in a range of possible outcomes for each year. This range represents the multitude of possibilities for funding required to execute each case. To display the budget requirements relative to one another, the team plotted them at the 80 percent probability interval. This means there is an 80 percent probability that the amount, in that year, will not exceed the amount plotted on the chart. Stated differently, the charts represent the expected cost of each of the alternative if they were to be funded at the 80 percent probability level. This cash flow analysis was conducted for the bases cases as well as the alternative scenario and sensitivity analyses.

7.1.2.6 STAFFING REQUIREMENTS (FULL-TIME EQUIVALENTS)

The team also modeled the full-time equivalent (FTE) staffing required for each of the cases analyzed, showing the changes in staffing through 2060. This approach allowed the team to highlight similarities and differences among the sites and cases. The FTE data were used as input for many of the operating cost calculations. In a few other parts of the analysis, the FTE data were derived from the cost estimates.

7.2 COST ANALYSIS

This section discusses the specific methods used to develop the costs for new construction and operations. The team prepared a survey and collected data on many projects to use as benchmarks for the cost analysis. This section summarizes our approach. Subsection 7.2.1 describes Y-12 costs, Subsection 7.2.2 describes SRS costs, and Subsection 7.2.3 describes Pantex costs. Appendix C details the team's approach and results for construction cost and schedule. All costs, unless otherwise stated, are the input (expected or most likely) values to the analysis and are expressed in FY08 dollars. All input data were assigned a cost range category as discussed in Section 7.1.

7.2.1 Y-12 Cost Analysis

The team evaluated two basic Y-12 situations (subsection numbers are in parentheses):

- Y-12 continues operating either without new construction (7.2.1.1) or with new construction (7.2.1.2).
- The Y-12 mission is moved to another site (7.2.1.3).

7.2.1.1 CONTINUED Y-12 OPERATION—REFURBISHMENT AND NO NEW CONSTRUCTION (CASE 1A)

In this case, no new facilities are planned and the existing facilities are refurbished as needed to continue operation. Table 7-1 shows the planned refurbishment activities and costs in 2008 dollars.

Table 7-1. Y-12 Refurbishment Activities—No Major New Construction

Item	Cost[a] ($ million)	Notes
DBT, PIDAS, and security upgrades	73.4	Current projects
Facility infrastructure revitalization program	271.4	Same as above
Beryllium capability improvement	21.6	Same as above
Complex Command Center (CCC)	18.4	Planned FY11
Steam plant life extension	46.8	Planned FY08
Potable water upgrades	54.2	Current
HEU production facilities upgrades[b]	2,700.0	Start FY10
Non-HEU production facilities upgrades	1,700.0	Start FY20
Balance of plant upgrades	517.0	Start FY20
Total	5,402.6	—

DBT = design basis threat.
[a] Costs shown in FY08 dollars.
[b] Source: BWXT Y-12 input referencing *Life-Cycle Cost Analysis for Uranium Processing Facility (U)*, May 2007 (AR-PJ-801768, Rev. 1).

In this case, HEUMF is completed on the current schedule, but UPF is cancelled, and the only expenditures for UPF are those planned for FY08 plus nominal close-down costs of $5 million in FY09. Section 3.2 describes these costs.

Operating, indirect, security, and related costs for this alternative are essentially the current costs extended, adjusting for HEUMF operations starting in FY10. Section 3.1 describes the current Y-12 operating costs, capital renewal costs for HEUMF, and the existing Y-12 waste treatment.

7.2.1.2 CONTINUED Y-12 OPERATION—NEW CONSTRUCTION (CASE 2A)

In this case, the currently planned Y-12 projects are continued along with future projects needed to maintain uranium mission capability at Y-12.

7.2.1.2.1 Construction

This subsection describes the new construction costs used in the cost model for HEU processing and storage facilities, non-HEU manufacturing facilities, and infrastructure/support facilities, assuming continued Y-12 operations.

7.2.1.2.1.1 HEUMF

HEUMF is currently in the late-construction and early-start-up phases at Y-12. Physical construction is scheduled for completion in 2008, and CD-4 (turnover to operations) is scheduled 18 months later. Actual costs are available for a significant portion of the design and construction of this facility. The team's estimate for the TPC is based on a combination of

- ◆ actual costs-to-date,
- ◆ an updated estimate to complete prepared by Y-12 project personnel,
- ◆ a TechSource/LMI independent estimate to complete prepared in 2007, and
- ◆ the team's assessment of likely costs.

The team bracketed the costs for HEUMF at $538 million–$598 million, and, for purposes of the IBCA model, it used the current baseline total project cost estimate, $549 million, as the most likely value. For the analysis, current costs (FY08–10) are estimated at $259.1 million. The team modeled the estimate range using the uncertainty range in the analysis.

7.2.1.2.1.2 UPF

UPF is currently planned for Y-12, and preliminary design is underway as discussed in Section 4.2. The TPC is estimated at $2.2 billion for Y-12 in year-of-performance dollars (or $1.9 billion in FY08 dollars).

7.2.1.2.1.3 Non-HEU Manufacturing

Non-HEU manufacturing is currently performed in a number of buildings at Y-12. Sections 3.2.4 and 4.3 provide information on the current and future planned operations. Y-12 provided a preliminary, preconceptual estimate for a new 130,000-square-foot CMC facility of $1 billion.

The team's independent estimate for a new CMC at Y-12 is $437 million (FY08 dollars). This is based on a parametric estimate using cost-estimating relationships and certain benchmark data from DOE projects and input from Y-12 on the preconceptual design of a CMC facility. Appendix C contains further information on the team's analysis.

7.2.1.2.1.4 Infrastructure and Support Facilities

Y-12 has the necessary infrastructure and support facilities or is in the process of upgrading them to meet the requirements of the new facilities. The most extensive new support activity is the downsizing of the existing PIDAS once the new facilities (HEUMF and UPF) are operational. The PIDAS reduction project is currently estimated at $383 million (FY08 dollars).

7.2.1.2.2 Modifications

Table 7-2 shows the other planned modifications for the new construction at Y-12.

Table 7-2. Y-12 Modifications for Case 2a

Item	Cost ($ million)	Notes
DBT, PIDAS, and security upgrades	73.4	Current project
FIRP projects	271.4	Same as above
Be capability	21.6	Same as above
CCC	18.4	FY11 project
Steam plant life extension	46.8	Current project
Potable water upgrades	54.2	Same as above
Facility risk review	210.7	Completes in FY21
Security improvement project (SIP)	69.4	Ongoing project
Total	765.9	—

Note: FIRP includes estimated work for the HEU and non-HEU facilities needed for repair and maintenance to allow continued operations until replaced.

7.2.1.2.3 Capital Renewal

Existing and new facilities must be overhauled periodically to ensure long-term operation. This effort is in addition to ongoing maintenance and repairs. These overhauls include replacement of roofing materials and renewal of ventilation and electrical equipment. The team estimated these renewal costs at 20 percent of the new-construction TPC or existing facility replacement cost. The team assumed this would occur 25 years from the start of operations and the costs would be spread over 5 years. This approach is consistent with that used for other DOE and commercial facilities. Table 7-3 shows the capital renewal costs for Y-12.

Table 7-3. Y-12 Capital Renewal

Facility	Cost[a] ($ million)	Fiscal year initiated
HEUMF	109.8	2036
Waste treatment[b]	18.0	2020
UPF	379.9	2044
CMC	87.5	2044
Total	595.2	—

[a] FY08 dollars.

[b] The existing waste treatment facility requires renovation to extend its useful life.

7.2.1.2.4 Operations

Direct production operations—including HEU operations and support, non-HEU operations and support, waste management, direct support materials, materials management, and other production support—continue at about the same level as current operations until transition to the new facilities. Staffing and related costs increase in FY15–18 due to parallel activities in the old and new facilities and then decrease to a new steady state.

Table 7-4 shows the Y-12 annual costs by category pre-transition, during transition and post-transition for the years noted in the table. The year listed for transition is nominally the peak cost year. The year noted for post-transition is the year the costs reach essentially a steady state value as they are reduced during the phase-in activities. For Y-12, transition into the new facilities is expected to be completed by the end of FY22.

Table 7-4. Y-12 Annual Direct Operating Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY19)	Post-transition (FY27)
HEU operations	39.2	56.5	23.2
HEU support	45.8	62.4	22.5
Non-HEU operations	26.4	31.7	17.7
Non-HEU support	17.6	15.5	7.3
Waste management operations	22.9	23.4	23.4
HEUMF operations[a]	4.3	5.1	3.1
HEUMF support[a]	6.0	6.9	4.3
Materials management and local transportation	12.1	12.1	7.1
Other production support	36.1	36.1	14.8
Subtotal—labor	210.4	249.7	123.4
Direct support materials	164.7	164.7	153.5
Total	375.1	414.4	276.9

[a] HEUMF transition occurs in FY09–10.

The direct costs are essentially the same as those provided by the Y-12 site staff, adjusted as needed for any changes in operations or transition dates made by the team.

7.2.1.2.5 Indirect Costs

Indirect costs include the following:

- Compensation for legacy workers medical costs
- Computing operations
- Utilities
- Infrastructure support, including
  - building maintenance,
  - vehicle maintenance,
  - GSA lease,
  - heavy equipment,
  - local transportation,
  - laundry,
  - space management,
  - building services, and
  - building management.
- Environment, safety, and health (ES&H)
- Management and administration (M&A)
- Fee for site operating contractor
- Plant discretionary research and development (PDRD)
- Adjustment for indirect costs applied to line-item construction costs.

Table 7-5 shows the Y-12 indirect costs broken down by phase, similar to the previous operating cost phases.

Table 7-5. Y-12 Annual Indirect Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY19)	Post-transition (FY27)
Compensation for legacy workers	47.9	63.4	99.5
Computing operations	30.9	31.0	30.0

Table 7-5. Y-12 Annual Indirect Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY19)	Post-transition (FY27)
Utilities	49.5	55.9	49.8
Infrastructure support	53.6	55.4	47.9
ES&H	36.7	31.9	26.3
M&A	55.7	48.5	19.6
Fee	51.7	46.9	31.3
PDRD	11.7	10.7	7.1
Adjustment for indirect costs applied to line-item construction costs	–31.1	−1.1	0
Total	306.6	342.6	311.5

The indirect costs the team used were essentially the same as provided by the Y-12 site staff, except the team adjusted the legacy medical costs to account for the smaller staff during the transition and subsequent operations of the smaller, newer, facilities. For purposes of the analysis, this adjustment occurs with a 20-year delay time. Most of the indirect costs are ratios to the other cost elements; therefore, where the construction or operation costs or the timing were adjusted, the analytical model also adjusted the indirect costs proportionally.

7.2.1.2.6 Security

Security costs include costs for the HEU operations security guard force, physical security systems, information security, personnel security, material accountability, and security management and support services. Table 7-6 shows the costs broken down into phases similar to the above categories.

Table 7-6. Y-12 Annual Security Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY19)	Post-transition (FY27)
HEU operations security guard force	93.0	105.0	60.0
Physical security systems	8.1	8.1	8.1
Information security	3.0	3.0	3.0
Personnel security	1.9	1.9	1.9
Material accountability	7.0	7.0	3.5
Security management and support services	4.7	4.7	4.7
Total	117.6	129.7	81.2

For the security costs, the team used the inputs provided by the site and adjusted the timing, as necessary, to conform to the team's construction and transition schedule.

7.2.1.2.7 D&D

The only D&D costs assumed are for the current HEU and non-HEU manufacturing facilities after transfer of the operations into UPF and CMC. The costs are for removal of the SNM materials and dismantlement of the old buildings to grade with no environmental remediation. These minimal decommissioning activities will remove the security requirements and eliminate any safety issues for these old buildings such that the PIDAS or limited area can be reduced to include only the new facilities. The estimate for this minimal effort, estimated over 12 years starting in FY27, is $600 million (FY08 dollars).

D&D costs currently underway or planned in the Integrated Facilities Disposition Project (IFDP) by DOE EM are not included in the analysis. Although these activities are necessary, the same values would be included in all cases and the decision on site location does not affect the IFDP. Likewise, the ultimate decommissioning of the Y-12 site, should the mission remain at Y-12 (Cases 1a and 2a), is not part of the current economic analysis and decision horizon.

7.2.1.2.8 OTHER COSTS (CONTRACTOR and DOE)

No other site contractor costs were identified. DOE (NNSA Y-12 Site Office) costs of $14.2 million (FY08 dollars) were provided by the site office and used by the team for the analysis. These costs were kept constant for the duration of the study period.

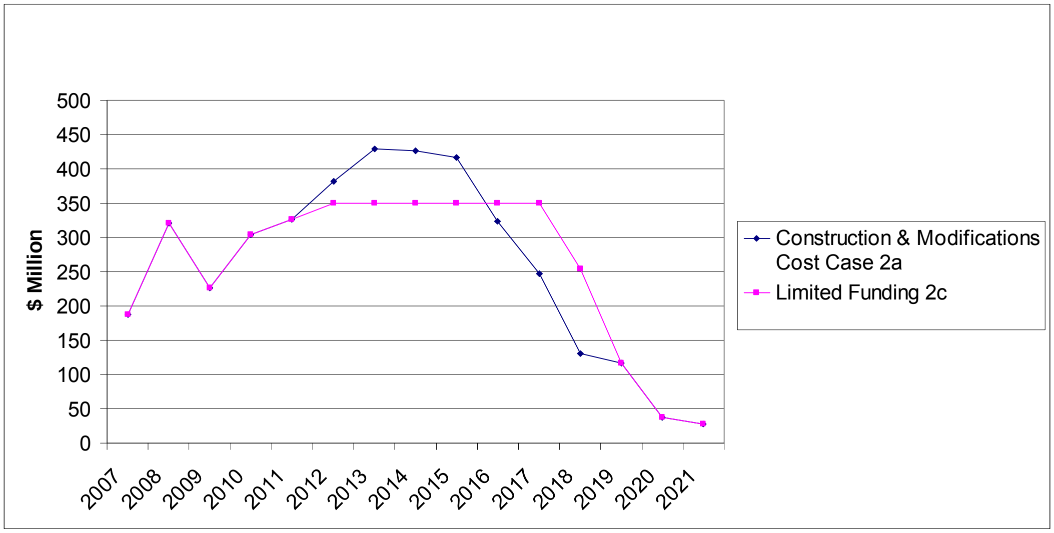
7.2.1.2.9 Transportation Operations

Chapter 6 discusses transportation operations and costs.

7.2.1.2.10 Y-12 Constrained Construction Alternative Scenario (Case 2c)

The team analyzed an alternative scenario where the annual construction and modification costs were arbitrarily limited to $350 million (FY08 dollars), Case 2c. This arbitrary limit was roughly equivalent to the planned expenditures for construction and modifications in FY08 of $320 million. The effect of this constraint is to require replanning of the construction schedule for UPF and the CMC. Figure 7-3 shows that in the baseline scenario, the construction and modifications costs exceed this limit in FY11–15. Reducing the costs requires revising the construction schedule and causes a 1-year delay in the overall transition. However, Y-12 Case 2a has enough time that this delay would not impact the transition for full production of RRW-3 in UPF.

Figure 7-3. Constrained Funding for Y-12, Case 2c (FY08 Dollars)



Operating and indirect costs are adjusted to match the change in the construction completion and transition dates. The team decided not to adjust the actual construction cost because the difference of a 1-year delay is estimated at only about 2 to 3 percent. The cost uncertainty range is adequate to account for this additional cost due to the delay in project completion.

7.2.1.3 Y-12 Costs if Uranium Mission Operations Move to Another Site (Cases 3a, 4a, and 4b)

If the uranium mission is transferred to another site, Y-12 must continue in operation using existing facilities until the mission transfer is complete and the new operations are certified. For the purposes of this IBCA, the team assumes the Y-12 site is shutdown, decommissioned, environmentally restored, and closed. D&D and ER are discussed later in this section. These discussions are applicable to Cases 3a, 4a, and 4b.

7.2.1.3.1 Construction

Construction is limited to that required to complete current building or necessary work to keep existing facilities operational until work transfers. HEUMF would be completed and placed into operation. The UPF design effort would continue until CD-2 (estimated for August 2010) and then transfer to the new site. CD-2 (completion of preliminary design) is mostly the process and building design requirements providing the basis for detailed design. It would need adaptation to the new site. The new site would need to obtain funding and conceptual design approval prior to starting the preliminary design and could adapt most of the work done by the Y-12 design team to the new site. The total cost estimated for construction at Y-12 for these cases is $424 million (FY08 dollars).

7.2.1.3.2 Modifications

Modifications are limited to those already underway or required for continued operations, including an estimated cost for continuing operations in the existing HEU and non-HEU manufacturing buildings until mission transition to the new site is complete and product is certified. The team assumed that the major renovation costs to bring the existing buildings up to current standards would not be required. Phaseout of the existing buildings is estimated in FY23–27, depending on the case assumptions. Total cost for Y-12 modifications in these cases is $621 million (FY08 dollars).

7.2.1.3.3 Operations

Y-12 would continue operations in the existing HEU and non-HEU manufacturing buildings until mission transition to the new site is complete and product is certified. Operating costs include labor and direct support materials and are similar to those identified for pretransition in Subsection 7.2.1.2.4. Included in operations for this case is the transfer of all SNM stored in HEUMF to the new site storage facility.

7.2.1.3.4 Post-Transition Operations

After Y-12 transfers the mission to the new site, the Y-12 facilities are cleaned up and shut down. Initial clean-up involves removal of SNM from all process areas, including that held in equipment, piping, and ducts. Operations and support staffing will gradually decrease over the 6 years estimated to complete the cleanout, shutdown, and turnover to DOE EM for decommissioning and environmental restoration, as described in Subsection 7.2.1.2.7. The team used the input provided by the Y-12 site staff for these costs, adjusting for timing as needed for the individual cases.

7.2.1.3.5 Indirect Costs

For the indirect costs, the team used the input provided by the Y-12 site staff, adjusting proportionally for any changes in the other cost categories. Indirect costs pretransition are similar to those in Subsection 7.2.1.2.5. After transition to the new site, indirect costs are included in the direct costs for post-transition operations using the appropriate indirect cost ratio.

7.2.1.3.6 Security

Security costs are consistent with the pretransition costs provided in Subsection 7.2.1.2.6. After transition, security costs decrease as staffing is reduced and SNM materials are removed, eliminating the requirements for an SNM security posture. Security during decommissioning is limited to that required for a DOE industrial site. Upon completion of the decommissioning, security staffing is no longer required.

7.2.1.3.7 Other Costs (Contractor and DOE)

The team identified no other Y-12 site contractor site costs. DOE (site office) costs are similar to the pretransition costs provided in Subsection 7.2.1.2.8. After transition, the site office or EM office costs decrease on the basis of the level of activity.

7.2.1.3.8 Transportation

Chapter 6 describes transportation costs, which differ depending on which case (location) is chosen.

7.2.1.3.9 D&D and ER

The team determined that D&D and ER would be required should the Y-12 mission transfer to another site and Y-12 shut down. For the IBC, the team included only the D&D and ER required for the siting decision. Other D&D, not germane to the decision, including Y-12 IFDP, was not included. The team reviewed the Y-12 site-provided D&D and ER costs and considered them appropriate for this stage of analysis. Two sensitivity cases were run on the decommissioning costs as described in the next subsection.

7.2.1.3.10 Sensitivity Analyses for Site Surveillance and Maintenance Costs for No Decommissioning

The team evaluated the following sensitivities regarding site S&M costs when there is no decommissioning:

- Y-12-recommended S&M costs (1,000 FTEs long term)
- Reduced S&M costs (100 FTEs long term).

Site S&M is required if the buildings and contamination remain to ensure the safety of the workers and public. S&M includes the costs to survey the buildings periodically for integrity and radiation and chemical contamination and to maintain the buildings to prevent spread of contamination. S&M also includes an environmental sampling program and any preventive actions required to ensure public safety. These cases, along with the D&D and ER in the base case, bound the potential cost impacts. The base case with D&D and ER is the reasonable-cost impact scenario. The other sensitivity analyses bound the lower end of the cost impacts.

7.2.1.3.11 Case-Dependent Differences in Y-12 Costs

Each case has differences in the Y-12 costs, as described below.

7.2.1.3.11.1 SRS (Case 3a)

For SRS, the team identified changes in the Y-12 input costs due to a revised construction and transition schedule. Costs were redistributed accordingly. The team determined that transition can be completed by 2023, allowing SRS to transition to full production to support the nominal 5a scenario. This case requires Y-12 existing facilities to remain fully functional until 2023.

7.2.1.3.11.2 Pantex (Cases 4a and 4b)

For Pantex, Case 4b (OP) has essentially the same impact on Y-12 as does Case 3a. The transition schedules and relative costs are the same. However, Case 4a (IP—compares with baseline IPT Case 4), has a 3½-year schedule delay on start-up and turnover (April 2027), which requires a split transition for RRW-3. Y-12 costs and schedules are adjusted to match these schedules.

7.2.2 Uranium Mission Moved to SRS (Case 3a)

In this subsection, the team presents a discussion and revision of costs required for the SRS cases. The team discusses changes to construction costs, including site-specific infrastructure. The team describes operating cost estimates and notes any site-specific differences. Costs are stated in FY08 dollars, unless otherwise stated.

7.2.2.1 CONSTRUCTION

SRS construction costs are discussed in the following subsections. Appendix C details the construction costs and assumption. Construction costs for SRS total $2.96 billion.

7.2.2.1.1 HEU Storage

The team evaluated the costs to construct and start up a HEU storage facility at another site. The facility is similar to HEUMF but should have fewer problems than those encountered at Y-12, which significantly added to the cost. Taking into account the known problems, delays, and rework at Y-12, and using best judgment, the team considers the most likely value for a 110,000-square-foot HEU storage facility at SRS is $440 million, the base cost (most likely value) with no site differentiator adjustments. The team does not see any significant site differentiators in the construction costs between SRS and Y-12.

7.2.2.1.2 HEU Processing

The cost estimate for UPF is essentially unchanged from the Phase 1 report. The current estimate (TPC of approximately $2.2 billion) is based largely on data received during Phase 1, and the team accepts the estimate as is for the cost model, including escalation at 3 percent per year. Deescalating the current estimate yields a constant dollar estimate (2008 dollars) of $1.9 billion. The team does not see any significant site differentiators in the UPF construction costs between SRS and Y-12; however, it did adjust the UPF estimate to remove the PIDAS costs ($18.4 million) included for Y-12. These costs are added in separately for SRS.

7.2.2.1.3 Non-HEU Manufacturing (CMC)

The team's independent estimate for a new CMC at SRS is $437.4 million for a 130,000-square-foot facility. This is based on a parametric estimate using cost estimating relationships and certain benchmark data from DOE projects. The team does not see any significant cost differentiators between construction at SRS and Y-12.

7.2.2.1.4 Infrastructure and Support Facilities

The Purification Facility is budgeted at $50 million for use in the cost model on the basis of actual costs incurred for a recent project at Y-12. A new four-sided PIDAS is assumed for this case. Revised input from the Y-12 site indicated a cost of about $10,200 per linear foot, compared with a previous estimate of $22,000 per linear foot. The latter cost is more consistent with costs identified at other sites, including Y-12 and Pantex, so the team decided to keep the original estimated cost. The difference is about $55 million, which is insignificant in the total multibillion construction cost estimate. A new security central alarm station was included in the costs ($7 million). Also, as discussed in Chapter 4, a new OST FAF is included ($25.6 million).

7.2.2.2 Modifications

The SRS staff provided a list of modifications deemed necessary for the new mission, with which the team concurred:

- Utilities ($11 million)
- Waste solidification building modifications ($50 million)
- Laboratories ($55.6 million).

7.2.2.3 Capital Renewal

Capital renewal is estimated using similar factors to those discussed in the Y-12 case (Subsection 7.2.1.2.3). Table 7-7 provides the costs for SRS.

Table 7-7. SRS Capital Renewal

Facility	Cost[a] ($ million)	Fiscal year initiated
HEU storage	88.0	2042
UPF	376.3	2045

Table 7-7. SRS Capital Renewal

Facility	Cost[a] ($ million)	Fiscal year initiated
CMC	87.5	2045
Purification facility	10.0	2045
Analytical laboratory[b]	85.6	2017
Engineering and administrative support building[b]	18.0	2043
Waste systems[b]	12.0	2021
Total	677.4	—

[a] FY08 dollars.
[b] These existing facilities require renovation to extend their useful life.

7.2.2.4 OPERATIONS

Table 7-8 shows the annual direct operations costs for SRS divided by phase.

Table 7-8. SRS Annual Direct Operating Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY20/21)	Post-transition (FY27)
HEU operations	Not used; see Y-12	28.8	38.1
HEU support	—	37.3	39.0
Non-HEU operations	—	25.7	25.7
Non-HEU support	—	10.7	10.7
Waste management operations[a]	—	2.4	2.4
Subtotal—Labor	—	104.9	115.9
Direct support materials[a]	—	150.5	150.5
Transition other direct costs	—	2.0	—
Total	—	257.4	266.4

[a] Waste management and direct support material costs start in 2021.

The SRS costs are based on staffing data provided by Y-12 and using SRS labor rates for the appropriate cost categories. Some support costs are accounted for differently at Y-12 and SRS. The team used the SRS data input, but adjusted for additional costs estimated for the timing of construction completion, approximately 1 year earlier than SRS estimated.

7.2.2.5 INDIRECT COSTS

Table 7-9 shows the indirect costs for SRS by phase.

Table 7-9. SRS Annual Indirect Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY20)	Post-transition (FY27)
Computing operations	See Y-12	9.7	9.7
Utilities	—	9.6	9.6
Infrastructure support	—	11.9	11.9
ES&H	—	10.7	10.7
M&A	—	16.6	12.9
Fee	—	12.0	12.0
Total	—	70.5	66.8

For SRS, the team adjusted the M&A costs from those provided by the site staff to account for additional support costs during construction.

7.2.2.6 SECURITY

Table 7-10 shows the SRS security costs by phase.

Table 7-10. SRS Annual Security Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY20)	Post-transition (FY27)
HEU operations security guard force	See Y-12	23.0	23.0
Material accountability	—	4.0	4.0
Security management and support services	—	10.0	10.0
Information security	—	3.0	3.0
Vulnerability assessments and security planning during design[a]	1.2	—	—
Total	1.2	40.0	40.0

[a] SRS costs during design for 2 years, FY09–10.

The SRS staff provided inputs for security costs, which the team accepted. The security costs are about half of the Y-12 costs or less for similar periods and show the savings possible when site security services are shared among other missions.

7.2.2.7 DECOMMISSIONING

SRS has no estimated decommissioning costs. All construction is planned to be on new site areas. Y-12 decommissioning is discussed in the Y-12 section above.

7.2.2.8 TRANSPORTATION

Chapter 6 describes transportation costs.

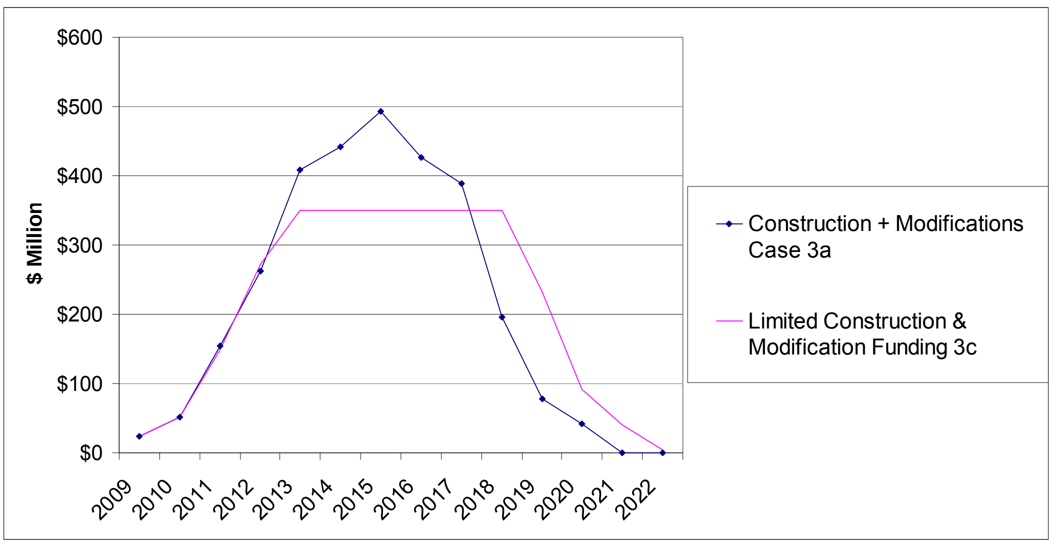
7.2.2.9 OTHER COSTS (CONTRACTOR AND DOE)

No other site contractor costs are estimated. Annual DOE (NNSA) site office costs are estimated at $5.4 million during transition and $4.8 during post-transition operation. These site office costs include only the additional costs due to moving the HEU mission to SRS. OST costs for relocation and training are estimated at $32 million total.

7.2.2.10 SRS CONSTRAINED FUNDING ALTERNATIVE SCENARIO (CASE 3C)

The team analyzed an alternative scenario where the construction and modification costs were arbitrarily limited to $350 million (FY08 dollars), Case 3c. This arbitrary limit was roughly equivalent to the planned Y-12 expenditures for construction and modifications in FY08 of $320 million. The effect of this constraint is to require replanning of the construction schedule for UPF and the CMC. Figure 7-4 shows that in the baseline scenario, and the construction and modifications costs exceed this limit in FY13–17. Reducing the costs requires revising the construction schedule and causes a 2-year delay in the overall transition. This would delay the transition for full production of RRW-3 or require Y-12 to remain open the additional 2 years. The team assumed that the RRW-3 manufacturing would be split between the two sites.

Figure 7-4. Constrained Funding for SRS, Case 3c (FY08 Dollars)



The team also constrained the funding for decommissioning Y-12 as part of this case. The constraint was set at $500 million in FY08 dollars. Implementing this limit adds 5 years to the decommissioning schedule, completing the work in 2043 versus 2038 in the baseline scenario, Case 3a.

7.2.3 Uranium Mission Moved to Pantex (Cases 4a and 4b)

In this section, the team presents a discussion and revision of costs required for the Pantex cases. The team discusses changes to construction costs, including site-specific infrastructure. The team presents operating cost estimates and notes any site-specific differences. Costs are in FY08 dollars, unless otherwise stated. For Pantex, the team evaluated two cases:

- *Case 4a*. Similar to the IPT Case 4, new HEU facilities (HEU storage and processing) are constructed inside the current Zone 12 PIDAS. To do so, some facilities located in the planned construction area would need to be relocated to a new facility, the non-destructive examination (NDE) and gas laboratory. Then, the existing facilities must be cleaned and demolished prior to construction of the new facilities. A cost premium is added for construction inside the Zone 12 PIDAS.

- *Case 4b*. New SNM facilities are constructed outside but adjacent to the Zone 12 PIDAS. (Appendix B2 of the IPT report briefly discusses this concept.) This alternative case allows construction to proceed earlier, and the PIDAS is later extended on three sides to accommodate the new facilities.

In either case, Pantex has experienced a construction labor shortage in the past, so the team assumed an additional cost (5 percent of TPC) to account for this shortage and the need to bring in construction labor from outside the area, with the associated additional cost. The construction inside the PIDAS has an approximate 10 percent of TPC premium due to the additional controls on moving materials and people into and out of the PIDAS, even with a separate fenced area set up for construction.

7.2.3.1 Construction

This subsection identifies any differences between Pantex and SRS. (Chapter 5 describes the construction schedule for these cases.)

7.2.3.1.1 HEU Storage

As discussed in the SRS section above, the team adjusted HEUMF costs downward to a starting point of $440 million, and this is the base cost before site differentiator adjustments. Site differentiators between Pantex and Y-12 include higher costs for (1) construction trades due to the need to bring in outside crews and (2) working inside the protected area. Our adjusted cost for an HEU storage facility at Pantex is $506 million for Case 4a (IP). For Case 4b (OP), only the labor shortage adjustment is added, and the TPC is $462 million.

7.2.3.1.2 HEU Processing

The HEU processing facility base cost is the same for all sites ($2.173 billion TPC, $1.9 billion in FY08 dollars). Site differentiators between Pantex and Y-12 include removal of the PIDAS costs that are included in the Y-12 cost ($18.3 million). The team made similar adjustments for site labor shortage and construction inside the PIDAS, as applicable. The resulting cost for Case 4a is $2.166 billion and for Case 4b is 1.977 billion, compared to the $1.9 billion baseline.

7.2.3.1.3 Non-HEU Manufacturing (CMC)

Our independent estimate for a new CMC at Pantex is $458.4 million for a 130,000-square-foot facility. Site differentiators between Pantex and Y-12 include higher costs for construction trades due to the need to bring in outside crews.

7.2.3.1.4 Infrastructure and Support Facilities

The Purification Facility is budgeted at $50 million for use in the cost model, same as that used for SRS.

For Case 4a, since the NDE/Gas Lab is required as part on the decision to construct the facilities inside the PIDAS, the cost for this facility is included in the case cost estimate. Other facilities required include waste processing, engineering support, warehouse, analytical laboratory, security facilities, demolition of existing buildings, and site access infrastructure. For Case 4b, building demolition (and the replacement NDE/Gas Lab) is not required, but additional PIDAS and 15th street relocation are added. Table 7-11 shows the construction projects and estimated costs by case.

Table 7-11. Pantex Construction Costs in FY08 Dollars

Facility	Case 4a ($ million)	Case 4b ($ million)
HEU storage	506.0	462.0
UPF	2,165.6	1,976.6
CMC	458.4	458.4
Purification	50.0	50.0
Waste treatment	46.2	46.2
Engineering support	22.0	22.0
Utilities building	11.0	11.0
Warehouse	33.0	33.0
Analytical laboratory	16.5	16.5
Security facilities	11.0	11.0
Site access infrastructure	66.0	66.0
NDE/gas lab	103.9	—

Table 7-11. Pantex Construction Costs in FY08 Dollars

Facility	Case 4a ($ million)	Case 4b ($ million)
Building demolition	15.7	—
PIDAS extension	—	50.0
15th Street relocation	—	3.0
Total	3,500.3	3,205.7

7.2.3.2 MODIFICATIONS

For Pantex, the only modifications required are to provide additional utilities—electricity and water—at an estimated cost of $50 million in FY08 dollars.

7.2.3.3 CAPITAL RENEWAL

Table 7-12 shows the Pantex capital renewal cost estimates for Cases 4a and 4b and the years initiated. The cost factors are the same as those used for the other sites.

Table 7-12. Pantex Capital Renewal in FY08 Dollars

	Case 4a		Case 4b	
Facility	Cost ($ million)	Fiscal year initiated	Cost ($ million)	Fiscal year initiated
HEU storage	101.2	2050	92.4	2044
UPF	433.1	2052	395.3	2048
CMC	91.7	2052	91.7	2047
Purification	10.0	2052	10.0	2047
Waste treatment	9.2	2045	9.2	2046
Engineering support	4.4	2042	4.4	2042
Utilities building	2.2	2045	2.2	2045
Warehouse	6.6	2044	6.6	2044
Analytical laboratory	3.3	2043	3.3	2043
Security facilities	2.2	2049	2.2	2043
Site access infrastructure	13.2	2042	13.2	2042
NDE/gas lab	20.8	2041	—	—
Total	697.9	—	630.5	—

7.2.3.4 OPERATIONS

Table 7-13 shows the direct operating costs by phase, which are the same for the two cases. The only difference is the timing of the transition and post-transition (as noted in the table). The operations staffing (FTEs) is the same as Y-12 and SRS. The cost difference among the three sites is due to site labor rates.

Table 7-13. Pantex Annual Direct Operating Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition	Transition[a]	Post-transition[b]
HEU operations	Not used; see Y-12	21.2	26.9
HEU support	See Y-12	26.2	27.5
Non-HEU operations	—	13.6	18.1
Non-HEU support	—	4.4	7.5
Waste management operations[a]	—	0.8	1.2
Subtotal labor	—	68.2	81.2
Direct support materials	—	150.5	150.5
Transition other direct costs	—	5.0	—
Total	—	223.7	231.7

[a] Transition cost date for Case 4a = FY24; Case 4b = FY21.

[b] Post-transition steady state date for Case 4a = FY31; Case 4b = FY27.

The team used the data provided by the Pantex staff for the operations costs, adjusting the timing as needed to match the team's construction and operations schedules, which differ from the Pantex IPT Case 4.

7.2.3.5 INDIRECT COSTS

Table 7-14 shows the indirect costs for Pantex by phase for Case 4a. During transition, the costs differ for each case because the indirect costs are based on a percentage of the other costs and the timing of costs differs for each case.

Table 7-14. Pantex Case 4a Annual Indirect Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY24)	Post-transition (FY31)
M&A	See Y-12	57.9	58.4
Common site support	—	49.1	48.7
Capital projects management staff (not included in capital project cost)	—	1.9	0.0
Total	—	108.9	107.1

For Pantex indirect costs, the team reviewed and accepted the costs provided by the site staff. Table 7-15 shows the indirect costs for Pantex by phase for Case 4b.

Table 7-15. Pantex Case 4b Annual Indirect Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY21)	Post-transition (FY27)
M&A	See Y-12	57.4	58.4
Common site support	—	48.5	48.7
Capital projects management staff (not included in capital project cost)	—	1.9	0
Total	—	107.8	107.1

7.2.3.6 Security

Table 7-16 shows the Pantex security costs by phase for Cases 4a and 4b.

Table 7-16. Pantex Annual Security Costs by Phase ($ million) in FY08 Dollars

Cost category	Pre-transition (FY08)	Transition (FY24/21)[a]	Post-transition (FY31/27)[a]
HEU operations security guard force	See Y-12	23.3	23.3
Material accountability	—	8.8	8.8
Other security support (nonlabor)	—	0.1	0.3
Total	—	32.2	32.4

[a] Dates are for Cases 4a/4b, respectively.

The Pantex staff provided inputs for security costs, which the team accepted. The security costs are about half of the Y-12 costs or less for similar periods and show the savings possible when site security services are shared among other missions.

7.2.3.7 Decommissioning

Pantex has demolition costs for buildings in the way of construction for Case 4a as discussed in the construction section above. For Case 4b, all construction is planned on new site areas. Y-12 decommissioning is discussed in the Y-12 section above.

7.2.3.8 Transportation

Chapter 6 describes transportation costs.

7.2.3.9 Other Costs (Contractor and DOE)

Other site contractor costs are estimated at $4.3 million per year for lease of a new administrative support building (alternative financing project). In addition, during the transition period, $1 million per year for a total of $16 million is added for a college and university endowment to provide assistance in recruiting and training the additional staff required to fulfill the new mission at Pantex. Annual DOE (NNSA) site office costs are estimated at $7.6 million during transition and $10 million during post-transition operations. These site office costs are limited to the additional costs for moving the HEU mission to Pantex.

7.2.3.10 PANTEX CONSTRAINED FUNDING ALTERNATIVE SCENARIOS (CASES 4A-C AND 4B-C)

The team analyzed an alternative scenario where the construction and modification costs were arbitrarily limited to $350 million (FY08 dollars) for both Pantex alternatives, labeled Cases 4a-c and 4b-c. This arbitrary limit is the same as was used for the other sites. The effect of this constraint is to require replanning of the construction schedule for HEU storage, UPF, and the CMC. Figure 7-5 shows that in the baseline scenario, the construction and modifications costs exceed this limit in FY17–22. Reducing the costs requires revising the construction schedule and causes a 3-year delay in the overall transition. This would delay the transition for full production of RRW-3 nominal scenario 5a schedule and require Y-12 to remain open the additional 3 years. The team assumed that the RRW-4 manufacturing would start at Pantex.

Figure 7-5. Pantex Constrained Construction, Case 4a-c (IP)

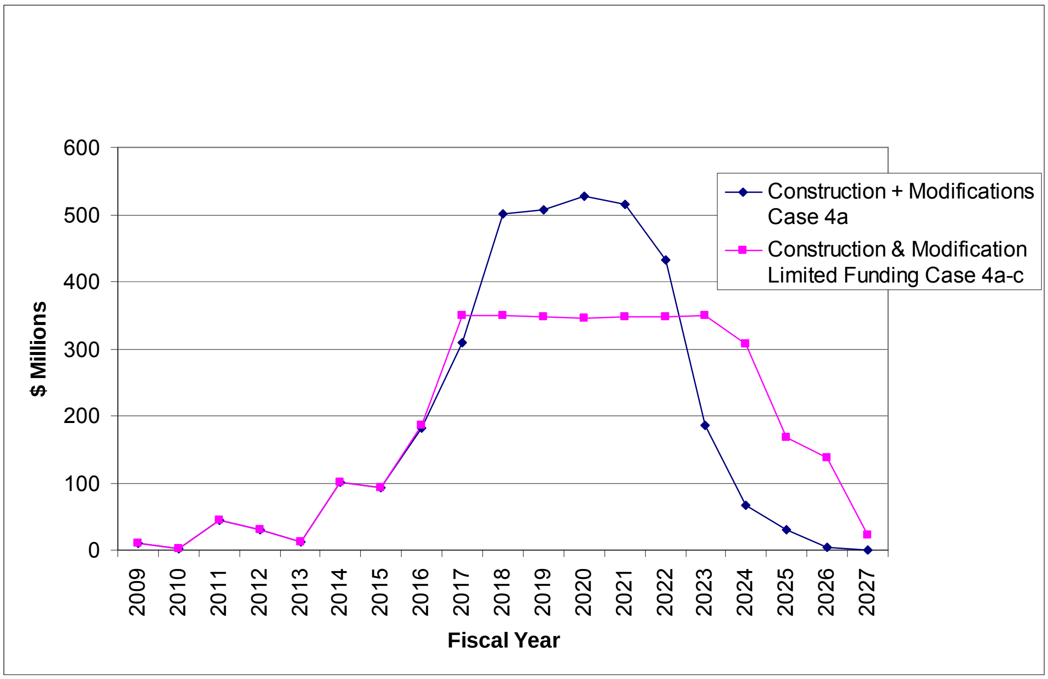
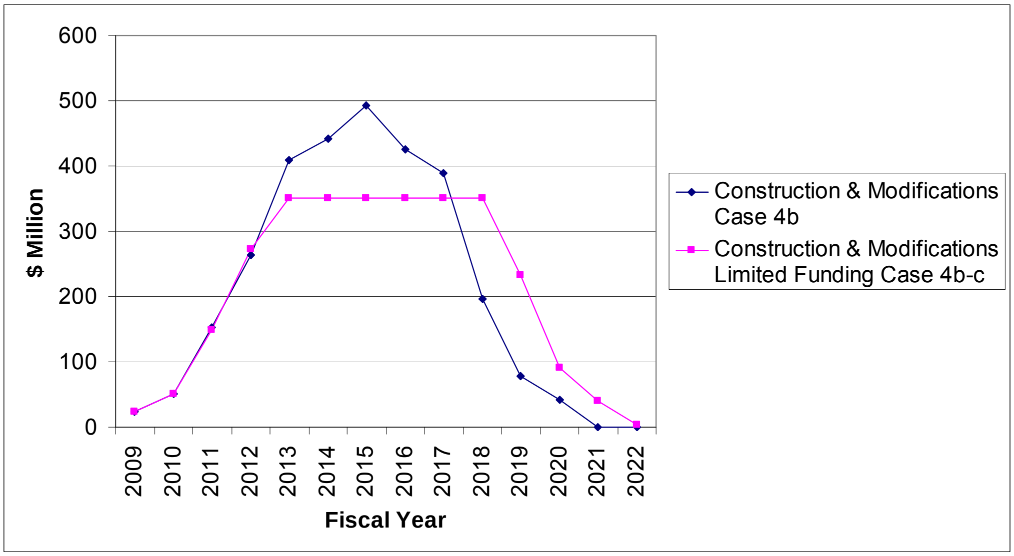


Figure 7-6 shows the effect of constrained funding for Case 4b-c (OP). The constraint affects the FY13–18 time frame and results in about a 2-year delay, causing the RRW-3 production to be split between Y-12 and Pantex for this case.

Figure 7-6. Pantex Constrained Construction, Case 4b-c (OP)



7.3 SUMMARY COST ANALYSIS

This section summarizes the cost inputs used for the analysis of cases. (Appendix D details these cost inputs.)

Table 7-17 summarizes the total cost and percentage of the total costs for the Y-12-only cases, 1a and 2a, for 2008–60. The costs for Case 2c are essentially the same in FY08 dollars; only the schedule changed resulting in escalated costs.

Table 7-17. Cost Summary, Y-12-Only Cases, 2008–60

Cost category	Total cost ($ billion)		Percentage of total cost	
	1a	2a	1a	2a
Construction	0.40	3.09	0.8	7.1
Modifications	5.33	0.62	10.2	1.4
Capital renewal	0.13	0.60	0.2	1.4
Direct operations	19.59	16.19	37.6	37.4
Indirect	18.74	15.56	36.0	35.9
Security operations	6.07	4.89	11.7	11.3
Other site	0.00	0.00	0.0	0.0
DOE site	0.79	0.75	1.5	1.7
Transportation	1.01	1.01	1.9	2.3
D&D	0.00	0.60	0.0	1.4
Total	52.06	43.31	100.0	100.0

Note: Total costs are sums of the most likely values.

Figure 7-7 shows the percentages for the cost categories for Cases 1a and 2a. These costs are dominated by operations, indirects, and security costs.

Figure 7-7. Cost Summary for Y-12 Cases 1a and 2a by Cost Category ($ billion)

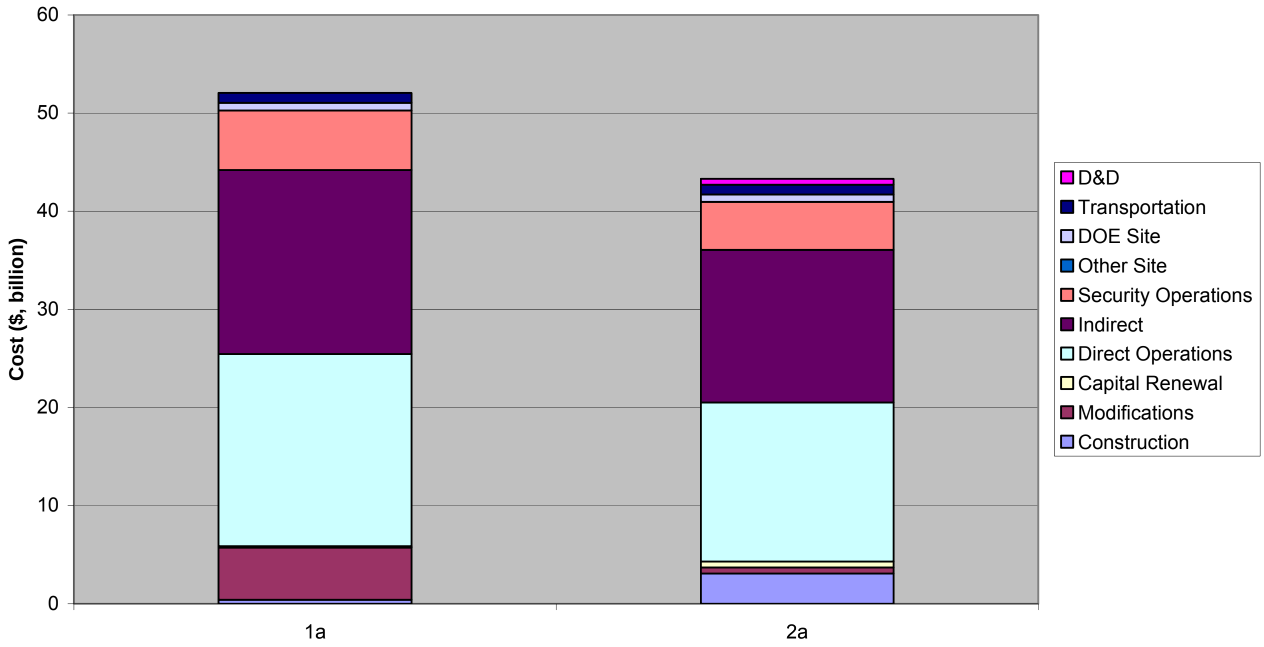


Table 7-18 summarizes the cost and percentage of the total cost for Y-12 and SRS portions and totals for Case 3a for 2008–60.

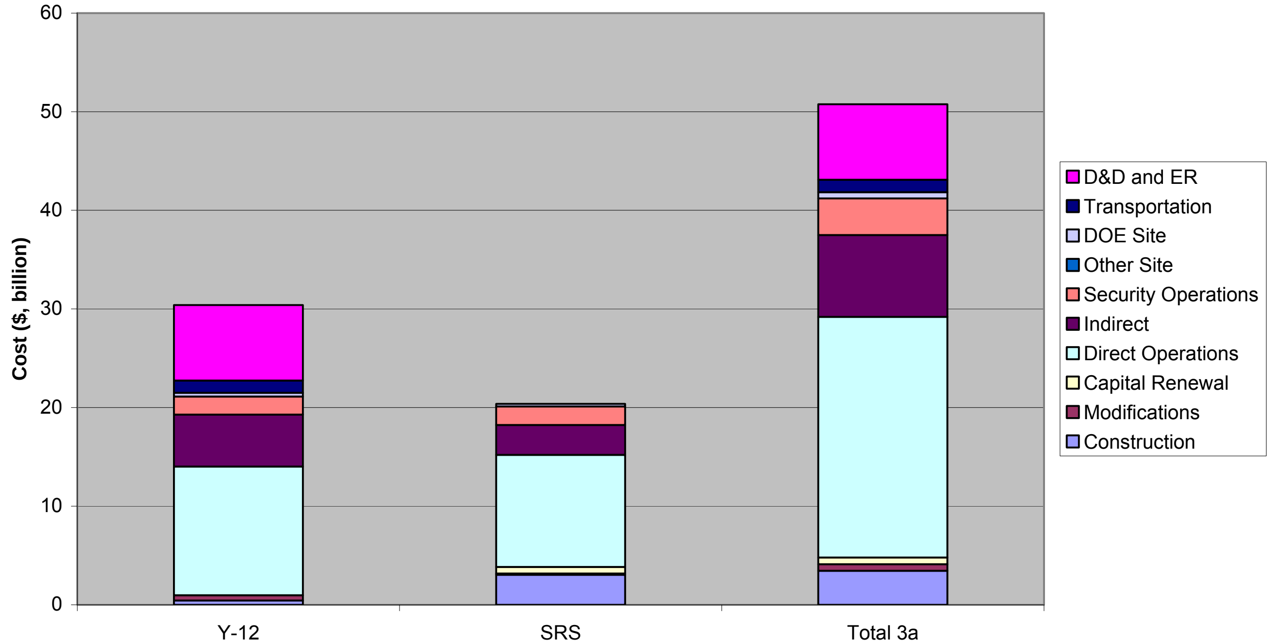
Table 7-18. Cost Summary SRS Case 3a, 2008–60

Cost category	Cost ($ billion)			Percentage of total cost		
	Y-12	SRS	Total 3a	Y-12	SRS	Total 3a
Construction	0.42	3.04	3.46	0.84	5.98	6.8
Modifications	0.55	0.12	0.66	1.08	0.23	1.3
Capital renewal	0.00	0.68	0.68	0.00	1.33	1.3
Direct operations	13.04	11.35	24.39	25.69	22.36	48.1
Indirect	5.28	3.03	8.30	10.40	5.96	16.4
Security operations	1.83	1.89	3.72	3.61	3.72	7.3
Other site	0.00	0.00	0.00	0.00	0.00	0.0
DOE site	0.36	0.27	0.63	0.70	0.54	1.2
Transportation	1.26	—	1.26	2.49	—	2.5
D&D and ER	7.65	0.00	7.65	15.07	0.00	15.1
Total	30.39	20.38	50.75	59.88	40.12	100.0

Note: Costs displayed are sums of the most likely values.

Figure 7-8 graphically displays the proportion of the costs for each cost category.

Figure 7-8. Summary by Cost Category for SRS Case 3a ($ billion)



The portion of the costs attributable to direct operations (labor plus materials) is a higher proportion of the costs than in the Y-12 cases. This is due to the reduced indirect and security costs, which result in larger proportion of operations costs. The actual operations costs are lower than those for Y-12, except for the need to overlap the HEU operations to ensure a certified operation at the new location before closing the exiting facilities. Y-12 operations and indirect costs are more than those for SRS, but they cover a shorter period, 2008–23 rather than 2021–60.

Table 7-19 summarizes the costs for a move to Pantex, Case 4a (IP).

Table 7-19. Cost Summary Pantex Case 4a (IP), 2008–60

Cost category	Cost ($ billion)			Percentage of total cost		
	Y-12	Pantex	Total 4a	Y-12	Pantex	Total 4a
Construction	0.42	3.56	3.99	0.80	6.70	7.5
Modifications	0.59	0.05	0.64	1.11	0.09	1.2
Capital renewal	—	0.70	0.70	—	1.31	1.3
Direct operations	15.06	8.07	23.13	28.31	15.18	43.5
Indirect	6.54	4.69	11.23	12.30	8.82	21.1
Security operations	2.23	1.27	3.51	4.20	2.40	6.6
Other site	—	0.23	0.23	0.00	0.43	0.4
DOE site	0.41	0.45	0.86	0.77	0.84	1.6

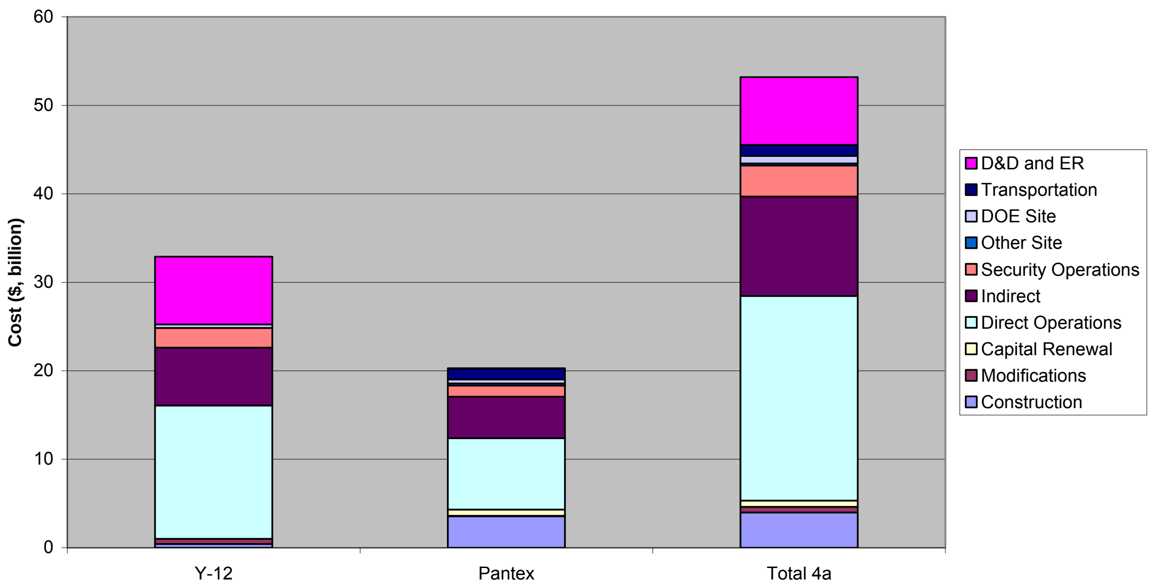
Table 7-19. Cost Summary Pantex Case 4a (IP), 2008–60

Cost category	Cost ($ billion)			Percentage of total cost		
	Y-12	Pantex	Total 4a	Y-12	Pantex	Total 4a
Transportation	—	1.24	1.24	0.00	2.34	2.3
D&D and ER	7.65	0.02	7.67	14.39	0.03	14.4
Total	32.9	20.28	53.2	61.88	38.14	100.0

Note: Costs displayed are sums of the most likely values.

Figure 7-9 graphically displays these costs.

Figure 7-9. Summary by Cost Category for Pantex Case 4a (IP) ($ billion)



The Pantex cases are similar to SRS regarding the portion of the case costs that are Y-12 costs.

Table 7-20 shows the costs and percentage of cost for Pantex Case 4b (OP).

Table 7-20. Cost Summary Pantex Case 4b (OP), 2008–60

Cost Category	Cost ($ billion)			Percentage of total cost		
	Y-12	Pantex	Total 4b	Y-12	Pantex	Total 4b
Construction	0.66	3.04	3.70	0.84	6.46	7.3
Modifications	0.59	0.01	0.60	1.17	0.01	1.2
Capital renewal	0.00	0.63	0.63	0.00	1.24	1.2
Direct operations	13.04	9.45	22.50	25.68	18.62	44.3
Indirect	5.28	4.94	10.21	10.39	9.72	20.1

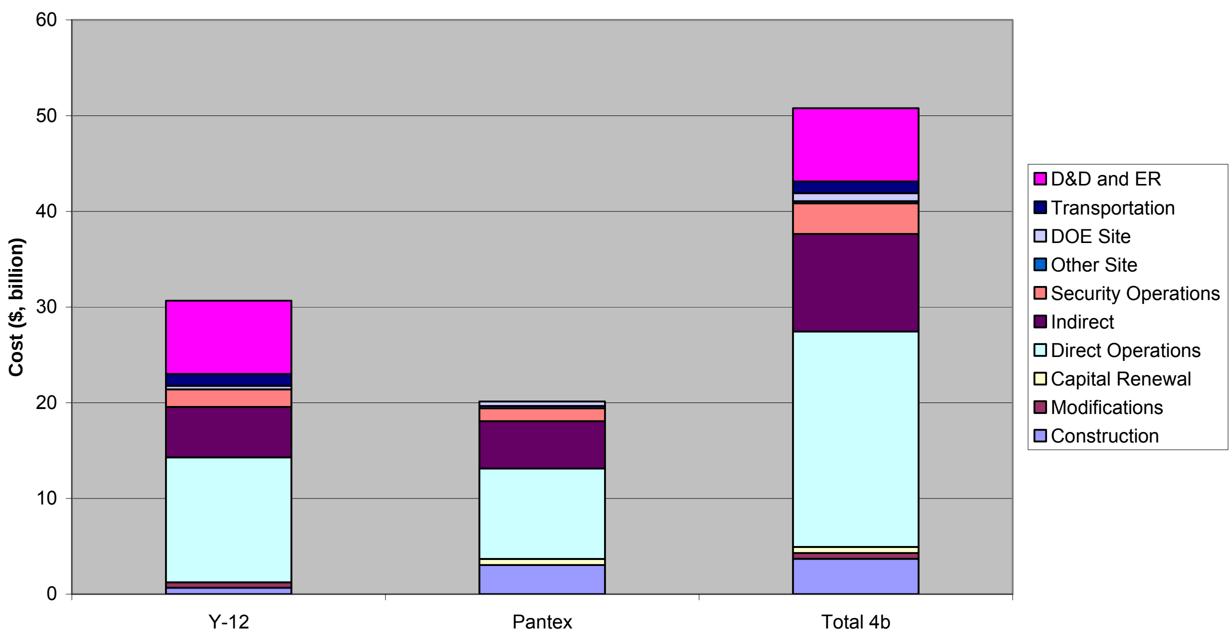
Table 7-20. Cost Summary Pantex Case 4b (OP), 2008–60

Cost Category	Cost ($ billion)			Percentage of total cost		
	Y-12	Pantex	Total 4b	Y-12	Pantex	Total 4b
Security operations	1.83	1.37	3.20	3.61	2.69	6.3
Other site	0.00	0.23	0.23	0.00	0.45	0.4
DOE site	0.37	0.45	0.82	0.73	0.89	1.6
Transportation	1.24	—	1.24	2.45	—	2.4
D&D and ER	7.65	0.00	7.65	15.07	0.00	15.1
Total	30.66	20.12	50.78	59.94	40.08	100.0

Note: Costs displayed are sums of the most likely values.

Figure 7-10 graphically displays the Case 4b cost breakdown.

Figure 7-10. Summary by Cost Category for Pantex Case 4b (OP) ($ Billion)



As discussed, the costs are dominated by operations: the Y-12 costs for operations and indirects are higher than those for Pantex, even though the time frame is shorter.

Table 7-21 summarizes the base case costs by cost category. Figure 7-11 shows the summary data graphically for each base case.

Table 7-21. Summary of Costs by Category for Base Cases

Cost Category	Total Cost by Category ($ billion)				
	1a	2a	3a	4a	4b
Construction	0.4	3.09	3.46	3.99	3.7
Modifications	5.33	0.62	0.66	0.64	0.6
Capital renewal	0.13	0.6	0.68	0.7	0.63
Direct operations	19.59	16.19	24.39	23.13	22.5
Indirect	18.74	15.56	8.3	11.23	10.21
Security operations	6.07	4.89	3.72	3.51	3.2
Other contractor site	0	0	0	0.23	0.23
DOE site	0.79	0.75	0.63	0.86	0.82
Transportation	1.01	1.01	1.26	1.24	1.24
D&D	0	0.6	7.65	7.67	7.65
Total	52.06	43.31	50.75	53.20	50.78

Note: Total costs are sums of the most likely values.

Figure 7-11. Summary of Base Cases by Cost Category ($ billion)

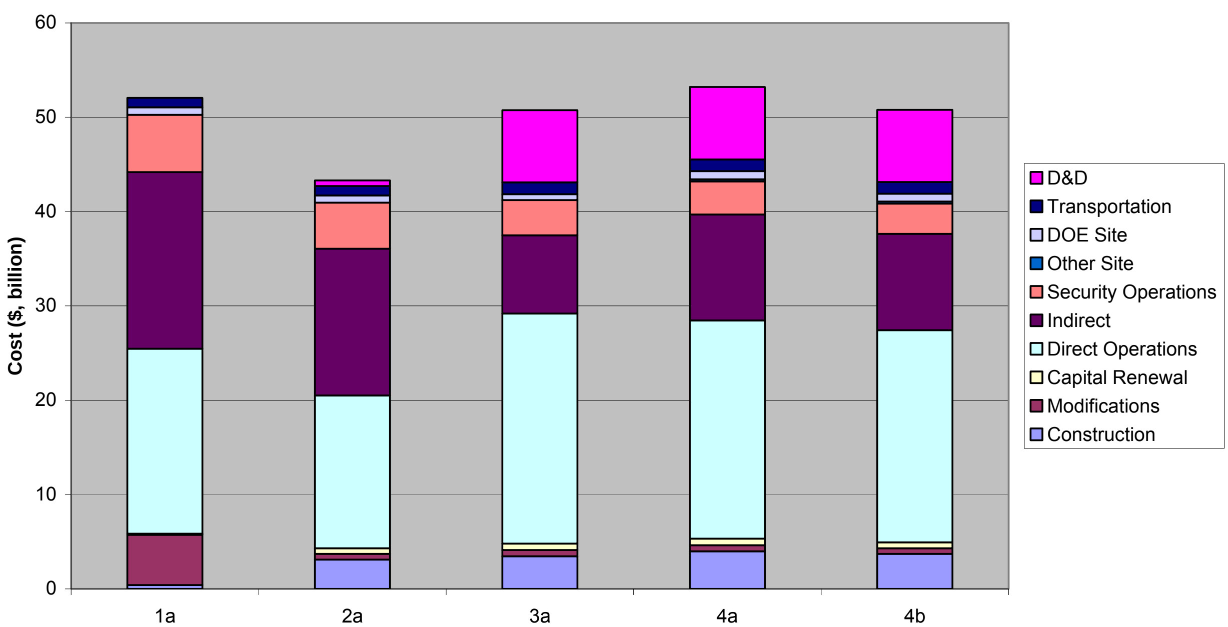


Figure 7-12 shows the total input FTEs for the base cases.

Figure 7-12. Uranium IBCA Staffing Summary

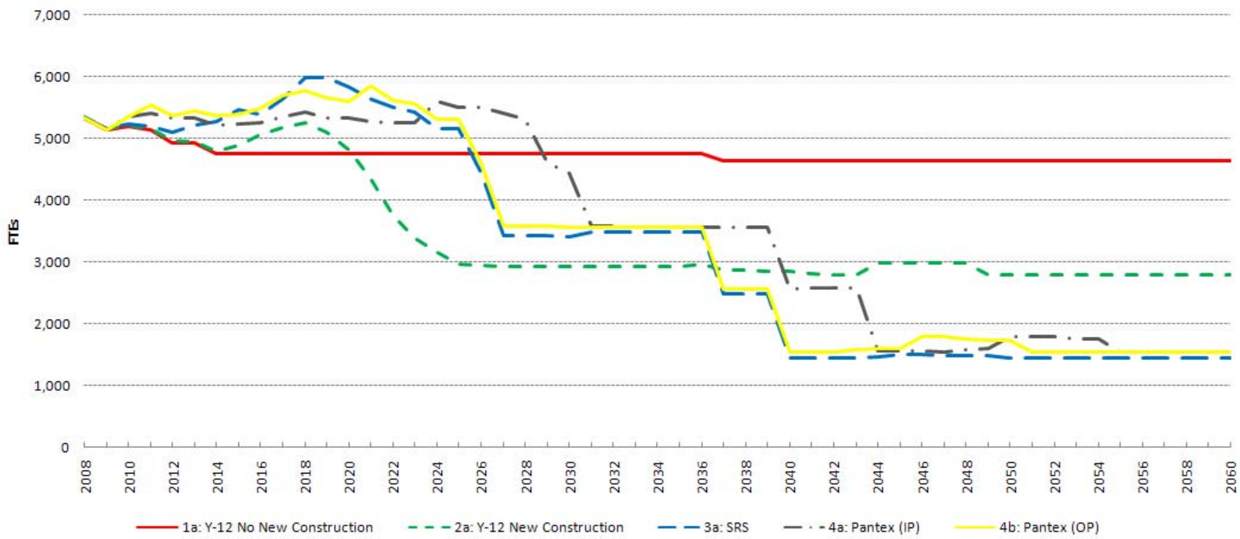
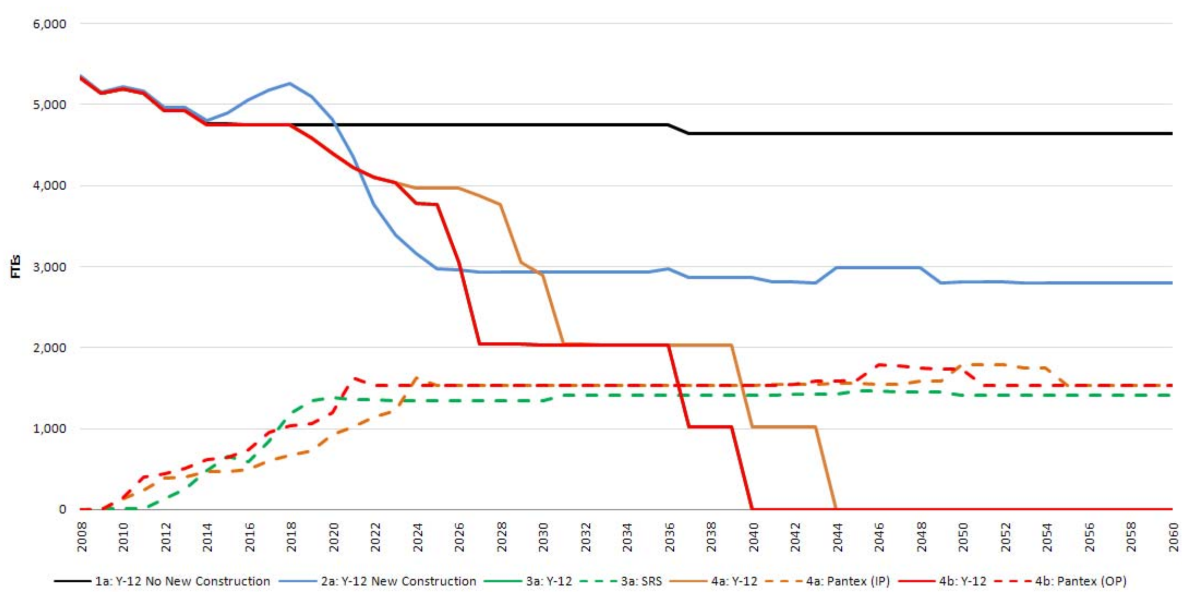


Figure 7-13 breaks the FTEs into the contributions from each site for the cases. Y-12 Cases 1a and 2a are only Y-12 staffing; the other cases have two components, Y-12 and the transfer site (SRS or Pantex). Note the contribution to the total FTEs from Y-12 for the SRS and Pantex cases. (Appendix D includes a figure with the FTEs for each of the cases analyzed.)

Figure 7-13. Uranium IBCA Staffing by Site Component



Note: Y-12 FTEs for Cases 3a and 4b are the same. Only Case 4b shows on the chart. Also, Cases 1a and 2a display the total number of FTEs associated with those cases, whereas Cases 3a, 4a, and 4b display the number of FTEs by site. The intent is to display the ramping down at Y-12 and the ramping up at SRS and Pantex for those cases.

Chapter 8

Qualitative Evaluation Factors

8.1 OVERVIEW

The team reviewed its findings from the Phase I SNM consolidation study and determined that the qualitative evaluation of relocating or modernizing the HEU mission at Y-12, Pantex, or SRS was significantly less complex than that in Phase I. First, only three sites are involved, and second, only the HEU mission is considered. After reviewing the results from Phase I, the team concluded that the only critical factors related to mission risk. Neither environmental impacts nor site attractiveness features, factors utilized in Phase I, were discriminators.

8.2 MISSION RISK

Table 8-1 describes the multiple aspects of mission risk the team considered. Unlike earlier "stop light" charts, this table compares the three sites using the adjectives higher, moderate, and lower, rather than an absolute scale. Any of the three sites could adequately manage the HEU mission. To imply that any of them poses a high ("red") or low ("green") risk under any criterion would not reflect the sense of the team, so it employed the relative terms. However, the three sites do differ.

Table 8-1. Application of Relative Qualitative HEU Mission Risk Criteria

HEU mission consolidation qualitative evaluation risk criteria	Criteria rating		
	Pantex	SRS	Y-12
Completion schedule of construction or modifications, including start-up	Higher	Moderate	Moderate
Timeliness and success of transition and production readiness (for example, required R&D, equipment qualification, demonstration of feasibility, process prove-in, certification, and quality assurance)	Moderate	Moderate	Lower
Responsiveness to stockpile requirements and variations	Higher	Moderate	Lower
Transition risk (for example, facility, equipment, and personnel performance; relocation of requisite personnel; impact on preexisting operations; acquisition of required equipment; impact on cost or schedule of executing a specific nuclear weapon program)	Moderate	Moderate	Lower
Accident history and effectiveness of programs in protecting workers, population, and the environment	Moderate	Moderate	Moderate
Incident history and effectiveness of programs in protecting national security interests	Moderate	Moderate	Moderate

Table 8-1. Application of Relative Qualitative HEU Mission Risk Criteria

HEU mission consolidation qualitative evaluation risk criteria	Criteria rating		
	Pantex	SRS	Y-12
Site location vulnerabilities and potential consequences of adequately protecting the workers, population, environment, and national security interests	Moderate	Moderate	Higher
Facility location attractiveness to requisite competent personnel	Higher	Moderate	Lower
Capability of existing on-site and community infrastructure to support facility requirements	Moderate	Moderate	Lower
Timely resolution of facility commissioning and regulatory issues	Lower	Lower	Lower
Level of interference or congestion associated with planned concurrent construction	Higher	Moderate	Lower

Table 8-1 displays the collective judgment of the team on these 11 mission risk criteria. The team used quantitative data from Phase I as well as additional data collected in Phase II, when appropriate, in applying its expert judgment. In addition, the team used the combined knowledge and experience of its members to evaluate the site-specific risks and make relative judgments about the site alternatives and, in some cases, the relative value of the risk factor in the decision-making process.

The collective risk scores for mission risk for each site were combined to derive the overall mission risk for each site (Table 8-2).

Table 8-2. Composite Relative Mission Risk

HEU mission location	Composite relative mission risk rating		
Pantex	Higher		
SRS		Moderate	
Y-12			Lower

8.3 CONCLUSIONS

The term “mission risk” as used here is the risk of not meeting nuclear weapon stockpile requirements on the basis of existing mission-related manufacturing capabilities and capacities at a site. The team considered a variety of qualitative factors, as had been done in the Phase I SNM study, but only mission risk arose as a discriminator. Locating HEU processing and manufacturing operations at a site with no experience—Pantex—is considered a higher risk. Locating the mission at SRS, which has some HEU processing and manufacturing experience, poses a moderate risk. Y-12 poses a lower risk, as it has been the principal site responsible for this mission. At the same time, the mission could be performed at any of the three sites with an acceptable degree of risk, if so desired by NNSA.

Chapter 9

Comparative Results and Analysis

9.1 Overview

This report addresses the multifaceted choices that face NNSA in its consideration of alternatives for location of the uranium mission. To understand the dynamics and implications of alternatives, the team started with current Y-12 operations and developed the base cases (1a, 2a, 3a, 4a, and 4b) as identified in Chapter 5.

This chapter displays and discusses the various ways in which the team evaluated the economics of these alternatives:

- *Net present value*. NPV is the most meaningful way to compare different cash flows over an extended period, in this instance, 2008–60. This period was selected to determine whether operational savings realized over the longer term due to consolidation sufficiently offset the higher capital costs required to consolidate. The team evaluated a shorter period, 2008–30, as a sensitivity analysis.

- *Cash flow requirements in 2008 dollars*. The team charted the budget requirements from year to year to understand the budgetary impacts of consolidation under the different consolidation assumptions.

- *Required short-term capital investment*. The team considered the capital funding requirement for each site location option for the major facilities that constitute the uranium mission and performed an alternative scenario analysis for constrained funding.

- *Qualitative factors*. In addition to applying the qualitative site-selection criteria (Chapter 8), the team considered the various programmatic risks posed by different options.

9.2 Base Cases Economic Analysis

Figure 9-1 shows the NPV for the five base cases; the bars represent the “middle 90th percentile,” as described in Subsection 7.1.2.3, and the triangle represents the mean value.

Figure 9-1. Model Results—Base Cases, NPV ($ billion)

Table 9-1 shows the results of the analysis in tabular form.

Table 9-1. Model Results—Base Cases, 2008–60 NPV ($ billion)

Case	Mean	SD	5%	95%
1a: Y-12 no new construction	37.1	2.1	33.8	40.7
2a: Y-12 new construction	30.6	1.7	27.9	33.4
3a: SRS	38.0	1.9	35.0	41.3
4a: Pantex (IP)	38.8	2.1	35.5	42.3
4b: Pantex (OP)	37.6	1.9	34.6	40.8

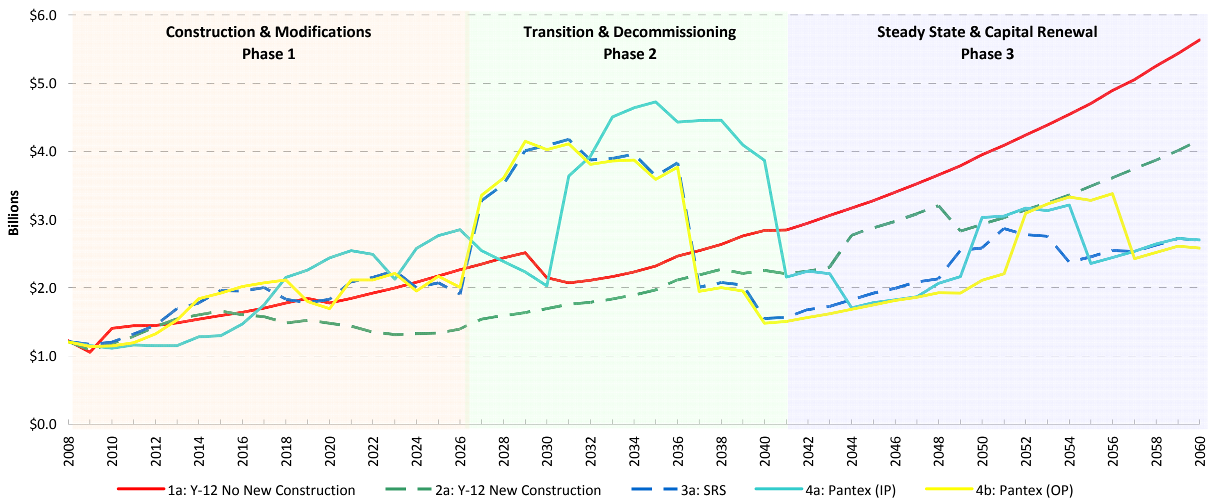
Note: SD = standard deviation.

Appendix D contains the full model results and graphs of the probability distributions.

Case 2a (Y-12 with new construction) entails the least amount of financial risk and has the lowest mean value. The other four cases show overlapping ranges. The other locations, SRS and Pantex, are about equal and clearly have a higher NPV than staying at Y-12 with the new construction.

Figure 9-2 shows the escalated annual budget requirements using the costs at the 80th percentile as described in Subsection 7.1.2.5.

Figure 9-2. Baseline Model Results—Annual Budget Requirements ($ billion)



For Figure 9-2, the following interpretations are provided:

- *Case 1a*. The increase in the early years is due to the cost associated with upgrading the facilities to keep them operational through 2060.
- *Case 2a*. The increase in the early years is associated with completing the construction of HEUMF, the CMC, and UPF (Phase 1). After those facilities are completed (in the 2018 time frame), other facilities can be closed and operational costs decrease steadily in 2018–26. From this point, costs are steady with inflation until facilities are renewed in 2035–46 (Phase 2).
- *Cases 3a, 4a (IP), 4b (OP)*. These three cases have about the same budget profile, except the transition in case 4a is approximately 2 years behind cases 3a and 4b. The large increases in the early years are due to construction and modifications (Phase 1). In 2026–41, the cost increases shown are due to decommissioning at Y-12 and transition to the new site (Phase 2). In 2042–54, the cost increases are due to the capital renewal costs (Phase 3).

The steady state costs of Case 1a are clearly higher than the other alternatives. The Y-12 steady state costs in Case 2a are higher than the steady state costs of Cases 3a, 4a, and 4b in the long term because the other sites are projected to leverage overhead resources and achieve economics of scale not possible at Y-12. Chapter 7 details these cost differences.

9.3 ALTERNATIVE SCENARIO—CONSTRAINED FUNDING

Recognizing that some of the spikes in the budget requirements may be difficult to fund, the team devised an alternative scenario (constrained funding), labeled Case "c" where the construction and decommissioning schedules would be revised to smooth out the budget requirements. Subsection 7.2.1.2.10 details the inputs used for this set of cases. Case 1a was not affected by the constraints. The constraints were

- $350 million per year (in FY08 dollars) for construction and modifications, and
- $500 million per year (in FY08 dollars) for decommissioning.

Figure 9-3 shows the NPV results from this alternative scenario for each of the four cases affected. Case 1a was not affected, and the relative ranking of the alternatives as discussed in Section 9.2 were not altered.

Figure 9-3. Model Results—Constrained Funding, NPV ($ billion)

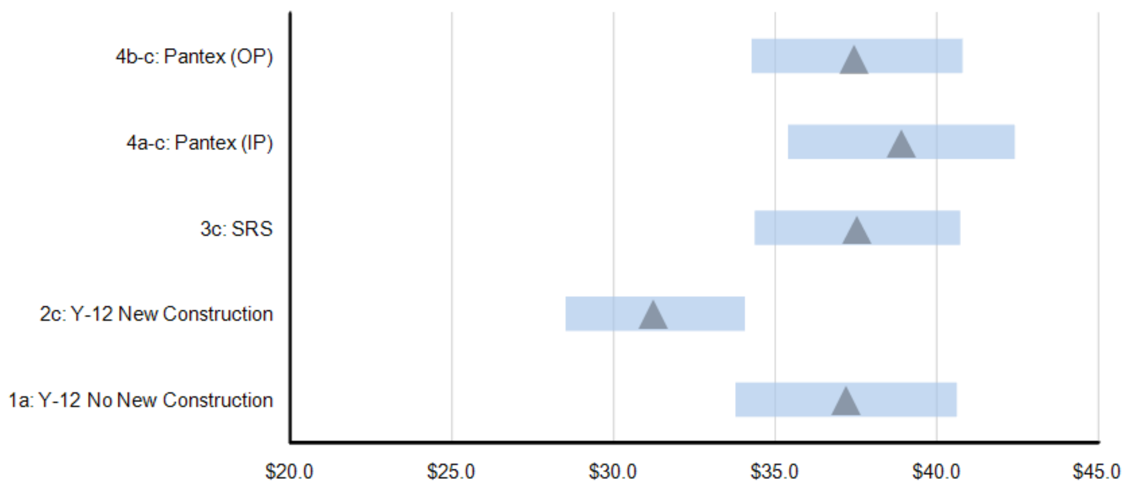


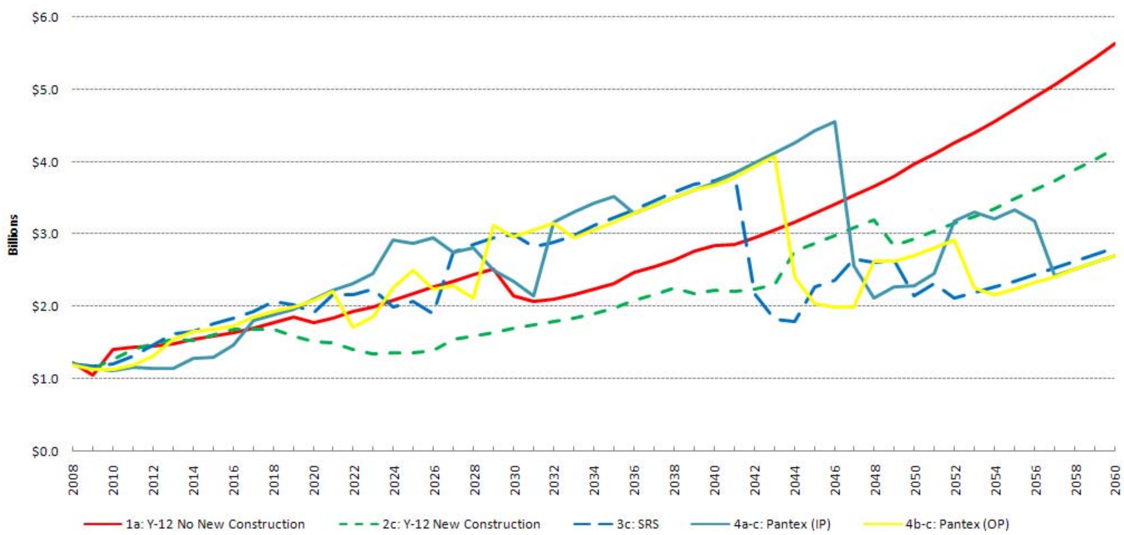
Table 9-2 shows the results from this alternative scenario.

Table 9-2. Model Results—Constrained Funding, 2008–60 NPV ($ billion)

Case	Mean	SD	5%	95%
1a: Y-12 no new construction	37.1	2.1	33.8	40.7
2c: Y-12 new construction	31.2	1.7	28.5	34.1
3c: SRS	37.4	1.9	34.4	40.6
4a-c: Pantex (IP)	38.7	2.1	35.4	42.4
4b-c: Pantex (OP)	37.4	2.0	34.3	40.8

Figure 9-4 shows the budget requirements for the constrained funding cases.

Figure 9-4. Constrained Funding Results, Budget Requirements

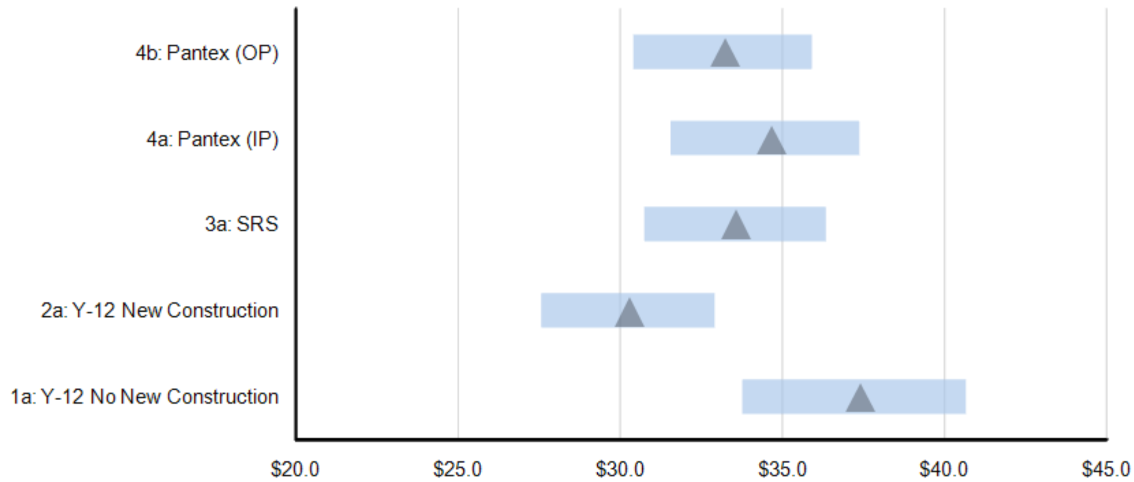


The effect of the constrained funding can be clearly seen in the first two periods, construction and decommissioning, compared with Figure 9-2. The capital renewal costs were not altered as they did not rise to the level that the constraint had an effect. The net effect of the constraint is between 1 and 3 years delay in transition, depending on the site. For the alternate sites, SRS and Pantex, this delay affects the Scenario 5a production schedule.

9.4 No Y-12 Decommissioning Sensitivity Analysis

The team evaluated the impact of not including the Y-12 decommissioning costs compared with the baseline cases to bound the decommissioning costs on the low side and determine whether that affected in the results. The team analyzed all cases, except Case 1a, which did not involve decommissioning. Subsections 7.2.1.3.9, 7.2.2.7, and 7.2.3.7 discuss the costs if decommissioning is not included. Long-term site closure S&M is required in this situation. Figure 9-5 shows the NPV model results of this sensitivity analysis. Case 1a is included for reference.

Figure 9-5. Model Results—Excluding Y-12 Decommissioning, NPV ($ billion)



Although the 90th percentile ranges overlap in Cases 2a–4b, the overall conclusion is consistent with the baseline analysis, Section 9.1. The Case 2a mean value is clearly lower than the SRS and Pantex cases. This analysis was purely a "sensitivity": the decommissioning costs need to be included in the analysis, as discussed in Subsection 7.2.1.3.9.

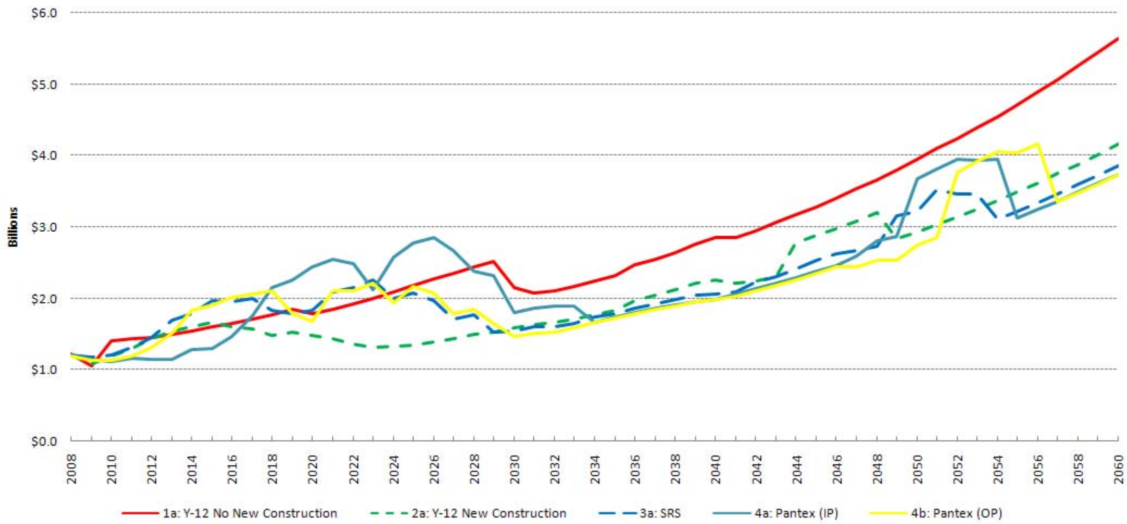
Table 9-3 shows the results for this sensitivity analysis

Table 9-3. Model Results—No D&D, 2008–60 NPV ($ billion)

Case	Mean	SD	5%	95%
1a: Y-12 no new construction	37.1	2.1	33.8	40.7
2a: Y-12 new construction	30.1	1.6	27.6	32.9
3a: SRS	33.5	1.7	30.7	36.3
4a: Pantex (IP)	34.3	1.8	31.5	37.4
4b: Pantex (OP)	33.0	1.7	30.4	35.9

Figure 9-6 shows the annual budget requirements for this sensitivity analysis. The team used the full required funding for this analysis.

Figure 9-6. Model Result—Excluding Y-12 Decommissioning, Budget Requirement



9.5 NO Y-12 DECOMMISSIONING AND REDUCED SITE CLOSURE S&M COSTS

The team performed an additional sensitivity analysis with no Y-12 decommissioning and reduced the estimated site closure S&M costs at Y-12 after shutdown and cleanout using the base cases as a starting point. Subsection 7.2.1.3.10 describes the inputs for this analysis. The team ran this "sensitivity" because the S&M costs estimated by Y-12 seemed high, but the team had no direct basis for a better estimate; hence, the "sensitivity" analysis to determine the impact of a reduced cost estimate.

Figure 9-7 shows the NPV results. The figure shows the comparison between the baseline cases in lighter blue bars and this sensitivity analysis "(Sens)" with the darker blue bars. Cases 1a and 2a are not affected by this sensitivity analysis and are shown for comparison purposes. This analysis shows that the results are sensitive to the long-term site closure S&M costs, and in one case (Pantex 4b), the mean approaches the baseline Y-12 (Case 2a) mean.

Figure 9-7. Model Results—No Y-12 Decommissioning with Reduced S&M, NPV ($ billion)

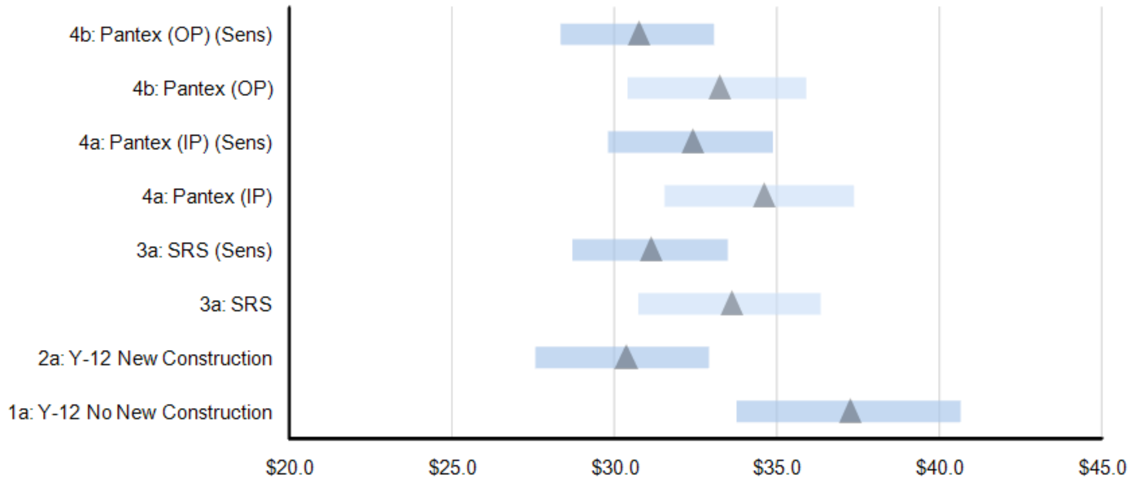


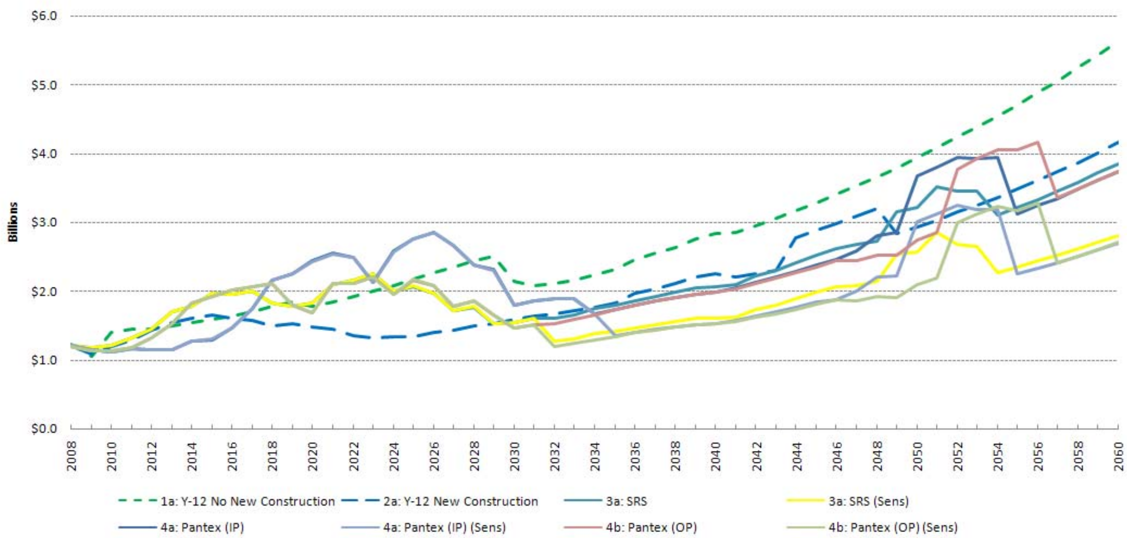
Table 9-4 shows the model results for the reduced S&M analysis.

Table 9-4. Model Results—Reduced S&M, 2008–60 NPV ($ billion)

Case	Mean	SD	5%	95%
1a: Y-12 no new construction	37.1	2.1	33.8	40.7
2a: Y-12 new construction	30.1	1.6	27.6	32.9
3a: SRS	33.5	1.7	30.7	36.3
3a: SRS (Sens)	31.0	1.4	28.7	33.5
4a: Pantex (IP)	34.3	1.8	31.5	37.4
4a: Pantex (IP) (Sens)	32.3	1.5	29.8	34.9
4b: Pantex (OP)	33.0	1.7	30.4	35.9
4b: Pantex (OP) (Sens)	30.6	1.4	28.3	33.1

Figure 9-8 shows the annual budget requirements for the reduced S&M sensitivity analysis.

Figure 9-8. Model Results—No Y-12 Decommissioning and Reduced S&M, Budget Requirements



9.6 BASE CASE SENSITIVITY ANALYSIS WITH NEAR-TERM TIME HORIZON

The 2060 horizon was selected to permit a better understanding of the cost savings from a potential relocation of the uranium mission. Because many of the facilities would require construction into the 2020s, a reasonable operational period was needed to measure any overall benefits. The team also calculated NPV through 2030, utilizing the same base information as a sensitivity test. Figure 9-9 displays the results of the 2030 analysis. Table 9-5 shows the data in tabular format.

Figure 9-9. Model Results—Base Case to 2030, NPV ($ billion)

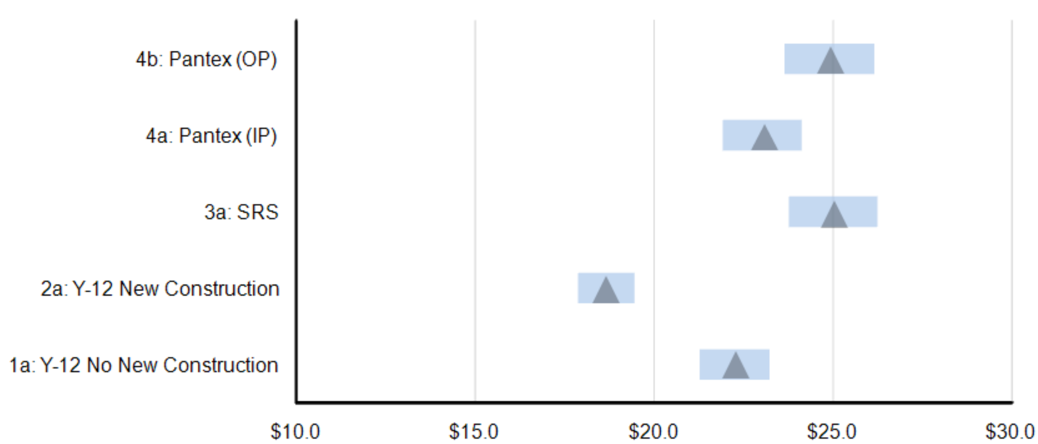
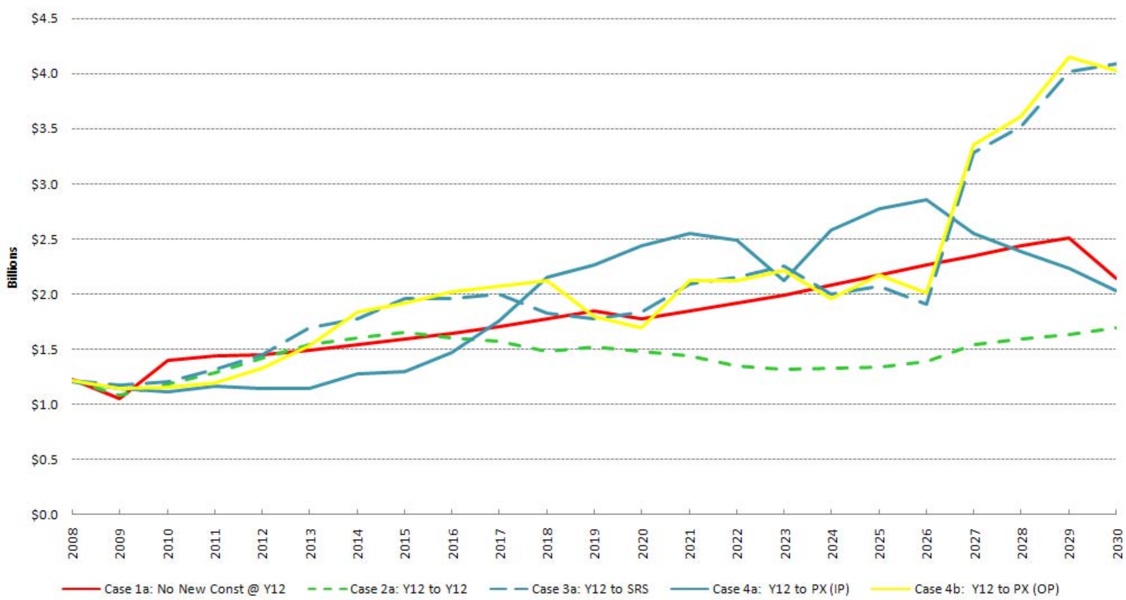


Table 9-5. Model Results—Base Case, 2008–30 NPV ($ billion)

Case	Mean	SD	5%	95%
1a: Y-12 no new construction	22.2	0.5	21.2	23.2
2a: Y-12 new construction	18.6	0.4	17.8	19.4
3a: SRS	24.9	0.7	23.7	26.2
4a: Pantex (IP)	22.9	0.6	21.9	24.1
4b: Pantex (OP)	24.8	0.7	23.6	26.1

Figure 9-10 shows the annual budget requirements for this reduced analysis period.

Figure 9-10. Model Results—Time Horizon to 2030, Budget Requirements



As can be seen from the graphs and table, the results are consistent with the baseline analysis. Case 2a (Y-12 with new construction) has the lowest mean value and data spread. With the shorter time horizon for the analysis, not all the construction and modifications are completed, so not all these costs are included in the analysis. Also, the decommissioning effort has started in Cases 3a and 4b but not in Case 4a, also affecting the results.

9.7 UNESCALATED CASH FLOW AND DISCOUNT RATE SENSITIVITY ANALYSIS

The team also performed sensitivity analyses to determine the impact inflation has on the analyses. Using the base cases as a starting point, the team excluded cost escalation and used corresponding OMB 20- to 30-year real discount rate of 2.8 percent.[1] Figure 9-11 shows the NPV model results for the baseline cases without escalation.

Figure 9-11. Model Results—No Escalation, NPV ($ billion)

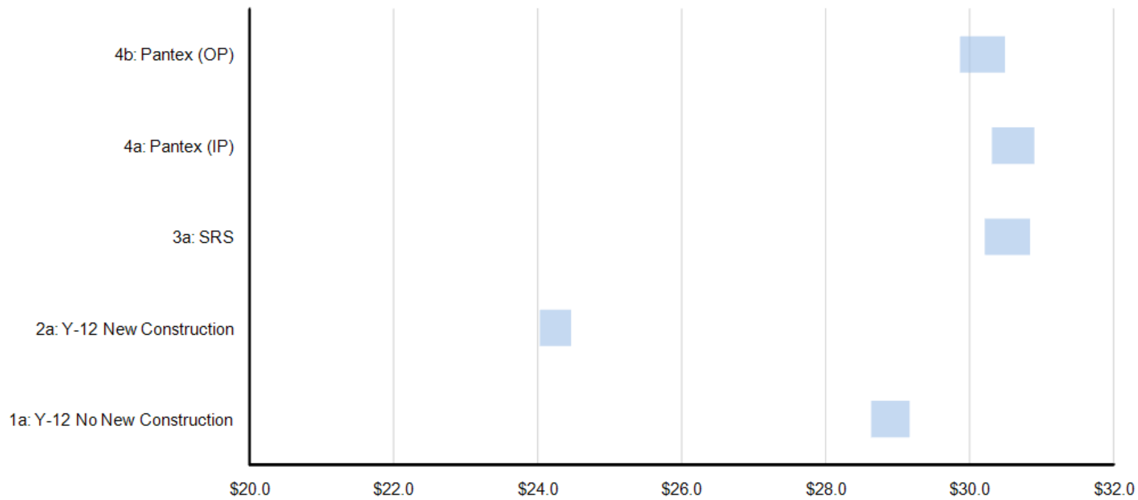


Table 9-6 shows the model results in tabular format. Appendix D details the results.

Table 9-6. Model Results—No Escalation, 2008–60 NPV ($ billion)

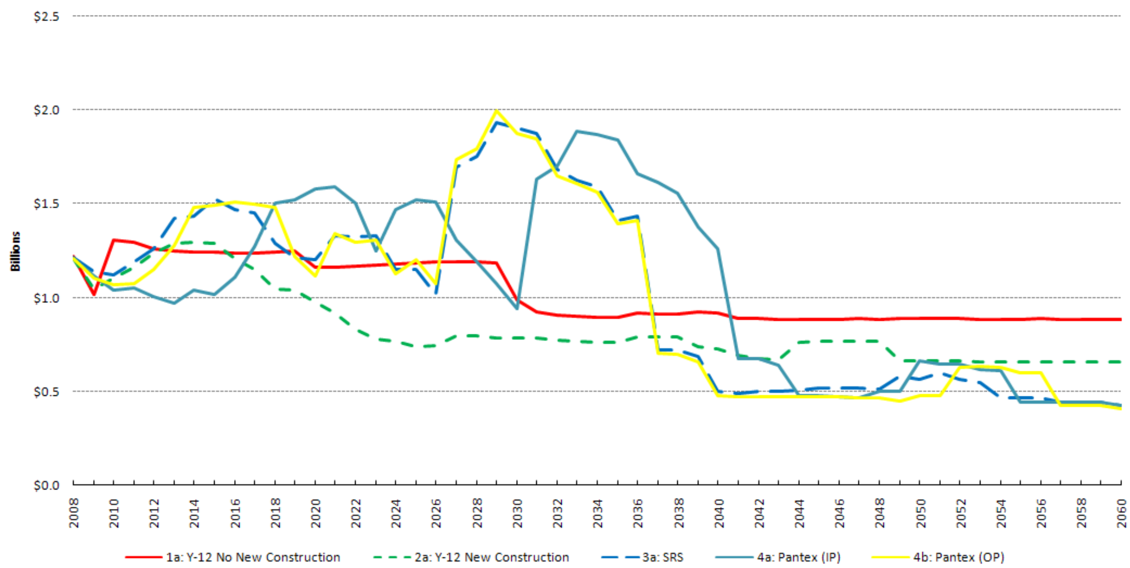
Case	Mean	SD	5%	95%
1a: Y-12 no new construction	28.9	0.2	28.6	29.2
2a: Y-12 new construction	24.2	0.1	24.0	24.5
3a: SRS	30.5	0.2	30.2	30.8
4a: Pantex (IP)	30.6	0.2	30.3	30.9
4b: Pantex (OP)	30.2	0.2	29.9	30.5

As can be seen from the data and graphs, the escalation uncertainty used in the analysis is a significant contributor to the spread of the data as shown in the standard deviation values. When cost escalation is removed for the analysis, the results are very tightly clustered about the mean value. This analysis was done as a "sensitivity" only: cost escalation must be appropriately modeled and included in any business case analysis.

Figure 9-12 shows the annual budget requirements without escalation. This differs from the FY08 data input because these results plot the 80th percentile from the Monte Carlo analysis with the uncertainty distributions, as explained in Subsection 7.1.2.6.

[1] OMB Memorandum, *2008 Discount Rates for OMB Circular No. A-94*, January 14, 2008.

Figure 9-12. Model Results—No Escalation, Budget Requirements



9.8 SUMMARY DATA

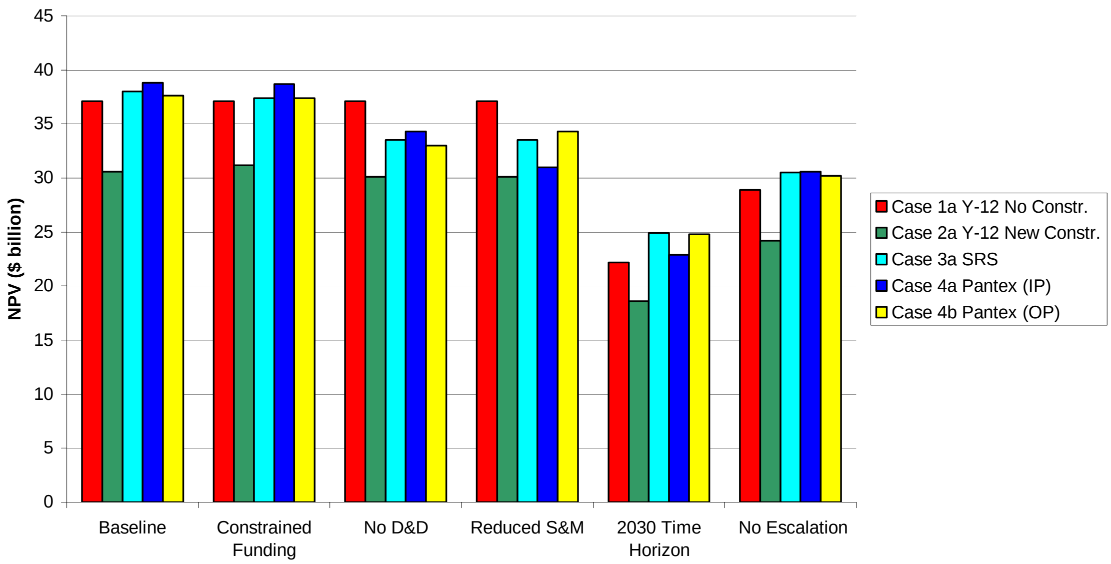
Table 9-7 shows a summary of the mean values from each of the analyses discussed in the previous sections.

Table 9-7. Model Results—Summary, Mean NPV ($ billion)

Case	Baseline	Constrained funding	No D&D	Reduced S&M	2030 time horizon	No escalation
1a: Y-12 no new construction	37.1	37.1	37.1	37.1	22.2	28.9
2a: Y-12 new construction	30.6	31.2	30.1	30.1	18.6	24.2
3a: SRS	38.0	37.4	33.5	33.5	24.9	30.5
4a: Pantex (IP)	38.8	38.7	34.3	31.0	22.9	30.6
4b: Pantex (OP)	37.6	37.4	33.0	34.3	24.8	30.2

Figure 9-13 shows the data from Table 9-7 in a graphic format. All analyses use escalated costs and the OMB nominal discount rate, except the sensitivity analysis “no escalation.” All analyses except “2030 time horizon” use the time frame 2008–60. Case 2a, Y-12 with new construction, as highlighted in Table 9-7, clearly shows the lowest mean NPV value for all the analyses performed.

Figure 9-13. Model Results—Summary, Mean NPV ($ billion)



Chapter 10
Conclusions

10.1 Least Expensive Option—NPV to 2060

The NPVs of each of the five cases out to 2060 show that the least expensive alternative is keeping the HEU operations at Y-12 and constructing UPF and CMC (Case 2a). Moving the HEU operations to either SRS or Pantex increases the mean value by approximately $8 billion. If the HEU operations remain at Y-12, and UPF and CMC are not constructed (Case 1a), the mean value increases by approximately $5 billion (Subsection 7.2.1 discusses the input values). The Case 1a expense is driven by the extraordinarily high cost of refurbishing the current HEU and non-HEU operations facilities up to current standards.

10.2 Cash Flow (Budget Requirements)

Moving the HEU operations to either SRS or Pantex requires major budget expenditures:

- Construction of HEUMF, UPF, and CMC
- D&D and ER of Y-12 after site shutdown.

Remaining at Y-12 reduces the first and eliminates the second from consideration. However, the maximum savings in operating costs after transition compared with current costs are realized by moving to SRS or Pantex. Moderate savings are realized at Y-12 if UPF and CMC are completed. Minimal operational savings are realized with Case 1a. Case 2a appears to be the most viable from a budget requirements point of view in the early years, but it does not maximize the savings in operating costs like SRS or Pantex in the long run.

10.3 Transition Investments

Each case evaluated requires substantial investment (in FY08 dollars) for new construction, modifications, and capital renewal. Even though Case 1a involves no new construction, it requires a major investment of more than $5 billion to refurbish the current facilities up to current requirements. Case 2a (Y-12) requires approximately $4.3 billion to construct UPF and CMC and modify other facilities for consolidated operations. Moving HEU operations to SRS or Pantex requires approximately $5 billion for new construction, modifications, and capital renewal. Moving the operations will also require approximately $7 billion to D&D and environmentally remediate Y-12 after plant shutdown. These investments are spread over 20–30 years.

10.4 Transportation

Transportation of HEU is an important element of the HEU enterprise, but the costs are not high enough to be a determining factor in the decision on a preferred location. The routine day-to-day movement of HEU and CSAs costs $10 million–$30 million annually (unless the operations move to Pantex, which would substantially reduce these operating costs). Moving HEU operations to SRS would involve a one-time cost of $145 million to move all the material from Y-12 to SRS. Relocation to Pantex would involve a one-time cost for moving the stored material of $450 million due to the longer distances. The transport requirements for each of the cases are within the current OST capability so long as at least 5 years are allowed for moving the stored HEU to a new location.

10.5 Security

Except for Case 1a, all cases generate security cost savings through consolidation of operations. Currently, Y-12 is spending $117 million on security. Consolidation at Y-12 (Case 2a) would reduce these costs by $37 million. Moving the operations to SRS or Pantex would reduce security costs by $40 or $32 million, respectively. All security options would meet the 2005 DBT requirements.

10.6 Current Y-12 Facilities

The majority of facilities currently used for the HEU and CSA operations at Y-12 are 40 to 50 years old. Case 1a assumes no additional new construction; thus, these facilities would have to be brought up to current standards at a cost of more than $5 billion, starting in 2010. For Cases 2a, 3a, 4a, and 4b, these aging facilities would have to remain operable until the transition to new facilities is complete in 2023–2028, with a minimum of refurbishment just to keep them operational. This is a high-risk assumption because most of the existing facilities have been allowed to deteriorate to a marginal state. Keeping these existing facilities operating for the next 15–20 years is key to consolidating to new and more efficient facilities, regardless of the location.

10.7 Constrained Budget

Future budget constraints are likely to limit the rate at which major construction can be accomplished. If annual construction and modification budgets for HEU operations are limited to $350 million in FY08 dollars (FY08 expenditures are $320 million), and annual D&D budgets are limited to $500 million (in FY08 dollars), the programmatic delays will be 1–3 years. The NPV (through 2060) does not change appreciably. Case 2a remains the least costly option.

10.8 DECOMMISSIONING

The team considers the costs of D&D and ER an integral part of the IBCA. However, the model was used to calculate the costs without D&D and ER to determine whether the conclusions differed greatly. Without D&D and ER, the NPV mean value of moving to SRS or Pantex decreases by approximately $5 billion, but remaining at Y-12 is still less expensive by about $3 billion. Case 1a becomes the most expensive option if D&D and ER costs are excluded.

10.9 Y-12 SITE SURVEILLANCE AND MAINTENANCE

If HEU operations are moved from Y-12, and no D&D and ER of the site is assumed, long-term site closure S&M is included in the cost model. The baseline data from Y-12 estimated a staff of 1,000 people would be required for long-term site S&M after shutdown. Decreasing the staff size to 100 people (and disregarding D&D and ER) reduces the cost of moving to either SRS or Pantex enough that the NPV is approximately equal to Case 2a where operations remain at Y-12. This analysis shows that the results are sensitive to the long-term site closure S&M costs, and in one case (Pantex 4b), the mean approaches the baseline Y-12 (Case 2a) mean.

10.10 QUALITATIVE CONSIDERATIONS

Currently, all HEU operations are carried out at Y-12, but the current facilities are old and have deteriorated to the point where the long-term capability to process HEU is in jeopardy.

The lowest mission risk option is to complete HEUMF, construct UPF and CMC, and consolidate all uranium mission manufacturing operations into these three facilities at Y-12. A skilled and experienced staff is already in place, and a transition to new facilities in the same geographic location is much simpler than moving an entire operation to a new site.

Although the team identified no qualitative factor that would preclude a move from Y-12 to SRS or Pantex, such a move would definitely pose higher mission risks. The risk involved in a move to SRS is moderate. SRS has a staff and existing facilities that are experienced in the processing of HEU and handling the associated waste products. Pantex has no such experience, so the HEU processing operation would be entirely new. Therefore, moving to Pantex poses a higher risk.

10.11 THE BOTTOM LINE

The team identified no qualitative or quantitative advantages in moving the HEU operations to either SRS or Pantex. Staying at Y-12 requires significant modernization of production facilities, best accomplished by building replacement facilities. The move to SRS or Pantex results in significant annual operational savings, but these savings are insufficient to compensate for the required investments. However, the team identified no factor that would preclude moving HEU operations from Y-12 to SRS or Pantex, if that move were part of some larger overall strategy.

Appendix A
Team Biographies

JOHN C. CRAWFORD, PH.D.—CHAIR

Dr. Crawford retired in 1999 as Executive Vice President and Deputy Laboratory Director at Sandia National Laboratories where he was responsible for all of Sandia's programs, operations, staff, and facilities and reported directly to the Laboratory Director.

Prior to this appointment, Dr. Crawford was Vice President and general manager of Sandia's California Laboratory. Previously, as Director of Weapon Development, Dr. Crawford was responsible for all nuclear weapon system development activities in New Mexico, including the Trident II warhead program, cruise missile warheads, nuclear weapon stockpile improvement programs, nuclear surety, and exploratory systems such as earth penetrators and direct optical initiation.

Dr. Crawford coordinated several Laboratories' committees, including the External Advisory Board for Extreme Ultraviolet Lithography. He is a past member of the American Physical Society, Senior Member of IEEE, and the California Environmental Business Council, Silicon Valley Joint Ventures (Economic Development), and served on the Advisory Council for the National Ignition Facility, and the Board of Directors for the Greater Albuquerque Chamber of Commerce. He also served as a member of the Senior Advisory Group for the Space Systems Directorate of the Air Force Research Laboratory. He served as chairman of the Defense Science Board Panel on Nuclear Simulation and is a former member of the Nuclear Engineering Advisory Council at Texas A&M University.

Dr. Crawford served as a member of a Federal Advisory Committee for the End-to-End Review of the U.S. Nuclear Command and Control System. He presently serves on the Strategic Advisory Group for U.S. Strategic Command as a member of the Stockpile Assessment Team. In addition he is a member of the DoD Joint Advisory Committee for Nuclear Surety. He recently served as a member of the Secretary of Energy Advisory Board's Panel on Nuclear Weapons Complex Infrastructure.

Dr. Crawford holds a B.A. in physics/math from Phillips University and an M.S. and Ph.D. in physics from Kansas State University.

DAVID M. BERKEY

Mr. Berkey has 31 years of experience assisting senior-level managers in private- and public-sector organizations solve difficult problems in the energy, environment, safety, health, emergency management, and transportation arenas. Areas of expertise include economic analysis, benefit-cost and cost-effectiveness analysis, cost estimating, policy and regulatory analysis, quality assurance, and organizational management. His work for the DOE and NNSA is broad and extensive. It includes participation in more than 200 management system evaluations addressing nuclear safety, technical safety, quality assurance, and emergency management; accident investigations; performing independent cost estimates (ICEs) and assessments of new nuclear weapons systems, environmental restoration projects, and construction activities; analyses of the root causes associated with hoisting and rigging incidents; statistical analyses of nuclear reactor pressure tube failures; external independent reviews (EIRs) of Environmental Management Programs; and developing and implementing a plan to evaluate DOE's facility fire and wildfire safety programs. Mr. Berkey was one of the principal authors of the "Guiding Principles" for safety management that continue to provide the basis of the DOE's integrated safety management (ISM) program. Recent DOE/NNSA task assignments include the Phase I independent business case analyses of major environmental test facilities and flight test facilities in support of the Complex Transformation, an independent business case to support LANL's Chemistry and Metallurgy Research Replacement Project, and performing ICEs and EIRs of various NNSA projects.

Mr. Berkey has a B.A. in economics from the State University of New York, an M.A. in economics from the University of Maryland, and completed additional coursework toward a Ph.D. in economics at the University of Maryland.

WILLIAM B. CHAMBERS

Mr. Chambers is a Principal Member of the Technical Staff at Sandia National Laboratories, with 25 years' experience in analytical chemistry and materials applications. Currently employed as a Systems Analyst in the Defense Programs Studies Department, he has participated in and authored numerous studies for NNSA related to nuclear weapons design, production and dismantlement, and the facilities and capabilities required for special nuclear material manufacturing, shipping, and storage. Most recently he has provided technical support and analysis for the independent business case team analyses of alternatives for the NNSA Complex Transformation SPEIS, Consolidated Nuclear Production Center. He has participated in the development of technology and procedures for bilateral monitored dismantlement of nuclear weapons with the former USSR and served as a technical consultant to the International Atomic Energy Agency.

Mr. Chambers has a B.S. from the University of New Mexico.

A. Scott Dam, P.E.

Mr. Dam is a consultant with LMI with more than 30 years' experience in commercial and government nuclear and management services businesses including senior and executive leadership positions. He has extensive experience in nuclear fuel-cycle facilities services and consulting, including developing new power generation and spent-fuel and waste management facilities and equipment. His experience includes all phases of projects from concept planning and project development, cost and schedule estimating, design, licensing, construction, testing, operations, decontamination, and decommissioning.

Mr. Dam has over 11 years' experience with U.S. Department of Energy (DOE) programs and projects including civilian radioactive waste management, environmental restoration, nuclear materials disposition, production and processing, nuclear energy, and science research. He has led or participated in external independent reviews of DOE design and construction and environmental restoration projects over the past 6 years. He was part of the team performing special nuclear materials facilities business case analyses for NNSA supporting Complex Transformation.

Mr. Dam has over 25 years of project and program management of design and construction projects including new nuclear power reactors, modifications and additions to reactor plants, new fuel cycle and waste management facilities, and decommissioning of power reactors and fuel cycle facilities. He began his career on the staff of Naval Reactors and was chief of the Windsor Field Office, U.S. ERDA.

Mr. Dam has B.M.E. and M. Eng. degrees in mechanical engineering from the University of Louisville, a Certificate of Completion (M.S. equivalent) in nuclear reactor engineering from Bettis Reactor Engineering School, and an M.B.A. from Rutgers University. He is a registered professional engineer in three states.

David R. Gallay, D.Sc.

Dr. Gallay has more than 30 years of experience as an engineering manager and operations research analyst. Currently, as the program director of LMI's Infrastructure and Engineering Management practice, he provides research and analysis services to public-sector clients in areas involving public works-related program and project management, engineering economics and finance, and cost uncertainty analysis. Dr. Gallay has been asked repeatedly by senior management at the Department of Energy to serve on a team of outside experts to review, from both an economic and technical perspective, the Department's plans for investments in capital infrastructure to carry out high-cost initiatives, such as the disposal of the national stocks of surplus plutonium and uranium. In addition to his affiliation with LMI, Dr. Gallay is an adjunct faculty member at The George Washington University, where he teaches courses in finance and engineering economics. Before joining LMI, he was a career Army officer who served in military engineer and operations research positions.

Dr. Gallay is a registered professional engineer and a certified cost engineer. He holds a B.S. in engineering from the U.S. Military Academy, an M.S. in civil engineering from Purdue University, an M.S. in systems management from the University of Southern California, and a doctorate in engineering management from The George Washington University.

DOUGLAS A. GRAY, P.E.

Mr. Gray is an LMI consultant with over 30 years of experience in engineering and design, project and program management, and consulting. His industry experience includes the nuclear, environmental, mining, energy, and petrochemical industries. He was past program manager for an independent cost estimating contract with DOE/FM-20. Mr. Gray's focus over the past 15 years has been in support of the U.S. Department of Energy, and in particular, performing independent cost estimates (ICEs), independent cost reviews (ICRs), and external independent reviews (EIRs) of over 50 major DOE projects and programs ranging in cost from $5 million to over $60 billion. These reviews include independent assessment of baseline life-cycle costs, construction/operations cost estimates, D&D costs, work breakdown structures, risk assessments, and contingency analyses.

Prior to his cost assessment work with DOE, Mr. Gray was a Project Manager for Los Alamos Technical Associates, overseeing engineering and design work for projects at several DOE sites, including Rocky Flats and Oak Ridge. He was also General Manager for a start-up company that marketed activated carbon to the North American gold industry. His career includes engineering and design work for Conoco, and he was a senior engineer for Rocky Mountain Energy Company, which focused on coal and uranium mining and processing.

Mr. Gray holds a B.S. in chemical engineering from Iowa State University. He is a registered professional engineer in Colorado and Ohio.

STEPHEN J. GUIDICE

For the past 10 years, Mr. Guidice has been an independent consultant advising the Department of Energy nuclear weapon laboratories, production plants and Nevada Test Site, the Department of Defense, the Congress and private companies.

In his 20-year career (1977-1997) at the DOE Albuquerque Operations Office (DOE/AL), he served in many different leadership positions in the nuclear weapons program, including more than 12 years in Senior Executive Service assignments. He has been a Weapon Program Manager and member of the DoD/DOE Project Officer Group, the Branch Chief for Weapon Surveillance, the Director of

Weapons Quality, the Director of Weapon Production, and the Head of the Office of National Defense Programs with about a $2 billion annual budget—the latter position being responsible for all the previous functions plus Nuclear Explosive Safety. After the end of the Cold War, Mr. Guidice was responsible for developing and managing the massive U.S. weapons dismantlement campaign as well as a plan for reconfiguration of the DOE Nuclear Weapons Complex that led to Secretary of Energy record of decisions in 1993 and 1996. In addition, he has managed large portions of Programs of Cooperation with U.S. allies and the former Soviet Union.

For the last 2 years of his career at DOE/AL, he headed the Office of Energy, Science and Technology, managing a combined $1 billion per year Work-for-Others program at Sandia and Los Alamos National Laboratories.

After graduating college in 1968 and prior to his career with DOE, Mr. Guidice worked as a civilian test engineer in the U.S. Navy's nuclear weapons program. During this period, he worked at Navy installations in Hawaii and California and at Sandia National Laboratories in New Mexico.

DONALD G. TROST

Mr. Trost is the Executive Vice President of TechSource, Inc. and has over 40 years' experience in real estate, facility management, program management, and project management in the federal sector. He spent over 30 years in the executive branch, working for the Corps of Engineers, U.S. Postal Service, and the Department of Energy. Since retiring in 1995 from DOE, he has been a senior program manager and Vice President in three consulting firms, working mainly with DOE, its M&O contractors, and the communities surrounding DOE sites. Since 2004 he has been in charge of all TechSource operations in the Washington, DC area and personally consults with NNSA, Nuclear Energy, Los Alamos, and the Strategic Petroleum Reserve. Mr. Trost has performed numerous business case analyses over his career for the U.S. Postal Service and the Department of Energy and as a private consultant. He was a member of the Secretary of Energy Advisory Board's Panel on Nuclear Weapons Complex Infrastructure and has served on multiple business case analyses for NNSA supporting Complex Transformation.

Mr. Trost has a B.A. in political science from the University of California.

ANTHONY E. WENIG

Mr. Wenig has more than 17 years of experience delivering management and economic consulting services to both commercial and government clients. Mr. Wenig is currently an independent consultant in the Washington, DC, metropolitan area where he provides economic and business consulting services to both the public and private sectors. Prior to being an independent consultant Mr. Wenig was a Director in Citigroup's Corporate and Investment Banking division where he was responsible for building and implementing a strategy to provide critical analytical data to support the Global Technology Services business unit. Prior to Citigroup. Mr. Wenig was a Director in BearingPoint's (formerly KPMG Consulting) Outsourcing Practice where he was responsible for all financial activities related to outsourcing, working with implementation teams to optimize solutions while maintaining profitability, and working with clients to ensure solutions meet financial goals. Prior to joining BearingPoint, Mr. Wenig was an Associate Director at DMR Consulting Group (acquired by Fujitsu Consulting) where he was responsible for delivering management and technology solutions to clients in the Telecommunications Industry. Prior to joining DMR, Mr. Wenig was a consultant to Logistics Management Institute (LMI) where he worked on a massive project to reengineer the way civilian personnel services are delivered in the U.S. Department of the Navy.

Mr. Wenig holds a B.S. in political science and economics from the University of Maryland and an M.B.A. from American University, Washington, DC.

Appendix B
Data Call

This appendix provides the data call used to collect the input data from each site and the data dictionary which describes the information required for the data categories. The data calls were essentially the same for each site and covered the time period 2007-2060, with 2007 being actual costs, where available. The forms reproduced here cover only 2007 and 2008. Two sample data calls are provided:

- Y-12 for both the no construction (case 1a) and new construction (case 2a).
- SRS, which is similar to the Pantex form. This form includes Y-12 pre-transition and transition costs. Hence, Y-12 actually filled out three different data call forms.

The same data call was used for the IPT and IBCA input data. The IBCA team modified the data call to address any differences in its cases and for the additional case, 4b.

DATA DICTIONARY—TYPICAL

The following are copies of an excel spreadsheet used for data call.

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
Case 1 (Current Y-12 + HEUMF): Assumes no new construction after HEUMF. (Phase I: Level 0, Option 1)	
Construction	
HEUMF	TPC for HEUMF project - expected total cost using actuals where available
[Insert Additional Construction Project]	
Construction Total	
Modifications	
PIDAS & Security Upgrades	
DBT Projects	
Security Improvement Proj (SIP)	
DBT Upgrades--incl facilities	
[Insert Additional Modification Project]	
PIDAS & Security Upgrades Sub-Total	

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
Other Planned Modifications - Listed	**Projects specific to Y-12** meeting DBT compliance by 2011
FIRP Projects	Projects to upgrade esisting facility systems (deferred maintenance or fixes to facility systems)
Be Capability	
Emergency Command Center	Projects to assure fire protection facility, plant operations center, and emergency response center
Steam Plant Life Ext	Project to assure steam services required by facilities or operations
Potable Water Upgrades	Project to assure potable water system reliability for next 20-30 years
Modifications Grand Total	
Cap Renewal (costs to maintain existing facilities)	
HEUMF	Expected capital investments over study period to assure HEUMF viability over the period
[Insert Cap Renewal Project]	Expected capital investments over study period to assure viability of all operating facilities over the period
[Insert Cap Renewal Project]	
Cap Renewal Total	
Direct Production Operations	Operations includes Production and production facility O&M, including ES&H direct support.
HEU O&M Cost	Operating and maintenance cost of current HEU operations at Y-12 (labor)
HEU Support Cost	Direct support costs include ES&H, QA, other supporting activities to the production of product. (labor)
Non-HEU O&M Cost	Operating and maintenance cost of current non-HEU operations at Y-12 (production facilities) (labor)
Non-HEU Support Cost	
Waste Treatment Operations Cost	Operating and maintenance cost for waste treatment/management facilities at Y-12 (labor)
HEUMF Operations Costs	Optional breakout for Y-12, if desired to be used. Category carried over from Phase 1.
Direct Support Materials	Materials and goods (non-labor) and outside services (subcontracts) required for direct production activities, not included in labor, construction, or modifications. (NOTE: if you wish to breakdown each of the labor categories with the non-labor costs, you may do so in the next rows, or insert rows.)
Direct Production Operations Costs Total	

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
Indirect Operations (excluding security)	
Legacy Activities	G&A costs for commitments made in the past that must continue--i.e retired employees
Computing Operations	IT and telecommunication costs--operating and facilities/equipment
Utilities	Site utility costs and operation of utilities
Infrastructure Support	Maintenance and operations of non-production facilities and property
Environment, Safety, Health	All supporting ES&H activities required to manage the site in compliant manner
Management & Administration	Overall management of site operations (to be defined)
Fee	M&O management fee for facility operations
[Insert Additional Indirect Operations Costs]	**Note: May choose to use different breakdown of above costs.**
Indirect Operations Costs Total	
Security Operations	
Security for CSA Production Operations	Guns, gates and guards---site cost for SNM protection
Additional Security for HEUMF Operations	Guns, gates and guards---site cost for HEUMF protection (optional breakout for Y-12, category carried over from Phase 1).
Material accountability	Nucllear material control and accountability
Security Management & Services (BWXT)	M&O costs for managing overall security program (including classification, etc)
Infosec--operating only	Separate information security program costs--funded different than above costs
[Insert Additional Security Operations Costs]	
Security Operations Total	
Other Site Costs - Contractor	
[Insert Other Site Costs - Contractor]	Other site costs not identified in categories above---consistent with total site budget
Other Site ContractorTotal	
Other Site Costs - DOE	
Site Office Program Direction	NNSA Site Office cost
[Insert Other Site Costs - DOE]	
Other Site DOE Total	
Transportation Operations (SST)	**Keep information Unclassified in the data sheet. Provide Classified at-**

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
	tachment separately if required
External Y12 Shipments To	Total cost of all SST shipments to and from Uranium Center site
External Y12 Shipments To	
Transporation Operations (SST) Total	

Total Case 1	
Total NNSA Y12 Budget	
Difference	

Personnel (FTE)	(Note: suggested breakdown, you may wish to provide additional categories)
HEU O&M Personnel	
HEU Support Personnel	
CSA O&M Personnel	
CSA Support Personnel	
Waste Treatment Personnel	
HEUMF Operations Personnel	
Security for HEU Personnel	
Additional Security for HEUMF Personnel	
Other Secruity Personnel (MA, MGMT & Support, InfoSec)	
Legacy Activity Personnel	
Computing Operations Personnel	
Utilities Personnel	
Infrastructure Support Personnel	
Environment, Safety, Health Personnel	
Management & Administration Personnel	
[Insert Additional Personnel]	
[Insert Additional Personnel]	
[Insert Additional Personnel]	

Y12 Site Personnel (FTE) Total	
Y12 Contractor Employment, NNSA (EOY From Budget)	
Difference	

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
Case 2: Y-12 to Y-12 (HEU/CSA Ops with HEUMF, UPF, CMC) (Phase I: Level IIB1, Option 5)	
Construction	TPC including Contingency/Management Reserve - identify Cont./MR
Construction From Case 1 Above (Applicable To Case 2)	
HEUMF	TPC for HEUMF project - expected total cost using actuals where available
[Insert Construction Projects From Case 1 As Necessary]	
New Construction For Case 2	
UPF	TPC for new UPF at Y-12 - updated for latest design approach (v.6.0) - if available
PIDAS Reduction Project/Security Upgrades	Projects required to put DBT compliant security perimeter and support systems in place
Consolidated Mfg Complex (CMC)	TPC for a new CMC
Waste Treatment Facitily (if any)	Construction of any new facilities required by other sites to support CSA mission
Other General Construction - Warehouse, office, etc. (if any)	
[Insert Construction Project]	
New Construction For Case 2 Total	Totals new construction for Case 2 only
Construction Total	
Modifications	
Modifications From Case 1 Above (Applicable To Case 2)	
PIDAS & Security Upgrades Sub-Total	**Projects specific to Y-12** meeting DBT compliance by 2011
FIRP Projects	Projects to upgrade esisting facility systems (deferred maintenance or fixes to facility systems)
Be Capability	
Emergency Command Center	Projects to assure fire protection facility, plant operations center, and emergency response center
Steam Plant Life Ext	Project to assure steam services required by facilities or operations
Potable Water Upgrades	Project to assure potable water system reliability for next 20-30 years
[Insert Modifications Projects From Case 1 As Necessary]	Other infrastructure projects to upgarde existing facilities/services required to support the CSA mission
New Modifications For Case 2	
[Insert Facility Modifications Project]	Modifications required to existing facilities planned to support the CSA mission
Modifications Total	
Cap Renewal (costs to maintain new & existing facilities)	
Existing Facilities	

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
HEUMF	Expected capital investments over study period to assure HEUMF viability over the period
[Insert Cap Renewal Project]	Expected capital investments over study period to assure viability of all operating facilities over the period
New Facilities	
UPF	Expected capital investments over study period to assure UPF viability over the period
CMC	Expected capital investments over study period to assure CMC viability over the period
[Insert Cap Renewal Project]	Expected capital investments over study period to assure viability of all new operating facilities over the period
Cap Renewal Total	
Direct Production Operation	
Direct Production Operations	Operations includes all Production and production facility O&M.
Pre-Transition Operations	
HEU Operations	Operating and maintenance cost of current HEU operations at Y-12 (labor)
HEU Support	Direct support costs for operating and maintenance of current HEU operations at Y-12, including ES&H direct support (labor)
Non-HEU Operations	Operating and maintenance cost of current non-HEU operations at Y-12 (production facilities) (labor)
Non-HEU Support	Direct Support costs to operating and maintenance of current non-HEU operations at Y-12 (production facilities) (labor)
Waste Management Operations	Operating and maintenance cost for waste treatment/management facilities at Y-12 (labor)
Direct Support Materials	Materials and goods (non-labor) and services (including subcontracts) required for direct production activities, not included in labor, construction, or modifications
Transition Operations	Transition includes going to safe shutdown and process cleanout for old production facilities
HEU Operations	Operating and maintenance cost of HEU operations for existing and new facilities
HEU Support	Direct support costs for operating and maintenance of new and existing HEU operations at Y-12, including ES&H direct support
Non-HEU Operations	Operating and maintenance cost of non-HEU production operations for existing and new facilities

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
Non-HEU Support	Direct Suport costs to operating and maintenance of existing and new non-HEU operations at Y-12 (production facilities)
Waste Mangement Operations	Operating and maintenance cost of waste management operations for existing and new facilities
Direct Support Materials	Materials, goods and services required for direct production activities, not included in labor, construction, or modifications
Transition Costs - non labor	Additional direct support costs other than labor, including subcontracts, to hire, clear, train additional staff; severance and relocation costs, if any. Costs not included in Indirect costs
Post Transition Operations	
HEU Operations	New Facilities-Operating and maintenance cost for operating all HEU facilities (HEUMF and UPF)
HEU Support	Direct support costs for operating and maintenance of new HEU operations at Y-12, including ES&H direct support
Non-HEU Operations	New Facilities-Operating and maintenance cost for operating all other production facilities
Non-HEU Support	Direct Suport costs to operating and maintenance of new non-HEU operations at Y-12 (production facilities)
Waste Management Operations	New Facilities-Operating and maintenance cost for waste management
Direct Support Materials	Materials, goods and services required for direct production activities, not included in labor, construction, or modifications. Includes work for others under contract. Not part of NNSA budgets
Direct Production Operations Total	
Indirect Operations (excluding security)	
Legacy Activities	G&A costs for commitments made in the past that must continue--i.e retired employees
Computing Operations	IT and telecommunication costs--operating and facilities/equipment
Utilities	Site utility costs and operation of utilities
Infrastructure Support	Maintenance and operations of non-production facilities and property
Environment, Safety, Health	All supporting ES&H activities required to manage the site in compliant manner
Management & Administration	Overall management of site operations (to be defined)
Fee	M&O management fee for facility operations
[Insert Additional Indirect Operations Costs]	**Note: May choose to use different breakdown of above costs.**

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
[Insert Additional Indirect Operations Costs]	
Indirect Operation Costs Total	
Security Operations	
Security for Direct Production Operations	Guns, gates and guards---site cost for SNM protection
Material accountability	Nuclear material control and accountability
Security Management & Services (B&W Pantex)	M&O costs for managing overall security program (including classification, etc)
Infosec--operating only	Separate information security program costs--funded different than above costs
[Insert Additional Security Operations Costs]	
Security Operations Total	
Other Site Costs - Contractor	
[Insert Other Site Costs - Contractor]	Other site costs not identified in categories above---consistent with total site budget
Other Site Contractor Total	
Other Site Costs - DOE	
Site Office Program Direction	NNSA Site Office cost
[Insert Other Site Costs - DOE]	
Other Site DOE Total	
Transportation Operations (SST) - Data to go to OST (not part of Y-12 budget)	**Keep information Unclassified in the data sheet. Provide Classified attachment separately if required**
External Y12 Shipments To	Total cost of all SST shipments to and from Uranium Center site
External Y12 Shipments To	
Transportation Operations (SST) Total	
Total Case 2 (without transportation)	
Total Y12 Budget	
Difference	
Personnel (FTE) -- Include Phase In/Out	
Operations Peronnel (FTE) -- Include Phase In/Out	
HEU O&M Personnel	
HEU Support Personnel	
Non-HEU O&M Personnel	

NNSA Complex Transformation Phase II Urainium Business Case Analysis: Data Collection Template

Cost Category/Project Name	Data Dictionary - Category Definitions
Non-HEU Support Personnel	
Waste Treatment Personnel	
Security for CSA Operations	
Other Security Personnel (MA, MGMT & Support, InfoSec)	
Legacy Activity Personnel	
Computing Operations Personnel	
Utilities Personnel	
Infrastructure Support Personnel	
Environment, Safety, Health Personnel	
Management & Administration Personnel	
[Insert Additional Personnel]	
[Insert Additional Personnel]	
[Insert Additional Personnel]	
Personnel (FTE) Total	Compare to site total - all site personnel to be counted

Appendix C
Construction Cost and Schedule Assumptions and Results

This appendix describes the objective, approach, assumptions, and cost basis used by the team to develop independent construction costs for HEU processing and storage facilities and non-HEU manufacturing facilities at three separate sites around the DOE complex. It also presents the results from the team's independent analysis.

The overall objective is to develop independent estimates to construct HEU processing and storage facilities and non-HEU manufacturing facilities at Y-12, Pantex, and SRS. The current effort builds on the work performed during Phase I, which relied primarily on cost estimate information provided by individual sites for many nuclear and nonnuclear projects in various stages of design and construction and some actual costs for projects completed and operating.

The team's approach for this report was to take a closer and more in-depth look at the specific projects encompassed in this study, analyze the site costs in more detail, and adjust the costs as the team determined reasonable. This implies that the costs developed by the team may differ from those estimated by the site. In addition, the team attempted to apply site differentiators to the estimates on the basis of known or perceived differences in the costs to construct facilities at the three sites of interest.

The database utilized in this study includes the following:

- Costs incurred and the estimated cost and schedule to complete HEUMF at Y-12
- Y-12 CD-1 cost and schedule estimates for UPF
- Y-12 cost information for CMC.

The team's overall approach was to develop more definitive design and construction estimates primarily for HEUMF, UPF, and CMC. The team then applied these new facility construction estimates to Y-12, SRS, and Pantex using known differentiators at each site.

All cost estimates in this IBCA

- reflect constant FY08 dollars,

- include all required processing and analytical equipment, and
- show the total project cost (TPC), which includes the total estimated cost (TEC) and other project costs (OPCs).

HEUMF/HEU STORAGE

HEUMF is in the late construction and startup phase at Y-12. Construction was completed in August 2008. CD-4 is scheduled 18 months later. Actual costs are available, the facility is well along toward completion, and the team has familiarity with the project through a number of previous cost reviews. Table C-1 summarizes the current cost baseline, the August 2007 updated estimate, and our independent estimate.

Table C-1. HEUMF Y-12 Costs ($ million)

Cost category	Current baseline	August 2007 update	IBCA estimate
TEC	467.4	463.8	—
OPCs	81.7	74.0	—
TPC	549.1	537.8	538–598

The team's estimate is premised on the results of a recent independent cost review performed by members of this team. The independent estimate represents a cost range, which assumes a low cost ($538 million) equivalent to the August 2007 updated estimate and an upper cost ($598 million) that assumes the construction phase takes 6 months longer than planned with no change in the 18-month subsequent start-up. For purposes of the cost model, the team assumed the IBCA cost for HEUMF is the same as the current baseline: $549 million. The range used in the analytical model was an uncertainty range around the baseline cost.

The HEUMF costs presented above pertain strictly to the facility currently being constructed at Y-12. The team then estimated the costs for a similar HEU storage facility at SRS and Pantex. The costs to construct and start up a similar storage facility at another site should be less than those encountered at Y-12. HEUMF experienced a number of problems that significantly added to the cost, which should not be repeated. These problems and delays included

- redesign per the 2004 DBT,
- security door vendor bankruptcy,
- rebar quality issues and work suspension, and
- additional M&A (hotel) costs due to work suspension and schedule delay.

Thus, the team estimated the "should cost," taking into account the known problems, delays, and rework at Y-12. Using best judgment, the team considers the "should cost" for an 110,000-square-foot HEU storage facility is about $440 million. For SRS and Pantex, the team starts with the "should cost" as the base and applies appropriate deltas on the basis of differentiators. Table C-2 shows the results of the team's "should-cost" analysis.

Table C-2. HEU Storage Cost Adjustments ($ million)

Description	SRS	Pantex
Base cost	440	440
Construction labor differences (+5%)	0	22
Working in protected area (+9.5%)	0	44
Total cost	440	506

The team did not identify any significant differentiators for construction at SRS.

For Pantex, the construction labor differences account for the historic difficulty of attracting local (Amarillo-based) construction trades and subcontractors to work at Pantex. The team considers that large-scale projects such as HEU storage and UPF will require importing and supporting skilled trades from other areas of the country, which will result in a premium on construction labor costs. The net effect is estimated at a 5 percent increase in the TPC.

The 9.5 percent increase in costs due to working in the protected area at Pantex is based on the site's assessment and caused by the extra time, security, and associated complications of working in a highly secure area. The estimate is based on previous experience.

UPF

The cost estimate for the UPF is essentially unchanged from the Phase 1 report. The current estimate ($2.173 billion escalated) is based largely on data received during Phase 1, and the team accepts the estimate as is. The team reviewed the summary-level cost report provided by the project team. The project costs included the HEU production equipment.

The project team is developing a new preliminary design building arrangement and cost estimate. The new arrangement results in an improved design that should aid construction. The project team is also completing a new cost estimate; however, this information was not finalized at the time of the team's review. The cost data used are the same for all sites (with the adjustments needed at Pantex), so a change in the cost, should that occur, would not have a major effect on the results of the study. Table C-3 provides the UPF cost breakdown.

Table C-3. UPF Construction Estimate ($ million)

Cost category	Phase 1 estimate	2/11/08 estimate
Construction	872	1,078
TEC	1,586	1,314
OPCs	414	332
Contingency	—	527
TPC	2,000	2,173

Using a 3 percent annual escalation, and the cost profile provided by the site (which shows the project being designed, constructed, and started up in 2007-2018), the team estimates the constant-dollar cost of UPF (FY08 dollars) at $1.9 billion. This is the starting base case estimate for Cases 2a, 3a, 4a, and 4b.

For SRS and Pantex, the team applied appropriate deltas based on differentiators. Table C-4 provides the results.

Table C-4. UPF Cost Adjustments ($ million)

Cost category	SRS, Case 3a	Pantex, Case 4a	Pantex, Case 4b
Base cost	1,900.0	1,900.0	1,900.0
Deduction for Y-12 PIDAS costs	−18.4	−18.4	−18.4
Construction labor differences (+5%)	0.0	95.0	95.0
Working in a protected area (+9.5%)	0.0	189.0	0.0
Total	1881.6	2,165.6	1,976.6

The team did do not identify any significant differentiators for construction at SRS, other than adjusting the base to remove the imbedded PIDAS costs from the Y-12 estimate. PIDAS costs are a separate item in the list of construction projects.

For Pantex, the construction labor differences account for the historic difficulty of attracting local (Amarillo-based) construction trades and subcontractors to work at Pantex. The team considers large-scale projects such as HEU storage and UPF will require importing and supporting skilled trades from other areas of the country, which will result in a premium on construction labor costs. The net effect is a 5 percent increase in the TPC.

The 9.5 percent increase in costs due to working in the protected area at Pantex is based on the site's assessment and caused by the extra time, security, and associated complications of working in a highly secure area. The estimate is based on previous experience. The imbedded PIDAS costs were also removed.

CMC

Rough parametric data and equipment costs are available from Y-12 (August 2007). On the basis of existing Y-12 operations, Table C-5 provides the estimated square footage for a new CMC.

Table C-5. CMC Building Areas (square feet)

Area	8/07 concept production area	8/07 concept total area
Lithium	23,880	35,820
DU	23,900	40,630
Non-rad manufacturing	54,430	81,645
General support	17,000	25,500
Total	119,210	183,595

From the conceptual areas shown above, the Y-12 staff based its cost estimate of $1 billion on a CMC of 130,000 square feet.

The IBCA team chose to develop an independent parametric cost estimate by

- applying cost-estimating relationships,
- using benchmarks from applicable DOE projects,
- professional judgment, and
- applying percentages for construction management (CM), project management (PM), Title III, and contingency consistent with NNSA benchmarks.

The basis of the CMC independent estimate includes the following:

- A total building area of 130,000 square feet (consistent with the area assumed by the IPT)
- An applied “as-is” Y-12 cost estimate for installed, government-furnished equipment (GFE) based on vendor quotes, historical purchases, and judgment
- Cost data from several similar projects
  - Microsystems Engineering and Science Applications (MESA)
  - High Explosive Pressing Facility (HEPF)
  - Biological Sciences Facility—PNNL

- ➤ Waste Receiving and Processing (WRAP)

- ◆ General requirements at 20 percent of direct construction costs, including general conditions, home office costs, bond, and fee
- ◆ Title I and II design costs at 20 percent of total construction cost (TCC)—15 percent for design and 5 percent for design management (conventional buildings usually are about 15 percent)
- ◆ Construction management at 10 percent of TCC
- ◆ Project management at 10 percent of the total of design costs and TCC and 5 percent of the GFE
- ◆ Title III ED&I at 7 percent of TCC
- ◆ Contingency at 25 percent for both TEC and OPC components and 10 percent on GFE
- ◆ OPCs at 16 percent of TEC, excluding TEC contingency
- ◆ Costs in constant FY08 dollars.

Table C-6 shows the team's independent parametric cost estimate for the CMC.

Table C-6. CMC Independent Cost Estimate ($ million)

Category	Estimated cost
Title I and II design and engineering	15.7
TCC	78.5
GFE (process equipment)	195.2
CM, PM, Title III design, engineering and inspection	32.5
Contingency	51.2
Subtotal—TEC	373.0
OPCs	51.5
Contingency on OPCs	12.9
Subtotal—OPCs	64.4
TPC	437.4

Table C-7 compares the team's independent estimate with similar and contrasting projects.

Table C-7. CMC Independent Cost Estimate Comparison

Project	TPC ($ million)	Area (ft^2)	Estimated cost ($\$/ft^2$)
CMC	437.4	130,000	3,365
HEUMF	549	110,000	4,991
UPF	2,200	388,000	5,670
CMRR	1,470	216,000	6,800
MOX	4,800	498,000	9,700
CEF	171	72,000	2,375

From the above, on the basis of square feet only, CMC costs 32–65 percent less than nuclear production and storage facilities. The team considers this is credible and reasonable.

For SRS and Pantex, the team applied appropriate deltas based on differentiators (Table C-8).

Table C-8. CMC Cost Adjustments ($ million)

Description	SRS	Pantex
Base cost	437.4	437.4
Construction labor differences (+5%)	0	21.0
Total cost	437.4	458.4

The team did not identify any significant differentiators for construction at SRS.

For Pantex, the construction labor differences account for the historic difficulty of attracting local (Amarillo-based) construction trades and subcontractors to work at Pantex. The team considers that large-scale projects such as HEU storage, UPF, and CMC will require importing and supporting skilled trades from other areas of the country, which will result in a premium in construction labor costs. The net effect is a 5 percent increase in the TPC.

No cost adjustment is required for construction in the protected area because CMC would be built outside the PIDAS.

INFRASTRUCTURE AND SUPPORT FACILITIES

The Purification Facility is estimated to cost $40 million without a new building on the basis of actual costs incurred at Y-12. For purposes of the cost model, an estimate of $50 million was used for new construction, which includes a building.

The ancillary facilities include primarily waste processing, engineering support, and a warehouse—the team uses Phase 1 cost data for the model or the data provided by the individual sites and compared to ensure that the costs were appropriate.

CONSTRUCTION COST SUMMARY

Table C-9 shows a cost comparison between the construction costs used for the IPT analysis (inputs provided to the IBCA team) and the construction cost used by the IBCA team for its analysis.

Table C-9. Construction Cost Comparison ($ million)

Team	Y-12 Case 2a		SRS Case 3a		Pantex (IP) Case 4a		Pantex (OP) Case 4b	
	08$	TPC	08$	TPC	08$	TPC	08$	TPC
HEUMF (110,000 ft^2)								
IPT	—	549	—	—	—	—	—	—
IBCA	—	549	—	—	—	—	—	—
HEU Storage (110,000 ft^2)								
IPT	—	—	550	652	590	840		
IBCA	—	—	440	515	506	707	462	557
UPF (388,000 ft^2) with production equipment[a]								
IPT	1,900	2,200	2,047	2,466	2,290	3,100	—	—
IBCA	1,900	2,200	2,047	2,466	2,331	3,234	2,142	2,654
CMC (130,000 ft^2) with production equipment								
IPT	1,000	1,215	1,000	1,324	1,000	1,439	—	—
IBCA	437	527	437	557	458	669	458	669

Note: TPC is in year-of-performance dollars.
[a] Assumes UPF design continues at Y-12 to CD-2 (8/2010) at a cost of $165 million.

UNCERTAINTY RANGES FOR CONSTRUCTION ESTIMATES

As discussed in Section 7.1, the team used uncertainty ranges to account for estimating errors. For this stage of estimates, the uncertainty is relatively high, so the ranges are broad. The exception is HEUMF, for which the costs are fairly well known because construction is nearly complete. Table C-10 shows the uncertainty ranges that the IBCA team used for construction estimates. The site IPTs provided initial input for the ranges, and the IBCA team adopted or modified the ranges depending on whether the cost estimate was changed by the IBCA team.

Table C-10. Uncertainty Ranges for Construction Estimates (percent)

Construction cost category	Y-12	SRS	PX (4a)	PX (4b)
HEUMF/HEU storage	90–110	90–150	90–150	90–150
UPF	90–150	90–150	90–150	90–150
CMC	90–150	90–150	90–150	90–150
Purification facility	—	80–150	80–150	80–150
Waste treatment facility	—	—	90–150	90–150
Security	90–120	75–125	90–150	90–150
Other	90–130	80–170	90–150	90–150

SCHEDULES FOR CONSTRUCTION AND TRANSITION

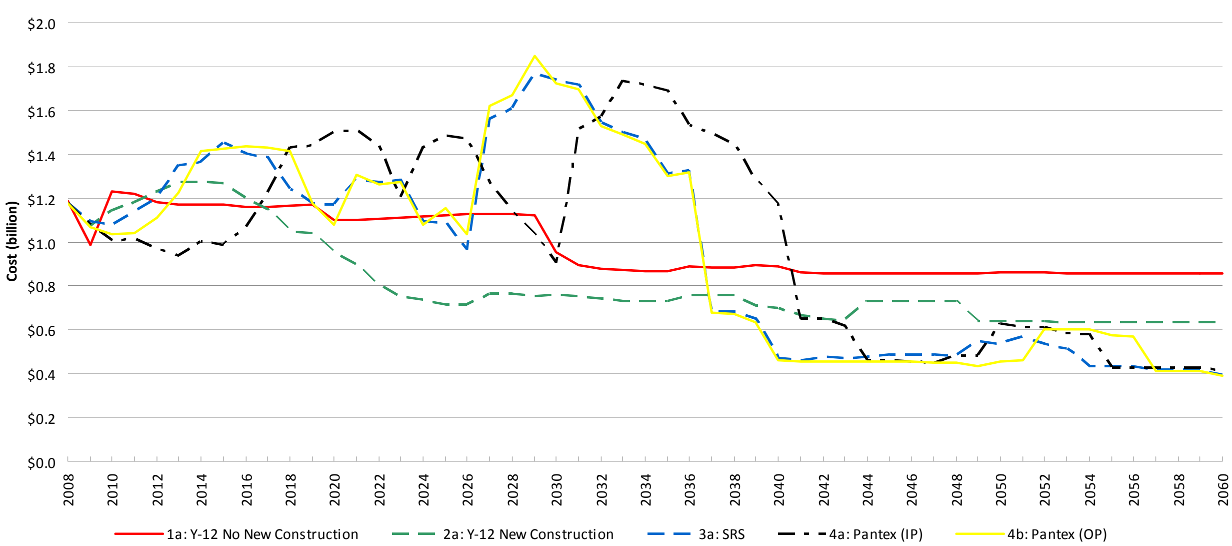
The team prepared construction and transition schedules for each case using the schedules provided by the sites as a starting point. Figure C-1 shows the Y-12 Case 2a schedule, which shows the completion of the major construction in FY18 followed by the readiness (testing and start-up operations) at the end of FY19. Transition from existing facilities to new facilities is estimated at about 2 years, and full operations commence in FY22. Figure C-2 shows SRS Case 3a completing major construction and start-up in FY20 and transition completing in FY22. Operations commence in FY23. Figure C-3 shows the Pantex Case 4a schedule with construction and start-up completing in FY25 and transition completing in FY27. Figure C-4 shows the schedule for Pantex Case 4b with construction and start-up completing in early FY21 and transition completing in early FY23.

Appendix D
Model Inputs, Distributions, and Results

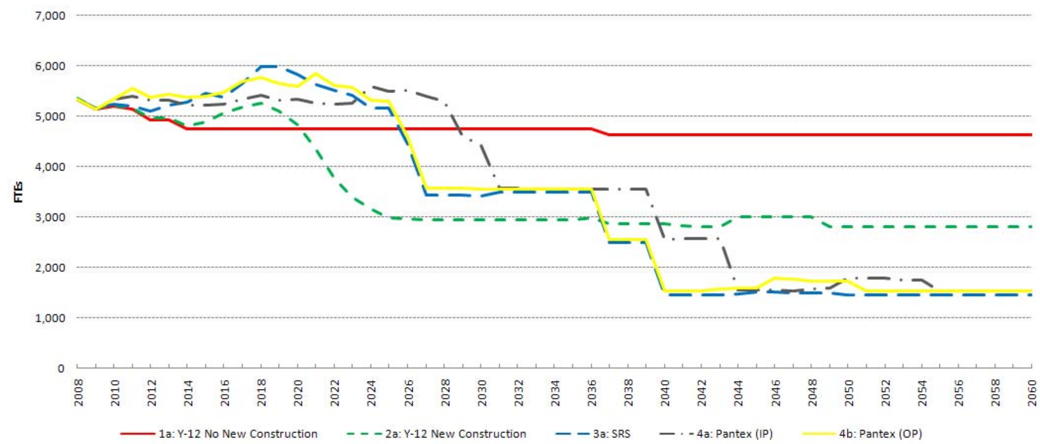
MODEL SUMMARY INPUTS: BASE CASE

Cost Organized By Cost Category										
Cost Category	2008 - 2060 Total Cost (Uninflated)					Percent Of Total				
	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)	Case 1 (Y-12)	Case 2 (Y-12)	Case 3 (SRS)	Case 4a (PX)	Case 4b (PX)
HEUMF (Construction)	$0.3	$0.3	$0.7	$0.8	$0.7	0.5%	0.6%	1.4%	1.4%	1.4%
UPF (Construction)	$0.1	$1.9	$2.0	$2.3	$2.1	0.1%	4.3%	4.0%	4.4%	4.2%
CMC (Construction)	$0.0	$0.4	$0.4	$0.5	$0.5	0.0%	1.0%	0.9%	0.9%	0.9%
Purification (Construction)	$0.0	$0.0	$0.1	$0.1	$0.1	0.0%	0.0%	0.1%	0.1%	0.1%
Waste Treatment (Construction)	$0.0	$0.0	$0.0	$0.0	$0.0	0.0%	0.0%	0.0%	0.1%	0.1%
Security -- PIDAS (Construction)	$0.1	$0.5	$0.2	$0.1	$0.1	0.1%	1.2%	0.4%	0.1%	0.2%
General (Construction)	$0.0	$0.0	$0.0	$0.3	$0.2	0.0%	0.0%	0.1%	0.5%	0.3%
Modifications Projects	$5.3	$0.6	$0.7	$0.6	$0.6	10.2%	1.4%	1.3%	1.2%	1.2%
Capital Renewal Projects	$0.1	$0.6	$0.7	$0.7	$0.6	0.2%	1.4%	1.3%	1.3%	1.2%
Direct Operations (Labor) - Pre-Transition	$10.9	$2.3	$3.3	$3.9	$3.3	20.9%	5.3%	6.4%	7.4%	6.4%
Direct Operations (Labor) - Transition	$0.0	$0.9	$0.3	$0.2	$0.2	0.0%	2.0%	0.6%	0.4%	0.4%
Direct Operations (Labor) - Post-Transition	$0.0	$4.8	$12.2	$10.2	$10.3	0.0%	11.1%	24.0%	19.1%	20.3%
Direct Support Materials (Non-Labor)	$8.7	$8.2	$8.7	$8.8	$8.7	16.8%	19.0%	17.1%	16.6%	17.1%
Indirect Costs	$18.7	$15.6	$8.3	$11.2	$10.2	36.0%	35.9%	16.4%	21.1%	20.1%
Security Operations	$6.1	$4.9	$3.7	$3.5	$3.2	11.7%	11.3%	7.3%	6.6%	6.3%
Other Site Contractor Costs	$0.0	$0.0	$0.0	$0.2	$0.2	0.0%	0.0%	0.0%	0.4%	0.4%
Other Site DOE Costs	$0.8	$0.8	$0.6	$0.9	$0.8	1.5%	1.7%	1.2%	1.6%	1.6%
Transportation	$1.0	$1.0	$1.3	$1.2	$1.2	1.9%	2.3%	2.5%	2.3%	2.4%
D&D	$0.0	$0.6	$7.7	$7.7	$7.7	0.0%	1.4%	15.1%	14.4%	15.1%
Total	**$52.1**	**$43.3**	**$50.8**	**$53.2**	**$50.8**	**100%**	**100%**	**100%**	**100%**	**100%**

Inputs Charted—Base Case



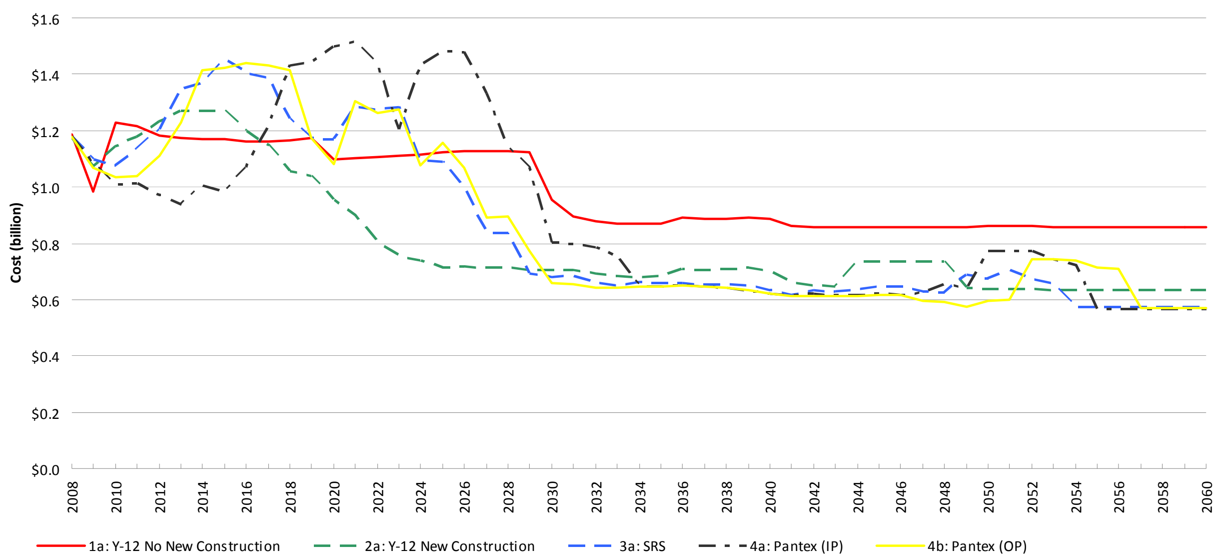
Total FTEs—Base Case



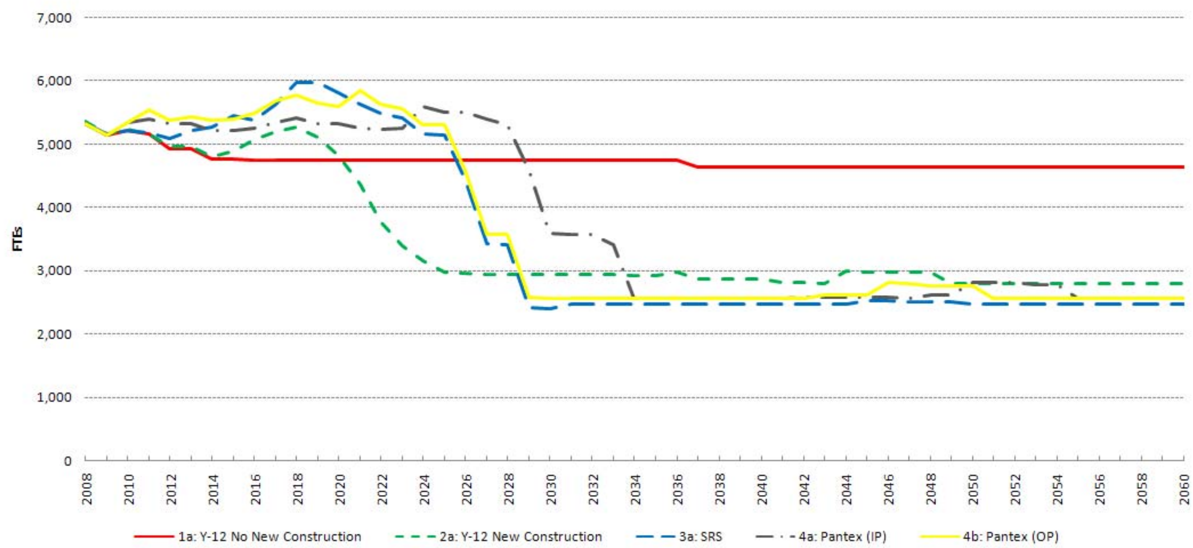
MODEL SUMMARY INPUTS: NO D&D

Cost Organized By Cost Category										
Cost Category	2008 - 2060 Total Cost (Uninflated)					Percent Of Total				
	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)
HEUMF (Construction)	$0.3	$0.3	$0.7	$0.8	$0.7	0.5%	0.6%	1.5%	1.6%	1.6%
UPF (Construction)	$0.1	$1.9	$2.0	$2.3	$2.1	0.1%	4.4%	4.5%	4.9%	4.7%
CMC (Construction)	$0.0	$0.4	$0.4	$0.5	$0.5	0.0%	1.0%	1.0%	1.0%	1.0%
Purification (Construction)	$0.0	$0.0	$0.1	$0.1	$0.1	0.0%	0.0%	0.1%	0.1%	0.1%
Waste Treatment (Construction)	$0.0	$0.0	$0.0	$0.0	$0.0	0.0%	0.0%	0.0%	0.1%	0.1%
Security -- PIDAS (Construction)	$0.1	$0.5	$0.2	$0.1	$0.1	0.1%	1.2%	0.4%	0.2%	0.3%
General (Construction)	$0.0	$0.0	$0.0	$0.3	$0.2	0.0%	0.0%	0.1%	0.6%	0.4%
Modifications Projects	$5.3	$0.6	$0.7	$0.6	$0.6	10.2%	1.5%	1.5%	1.4%	1.3%
Capital Renewal Projects	$0.1	$0.6	$0.7	$0.7	$0.6	0.2%	1.4%	1.5%	1.5%	1.4%
Direct Operations (Labor) - Pre-Transition	$10.9	$2.3	$3.3	$3.9	$3.3	20.9%	5.3%	7.2%	8.3%	7.2%
Direct Operations (Labor) - Transition	$0.0	$0.9	$0.3	$0.2	$0.2	0.0%	2.0%	0.6%	0.5%	0.5%
Direct Operations (Labor) - Post-Transitior	$0.0	$4.8	$14.3	$11.9	$12.4	0.0%	11.3%	31.5%	25.1%	27.4%
Direct Support Materials (Non-Labor)	$8.7	$8.2	$8.7	$8.8	$8.7	16.8%	19.2%	19.2%	18.6%	19.2%
Indirect Costs	$18.7	$15.6	$8.3	$11.2	$10.2	36.0%	36.4%	18.3%	23.7%	22.5%
Security Operations	$6.1	$4.9	$3.7	$3.5	$3.2	11.7%	11.5%	8.2%	7.4%	7.1%
Other Site Contractor Costs	$0.0	$0.0	$0.0	$0.2	$0.2	0.0%	0.0%	0.0%	0.5%	0.5%
Other Site DOE Costs	$0.8	$0.8	$0.8	$1.0	$0.9	1.5%	1.8%	1.7%	2.0%	2.1%
Transportation	$1.0	$1.0	$1.3	$1.2	$1.2	1.9%	2.4%	2.8%	2.6%	2.7%
D&D & ER	$0.0	$0.0	$0.0	$0.0	$0.0	0.0%	0.0%	0.0%	0.0%	0.0%
Total	**$52.1**	**$42.7**	**$45.4**	**$47.3**	**$45.4**	**100%**	**100%**	**100%**	**100%**	**100%**

Inputs Charted—No D&D



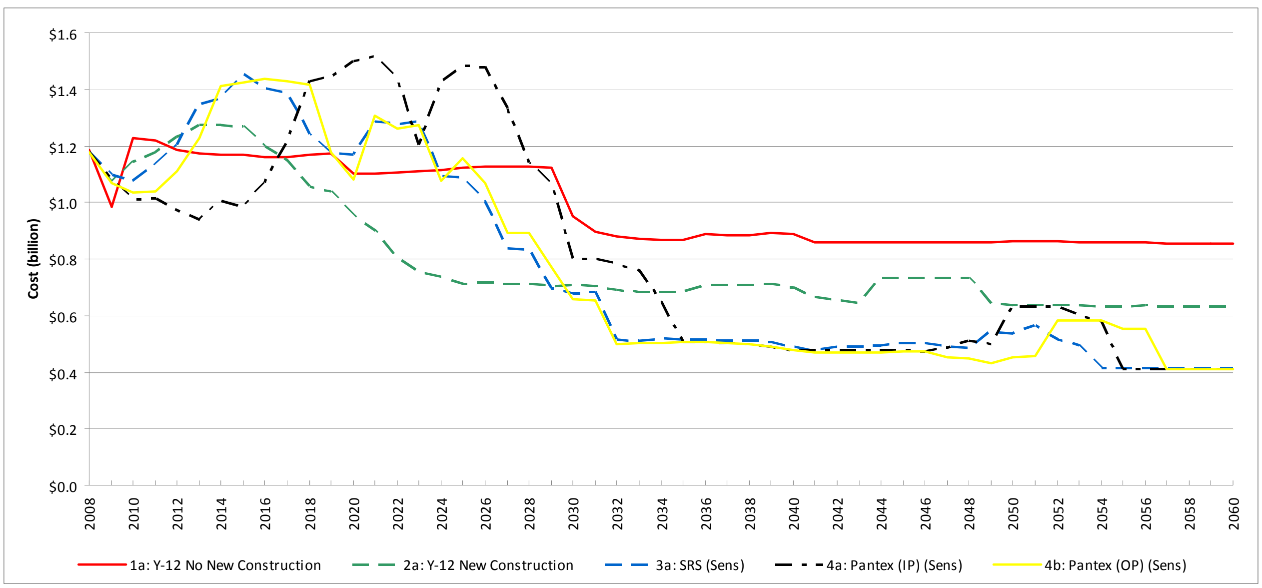
Total FTEs—No D&D



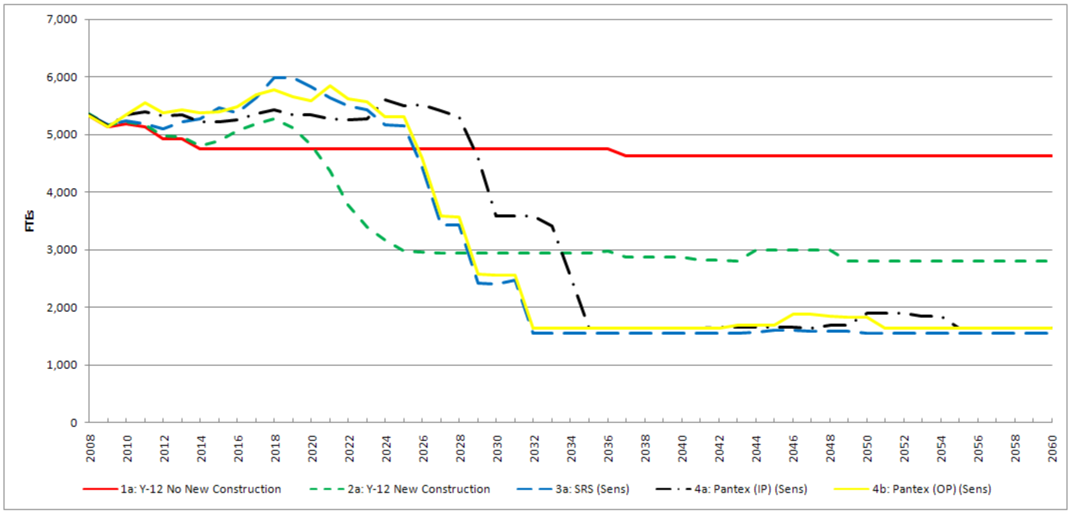
Model Summary Inputs: Reduced S&M

Cost Organized By Cost Category										
Cost Category	2008 - 2060 Total Cost (Uninflated)					Percent Of Total				
	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)
HEUMF (Construction)	$0.3	$0.3	$0.7	$0.8	$0.7	0.5%	0.6%	1.7%	1.8%	1.8%
UPF (Construction)	$0.1	$1.9	$2.0	$2.3	$2.1	0.1%	4.4%	5.0%	5.4%	5.2%
CMC (Construction)	$0.0	$0.4	$0.4	$0.5	$0.5	0.0%	1.0%	1.1%	1.1%	1.1%
Purification (Construction)	$0.0	$0.0	$0.1	$0.1	$0.1	0.0%	0.0%	0.1%	0.1%	0.1%
Waste Treatment (Construction)	$0.0	$0.0	$0.0	$0.0	$0.0	0.0%	0.0%	0.0%	0.1%	0.1%
Security -- PIDAS (Construction)	$0.1	$0.5	$0.2	$0.1	$0.1	0.1%	1.2%	0.5%	0.2%	0.3%
General (Construction)	$0.0	$0.0	$0.0	$0.3	$0.2	0.0%	0.0%	0.1%	0.6%	0.4%
Modifications Projects	$5.3	$0.6	$0.7	$0.6	$0.6	10.2%	1.5%	1.6%	1.5%	1.5%
Capital Renewal Projects	$0.1	$0.6	$0.7	$0.7	$0.6	0.2%	1.4%	1.6%	1.6%	1.5%
Direct Operations (Labor) - Pre-Transition	$10.9	$2.3	$3.3	$3.9	$3.3	20.9%	5.3%	7.9%	9.0%	7.9%
Direct Operations (Labor) - Transition	$0.0	$0.9	$0.3	$0.2	$0.2	0.0%	2.0%	0.7%	0.5%	0.5%
Direct Operations (Labor) - Post-Transition	$0.0	$4.8	$10.2	$8.2	$8.3	0.0%	11.3%	24.7%	18.9%	20.2%
Direct Support Materials (Non-Labor)	$8.7	$8.2	$8.7	$8.8	$8.7	16.8%	19.2%	21.1%	20.2%	21.2%
Indirect Costs	$18.7	$15.6	$8.3	$11.2	$10.2	36.0%	36.4%	20.2%	25.8%	24.9%
Security Operations	$6.1	$4.9	$3.7	$3.5	$3.2	11.7%	11.5%	9.1%	8.1%	7.8%
Other Site Contractor Costs	$0.0	$0.0	$0.0	$0.2	$0.2	0.0%	0.0%	0.0%	0.5%	0.6%
Other Site DOE Costs	$0.8	$0.8	$0.6	$0.8	$0.8	1.5%	1.8%	1.5%	1.9%	1.9%
Transportation	$1.0	$1.0	$1.3	$1.2	$1.2	1.9%	2.4%	3.1%	2.9%	3.0%
D&D & ER	$0.0	$0.0	$0.0	$0.0	$0.0	0.0%	0.0%	0.0%	0.0%	0.0%
Total	**$52.1**	**$42.7**	**$41.1**	**$43.6**	**$41.1**	**100%**	**100%**	**100%**	**100%**	**100%**

Inputs Charted—Reduced S&M



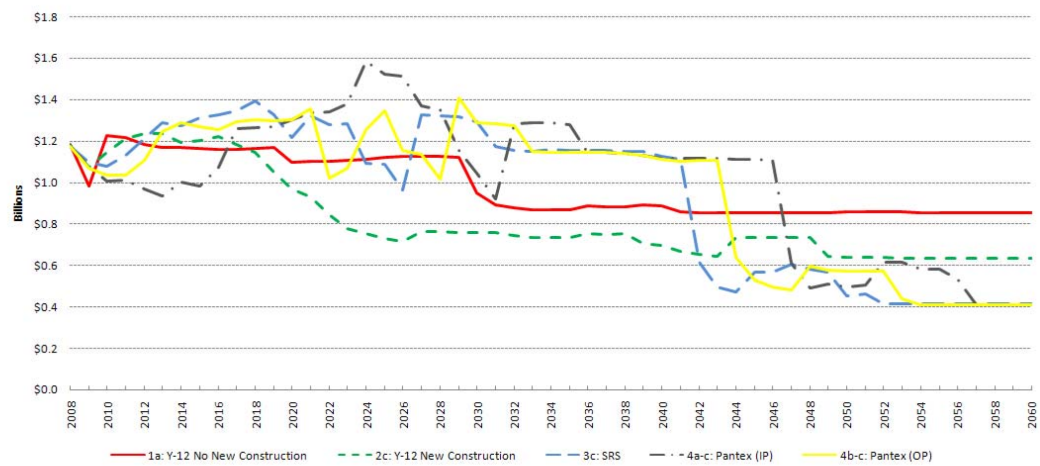
Total FTE—Reduced S&M



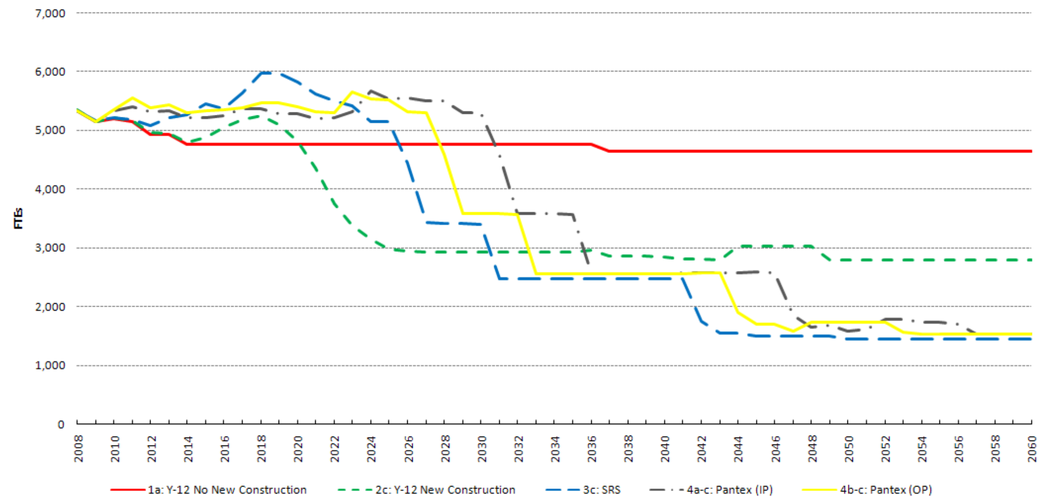
Model Summary Inputs: Constrained Construction

Cost Organized By Cost Category										
Cost Category	2008 - 2060 Total Cost (Uninflated)					Percent Of Total				
	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)	Case 1a (Y-12)	Case 2a (Y-12)	Case 3a (SRS)	Case 4a (PX)	Case 4b (PX)
HEUMF (Construction)	$0.3	$0.3	$0.7	$0.8	$0.7	0.5%	0.6%	1.4%	1.4%	1.4%
UPF (Construction)	$0.1	$1.9	$2.0	$2.3	$2.1	0.1%	4.3%	4.1%	4.3%	4.2%
CMC (Construction)	$0.0	$0.4	$0.4	$0.5	$0.5	0.0%	1.0%	0.9%	0.9%	0.9%
Purification (Construction)	$0.0	$0.0	$0.1	$0.0	$0.0	0.0%	0.0%	0.1%	0.1%	0.1%
Waste Treatment (Construction)	$0.0	$0.0	$0.0	$0.0	$0.0	0.0%	0.0%	0.0%	0.1%	0.1%
Security -- PIDAS (Construction)	$0.1	$0.5	$0.2	$0.1	$0.1	0.1%	1.2%	0.4%	0.1%	0.2%
General (Construction)	$0.0	$0.0	$0.0	$0.3	$0.2	0.0%	0.0%	0.1%	0.5%	0.3%
Modifications Projects	$5.3	$0.6	$0.7	$0.7	$0.6	10.2%	1.4%	1.3%	1.3%	1.2%
Capital Renewal Projects	$0.1	$0.6	$0.7	$0.7	$0.6	0.2%	1.3%	1.3%	1.3%	1.2%
Direct Operations (Labor) - Pre-Transition	$10.9	$2.5	$3.3	$4.2	$3.6	20.9%	5.8%	6.5%	7.9%	7.1%
Direct Operations (Labor) - Transition	$0.0	$0.9	$0.3	$0.2	$0.2	0.0%	2.0%	0.6%	0.4%	0.4%
Direct Operations (Labor) - Post-Transition	$0.0	$4.7	$11.7	$9.3	$9.5	0.0%	10.8%	23.2%	17.3%	18.7%
Direct Support Materials (Non-Labor)	$8.7	$8.3	$8.7	$9.1	$8.7	16.8%	19.0%	17.3%	16.9%	17.1%
Indirect Costs	$18.7	$15.6	$8.3	$11.8	$10.7	36.0%	35.8%	16.5%	22.0%	20.9%
Security Operations	$6.1	$4.9	$3.7	$3.7	$3.4	11.7%	11.3%	7.4%	6.9%	6.6%
Other Site Contractor Costs	$0.0	$0.0	$0.0	$0.2	$0.2	0.0%	0.0%	0.0%	0.4%	0.4%
Other Site DOE Costs	$0.8	$0.8	$0.6	$0.9	$0.8	1.5%	1.7%	1.3%	1.6%	1.6%
Transportation	$1.0	$1.0	$1.3	$1.2	$1.2	1.9%	2.3%	2.5%	2.3%	2.4%
D&D & ER	$0.0	$0.6	$7.7	$7.7	$7.7	0.0%	1.4%	15.2%	14.3%	15.0%
Total	**$52.1**	**$43.5**	**$50.3**	**$53.6**	**$51.1**	**100%**	**100%**	**100%**	**100%**	**100%**

Inputs Charted—Constrained Construction



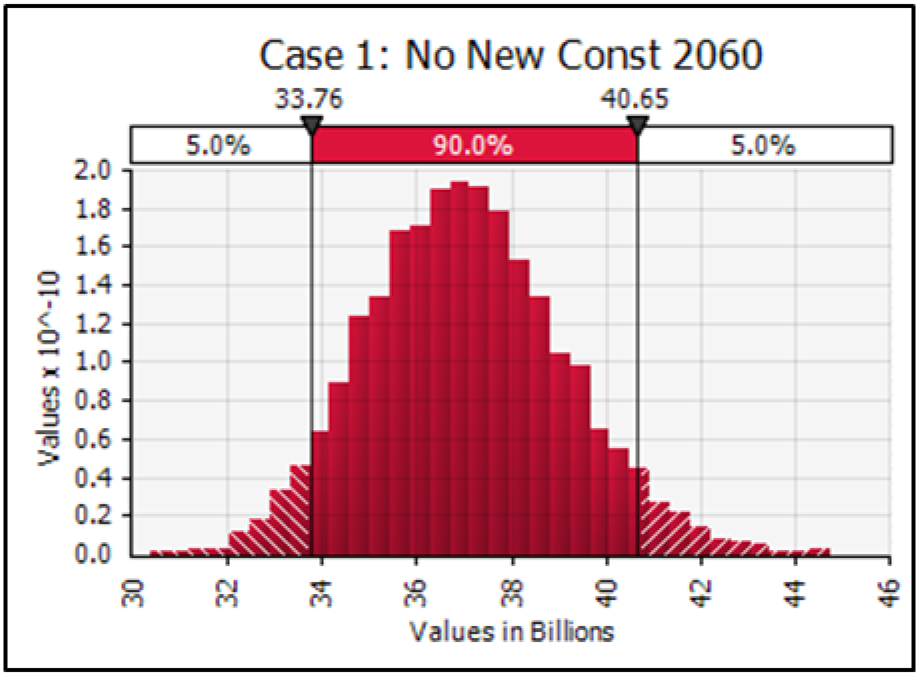
Total FTE-Constrained Construction



UNCERTAINTY DISTRIBUTIONS BY COST CATEGORY

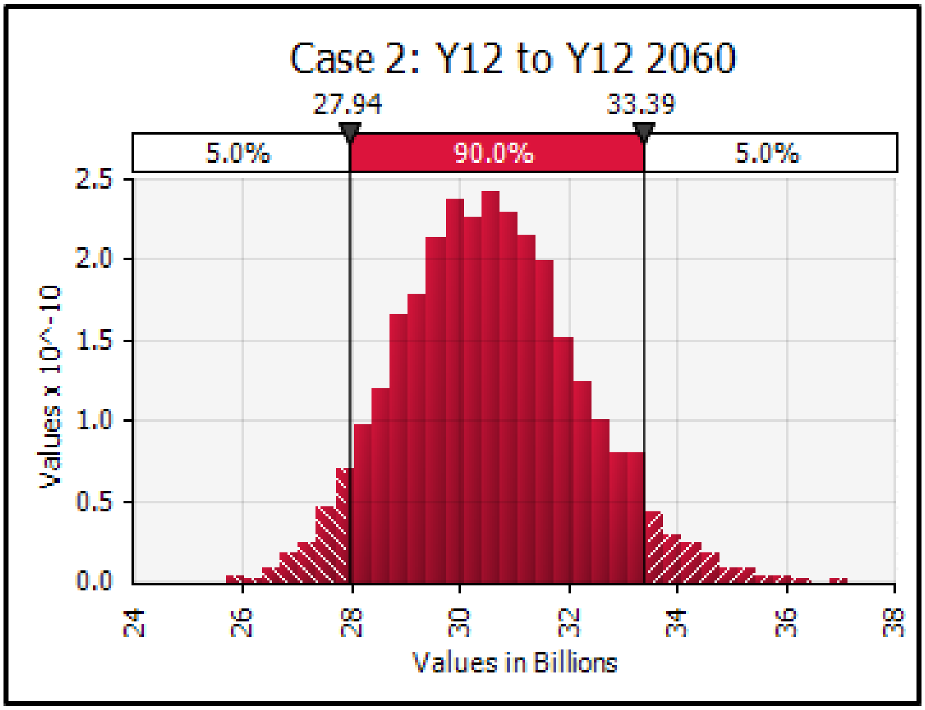
UNCERTAINITY DISTRIBUTIONS BY COST CATEGORY								
COST CATEGORY FOR DISTRIBUTION	**CASE 1a**	**CASE 2a**	**CASE 3a**		**CASE 4a**		**CASE 4b**	
	Y-12	**Y-12**	**Y-12**	**SRS**	**Y-12**	**PANTEX**	**Y-12**	**PANTEX**
A) HEUMF (Construction)								
Optimistic	90%	90%	90%	90%	90%	90%	90%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	110%	110%	110%	150%	110%	150%	110%	150%
B) UPF (Construction)								
Optimistic	90%	90%	90%	90%	90%	90%	90%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	150%	120%	150%	120%	150%	120%	150%
C) CMC (Construction)								
Optimistic	100%	90%	100%	90%	100%	90%	100%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	100%	150%	100%	150%	100%	150%	100%	150%
D) Purification (Construction)								
Optimistic	100%	100%	100%	80%	100%	80%	100%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	100%	100%	100%	150%	100%	150%	100%	150%
E) Waste Treatment (Construction)								
Optimistic	100%	100%	100%	100%	100%	90%	100%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	100%	100%	100%	100%	100%	150%	100%	150%
F) Security -- PIDAS (Construction)								
Optimistic	90%	90%	100%	75%	90%	90%	90%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	110%	130%	100%	125%	110%	150%	110%	150%
G) General (Construction)								
Optimistic	80%	80%	100%	80%	100%	90%	80%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	130%	100%	170%	100%	150%	120%	150%
H) Modifications Projects								
Optimistic	100%	80%	100%	90%	80%	80%	80%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	180%	130%	180%	185%	150%	150%	150%	150%
I) Capital Renewal Projects								
Optimistic	80%	80%	80%	85%	80%	80%	80%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	150%	150%	150%	120%	150%	150%	150%	150%
J) Direct Operations (Labor) - Pre-Transition								
Optimistic	90%	90%	90%	100%	90%	100%	90%	100%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	110%	110%	110%	100%	110%	100%	110%	100%
K) Direct Operations (Labor) - Transition								
Optimistic	100%	80%	80%	90%	100%	90%	100%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	100%	120%	120%	110%	100%	120%	100%	120%
L) Direct Operations (Labor) - Post-Transition								
Optimistic	80%	80%	80%	90%	80%	90%	80%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	120%	120%	110%	120%	120%	120%	120%
M) Direct Support Materials (Non-Labor)								
Optimistic	80%	80%	80%	90%	80%	80%	80%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	120%	120%	150%	120%	120%	120%	120%
N) Indirect Costs								
Optimistic	80%	80%	80%	90%	80%	80%	80%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	120%	120%	120%	120%	120%	120%	120%
O) Security Operations								
Optimistic	80%	80%	80%	90%	80%	80%	80%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	120%	120%	120%	120%	120%	120%	110%
P) Other Site Contractor Costs								
Optimistic	80%	80%	80%	100%	80%	90%	80%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	120%	120%	100%	120%	120%	120%	120%
Q) Other Site DOE Costs								
Optimistic	80%	80%	80%	90%	80%	80%	80%	80%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	120%	120%	120%	150%	120%	120%	120%	120%
R) Transportation								
Optimistic	90%	90%	90%	90%	90%	90%	90%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	110%	110%	110%	110%	110%	110%	110%	110%
S) D&D								
Optimistic	90%	90%	90%	100%	90%	90%	90%	90%
Most Likely	100%	100%	100%	100%	100%	100%	100%	100%
Pessimistic	150%	150%	150%	100%	150%	150%	150%	150%

SIMULATION RESULTS FOR 2060 NPV
BASE CASE 1A: NO NEW CONSTRUCTION AT Y-12



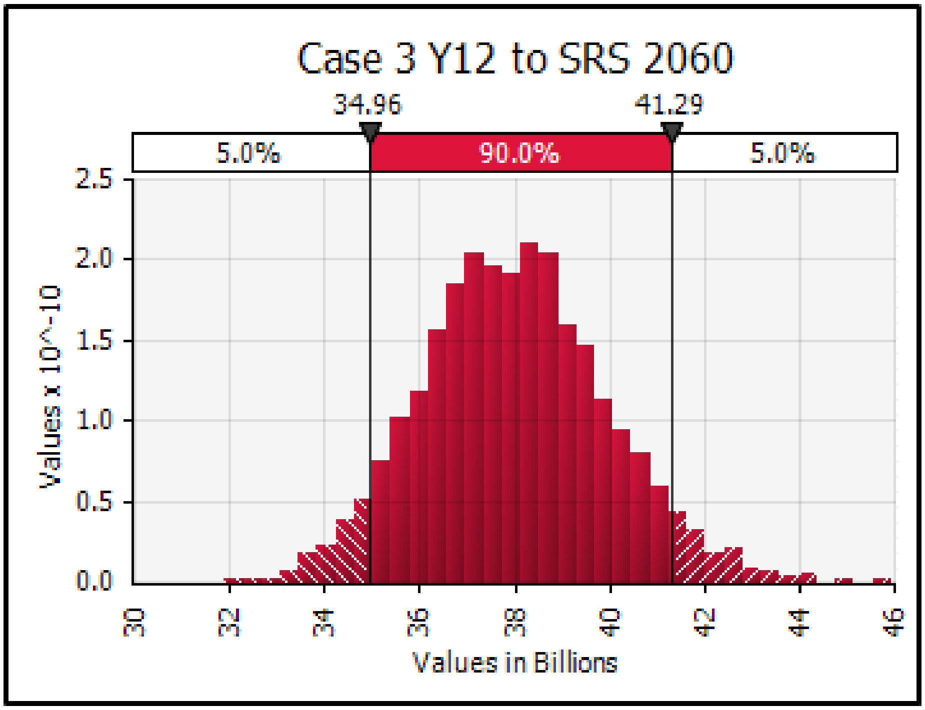
Summary Statistics for Case 1: No New Const 2060			
Statistics		Percentile	
Minimum	$30,355,883,718	**5%**	$33,762,335,646
Maximum	$45,606,980,616	**10%**	$34,409,639,348
Mean	$37,055,521,662	**15%**	$34,880,663,015
Std Dev	$2,094,182,577	**20%**	$35,283,771,315
Variance	4.3856E+18	**25%**	$35,597,242,371
Skewness	0.259644261	**30%**	$35,894,531,435
Kurtosis	3.117516022	**35%**	$36,188,480,928
Median	$36,993,108,871	**40%**	$36,455,139,563
Mode	$36,476,832,782	**45%**	$36,725,984,541
Left X	$33,762,335,646	**50%**	$36,993,108,871
Left P	5%	**55%**	$37,241,574,481
Right X	$40,653,550,716	**60%**	$37,505,006,098
Right P	95%	**65%**	$37,765,949,877
Diff X	$6,891,215,070	**70%**	$38,056,433,311
Diff P	90%	**75%**	$38,403,432,020
#Errors	0	**80%**	$38,771,856,674
Filter Min	Off	**85%**	$39,234,927,492
Filter Max	Off	**90%**	$39,765,006,649
#Filtered	0	**95%**	$40,653,550,716

SIMULATION RESULTS FOR 2060 NPV
BASE CASE 2A: Y-12 NEW CONSTRUCTION



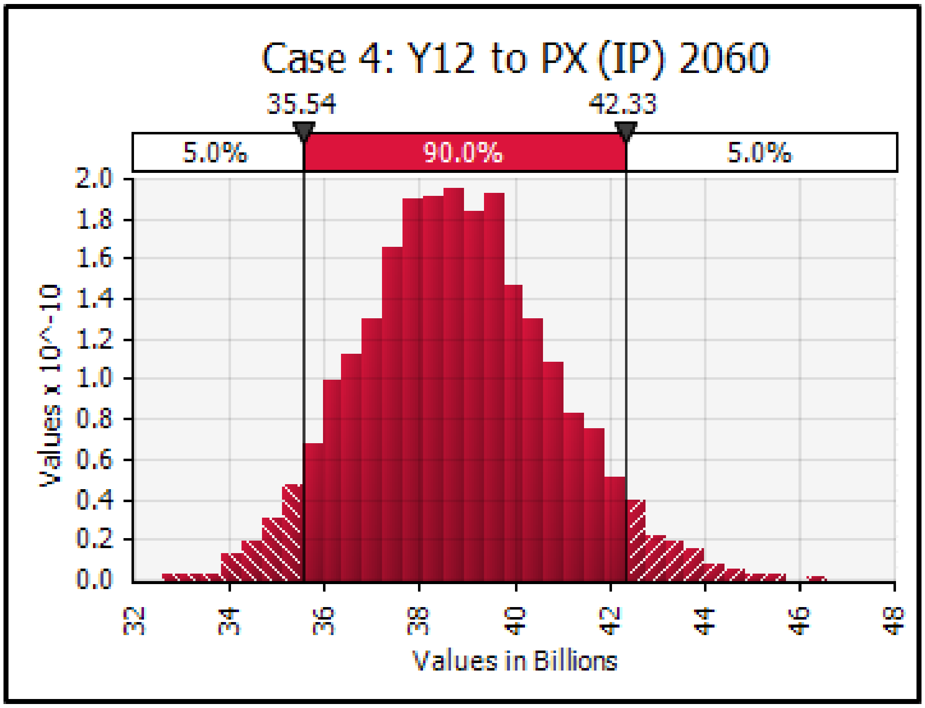
Summary Statistics for Case 2: Y12 to Y12 2060			
Statistics		**Percentile**	
Minimum	$25,345,191,079	**5%**	$27,944,817,441
Maximum	$37,480,390,802	**10%**	$28,477,401,534
Mean	$30,566,602,224	**15%**	$28,852,275,263
Std Dev	$1,670,411,277	**20%**	$29,135,961,094
Variance	2.79027E+18	**25%**	$29,403,334,359
Skewness	0.255307216	**30%**	$29,639,174,266
Kurtosis	3.099265598	**35%**	$29,869,331,071
Median	$30,506,877,007	**40%**	$30,070,610,276
Mode	$31,207,130,571	**45%**	$30,302,358,845
Left X	$27,944,817,441	**50%**	$30,506,877,007
Left P	5%	**55%**	$30,714,795,761
Right X	$33,394,574,114	**60%**	$30,923,307,553
Right P	95%	**65%**	$31,144,997,879
Diff X	$5,449,756,674	**70%**	$31,372,257,209
Diff P	90%	**75%**	$31,642,407,339
#Errors	0	**80%**	$31,906,610,932
Filter Min	Off	**85%**	$32,305,795,250
Filter Max	Off	**90%**	$32,763,104,484
#Filtered	0	**95%**	$33,394,574,114

SIMULATION RESULTS FOR 2060 NPV
BASE CASE 3A: SRS



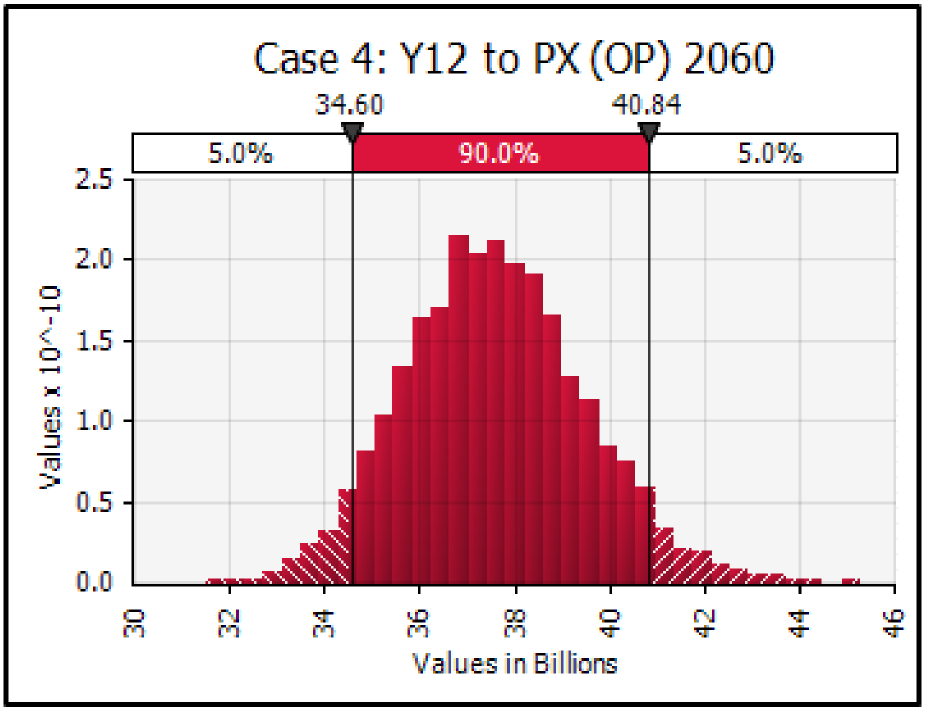
Summary Statistics for Case 3 Y12 to SRS 2060			
Statistics		**Percentile**	
Minimum	$31,901,979,504	**5%**	$34,956,638,848
Maximum	$45,935,206,696	**10%**	$35,606,481,306
Mean	$38,024,306,769	**15%**	$36,006,471,104
Std Dev	$1,933,095,981	**20%**	$36,378,859,244
Variance	3.73686E+18	**25%**	$36,706,529,650
Skewness	0.216158396	**30%**	$36,959,823,255
Kurtosis	3.077833864	**35%**	$37,211,634,078
Median	$37,973,326,447	**40%**	$37,458,839,125
Mode	$37,093,658,527	**45%**	$37,708,104,452
Left X	$34,956,638,848	**50%**	$37,973,326,447
Left P	5%	**55%**	$38,225,313,612
Right X	$41,292,518,614	**60%**	$38,464,753,659
Right P	95%	**65%**	$38,708,055,512
Diff X	$6,335,879,766	**70%**	$38,966,021,651
Diff P	90%	**75%**	$39,283,184,733
#Errors	0	**80%**	$39,593,714,564
Filter Min	Off	**85%**	$40,029,951,312
Filter Max	Off	**90%**	$40,530,408,062
#Filtered	0	**95%**	$41,292,518,614

SIMULATION RESULTS FOR 2060 NPV BASE CASE 4A: PANTEX (IP)



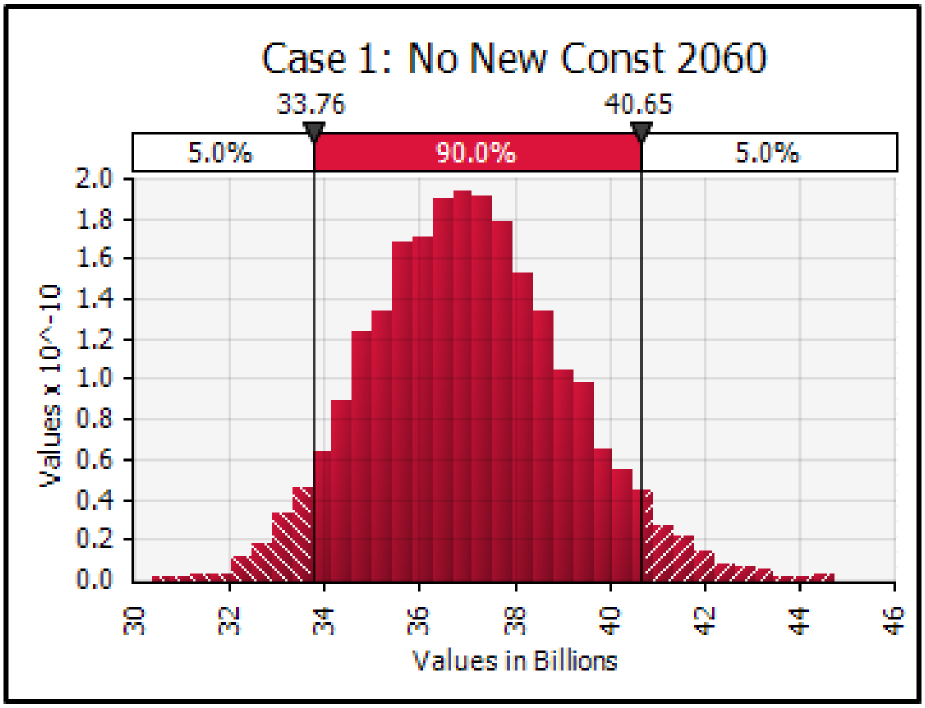
Summary Statistics for Case 4a: Y12 to PX (IP) 2060			
Statistics		**Percentile**	
Minimum	$32,145,415,110	**5%**	$35,540,493,941
Maximum	$47,424,788,586	**10%**	$36,188,220,670
Mean	$38,808,787,675	**15%**	$36,650,888,345
Std Dev	$2,072,379,500	**20%**	$37,067,734,627
Variance	4.29476E+18	**25%**	$37,389,880,587
Skewness	0.236377196	**30%**	$37,698,688,513
Kurtosis	3.113505178	**35%**	$37,952,487,336
Median	$38,735,261,043	**40%**	$38,234,142,407
Mode	$38,718,759,753	**45%**	$38,476,079,783
Left X	$35,540,493,941	**50%**	$38,735,261,043
Left P	5%	**55%**	$38,984,055,505
Right X	$42,328,789,606	**60%**	$39,265,874,053
Right P	95%	**65%**	$39,531,479,103
Diff X	$6,788,295,666	**70%**	$39,804,059,982
Diff P	90%	**75%**	$40,150,415,299
#Errors	0	**80%**	$40,508,683,537
Filter Min	Off	**85%**	$40,967,474,430
Filter Max	Off	**90%**	$41,517,271,193
#Filtered	0	**95%**	$42,328,789,606

SIMULATION RESULTS FOR 2060 NPV
BASE CASE 4B: PANTEX (OP)



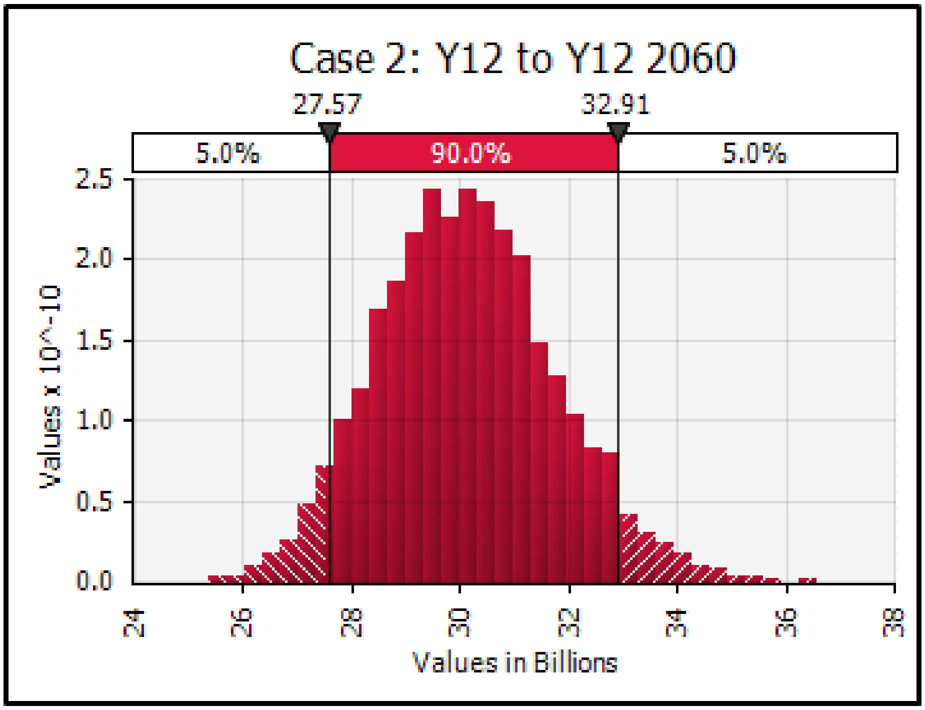
Summary Statistics for Case 4b: Y12 to PX (OP) 2060			
Statistics		Percentile	
Minimum	$31,531,902,115	5%	$34,601,574,247
Maximum	$45,690,647,387	10%	$35,226,871,977
Mean	$37,609,162,256	15%	$35,660,122,676
Std Dev	$1,909,141,818	20%	$35,970,561,421
Variance	3.64482E+18	25%	$36,286,617,088
Skewness	0.229108925	30%	$36,568,309,261
Kurtosis	3.114633978	35%	$36,822,564,088
Median	$37,544,734,633	40%	$37,056,716,201
Mode	$36,838,891,245	45%	$37,303,736,859
Left X	$34,601,574,247	50%	$37,544,734,633
Left P	5%	55%	$37,781,522,369
Right X	$40,843,366,610	60%	$38,019,354,908
Right P	95%	65%	$38,278,277,084
Diff X	$6,241,792,363	70%	$38,551,996,291
Diff P	90%	75%	$38,822,141,823
#Errors	0	80%	$39,184,546,629
Filter Min	Off	85%	$39,579,357,503
Filter Max	Off	90%	$40,119,659,595
#Filtered	0	95%	$40,843,366,610

SIMULATION RESULTS FOR 2060 NPV CASE 1A NO D&D: NO NEW CONSTRUCTION AT Y-12



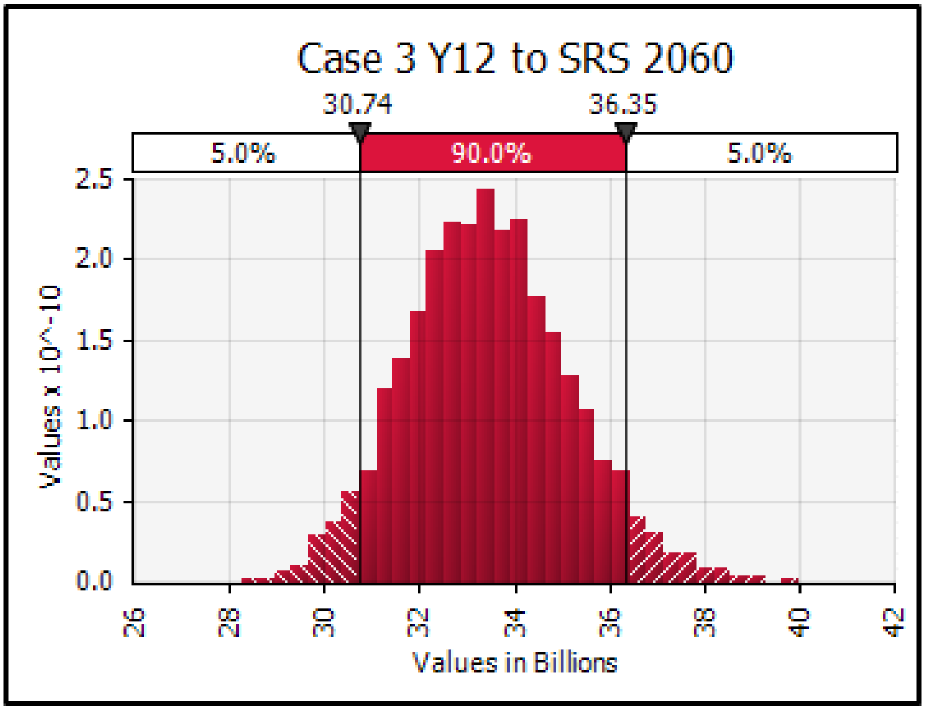
Summary Statistics for Case 1: No New Const 2060			
Statistics		Percentile	
Minimum	$30,355,883,718	**5%**	$33,762,335,646
Maximum	$45,606,980,616	**10%**	$34,409,639,348
Mean	$37,055,521,662	**15%**	$34,880,663,015
Std Dev	$2,094,182,577	**20%**	$35,283,771,315
Variance	4.3856E+18	**25%**	$35,597,242,371
Skewness	0.259644261	**30%**	$35,894,531,435
Kurtosis	3.117516022	**35%**	$36,188,480,928
Median	$36,993,108,871	**40%**	$36,455,139,563
Mode	$36,476,832,782	**45%**	$36,725,984,541
Left X	$33,762,335,646	**50%**	$36,993,108,871
Left P	5%	**55%**	$37,241,574,481
Right X	$40,653,550,716	**60%**	$37,505,006,098
Right P	95%	**65%**	$37,765,949,877
Diff X	$6,891,215,070	**70%**	$38,056,433,311
Diff P	90%	**75%**	$38,403,432,020
#Errors	0	**80%**	$38,771,856,674
Filter Min	Off	**85%**	$39,234,927,492
Filter Max	Off	**90%**	$39,765,006,649
#Filtered	0	**95%**	$40,653,550,716

SIMULATION RESULTS FOR 2060 NPV CASE 2A NO D&D: Y-12 NEW CONSTRUCTION



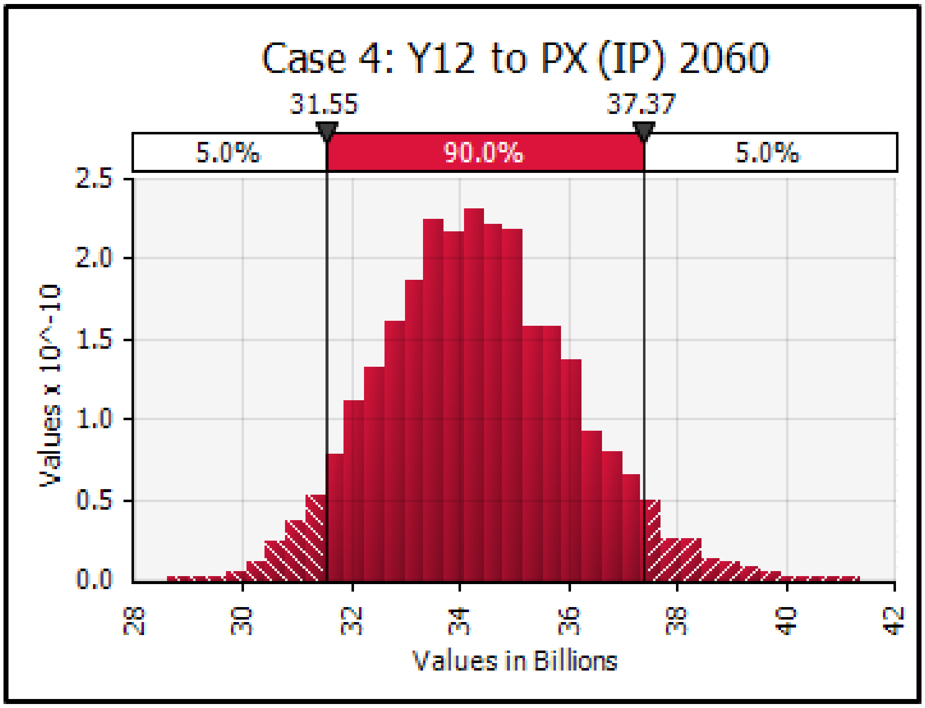
Summary Statistics for Case 2: Y12 to Y12 2060			
Statistics		**Percentile**	
Minimum	$25,018,028,809	**5%**	$27,565,243,619
Maximum	$36,930,643,589	**10%**	$28,082,586,359
Mean	$30,133,268,037	**15%**	$28,449,163,399
Std Dev	$1,639,894,785	**20%**	$28,731,967,713
Variance	2.68925E+18	**25%**	$28,991,082,361
Skewness	0.255833593	**30%**	$29,222,904,166
Kurtosis	3.09934099	**35%**	$29,447,514,370
Median	$30,075,652,852	**40%**	$29,645,556,108
Mode	$29,504,247,988	**45%**	$29,872,805,645
Left X	$27,565,243,619	**50%**	$30,075,652,852
Left P	5%	**55%**	$30,278,709,468
Right X	$32,909,425,451	**60%**	$30,484,887,670
Right P	95%	**65%**	$30,701,931,793
Diff X	$5,344,181,832	**70%**	$30,923,416,180
Diff P	90%	**75%**	$31,186,018,101
#Errors	0	**80%**	$31,447,124,159
Filter Min	Off	**85%**	$31,839,672,213
Filter Max	Off	**90%**	$32,295,789,319
#Filtered	0	**95%**	$32,909,425,451

SIMULATION RESULTS FOR 2060 NPV CASE 3A NO D&D: SRS



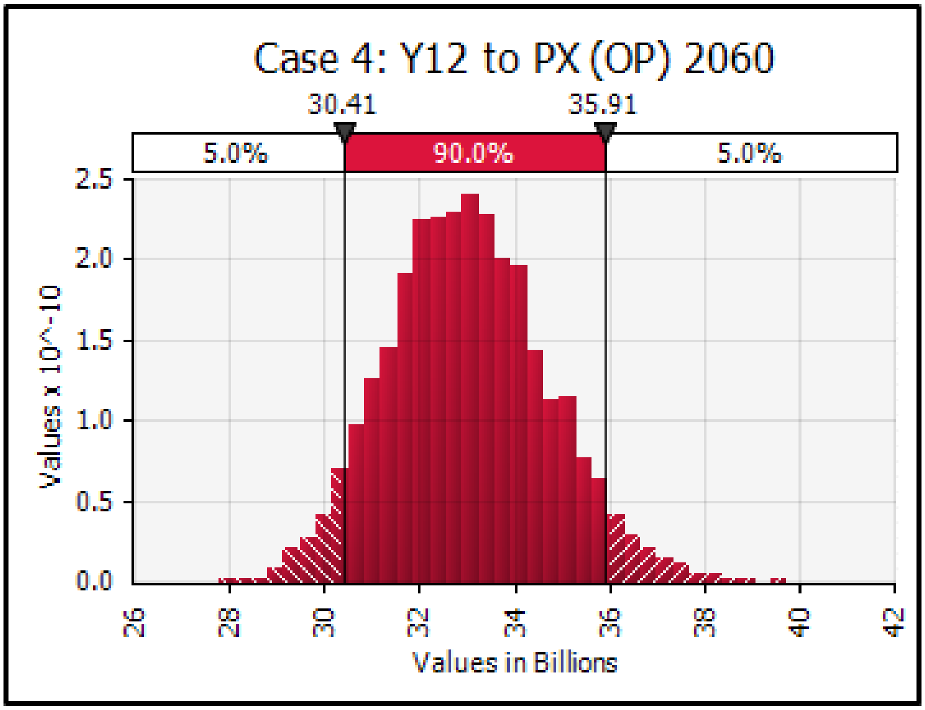
Summary Statistics for Case 3 Y12 to SRS 2060			
Statistics		**Percentile**	
Minimum	$27,888,504,344	**5%**	$30,739,643,541
Maximum	$40,704,866,507	**10%**	$31,296,353,220
Mean	$33,462,136,914	**15%**	$31,667,292,422
Std Dev	$1,707,768,269	**20%**	$32,023,957,151
Variance	2.91647E+18	**25%**	$32,291,775,495
Skewness	0.239996196	**30%**	$32,523,167,816
Kurtosis	3.091106807	**35%**	$32,740,832,785
Median	$33,402,044,014	**40%**	$32,958,745,714
Mode	$33,508,778,929	**45%**	$33,194,320,207
Left X	$30,739,643,541	**50%**	$33,402,044,014
Left P	5%	**55%**	$33,602,785,491
Right X	$36,345,871,933	**60%**	$33,844,206,055
Right P	95%	**65%**	$34,064,277,318
Diff X	$5,606,228,392	**70%**	$34,284,727,838
Diff P	90%	**75%**	$34,560,409,765
#Errors	0	**80%**	$34,875,679,635
Filter Min	Off	**85%**	$35,249,113,275
Filter Max	Off	**90%**	$35,689,677,958
#Filtered	0	**95%**	$36,345,871,933

SIMULATION RESULTS FOR 2060 NPV CASE 4A NO D&D: PANTEX (IP)



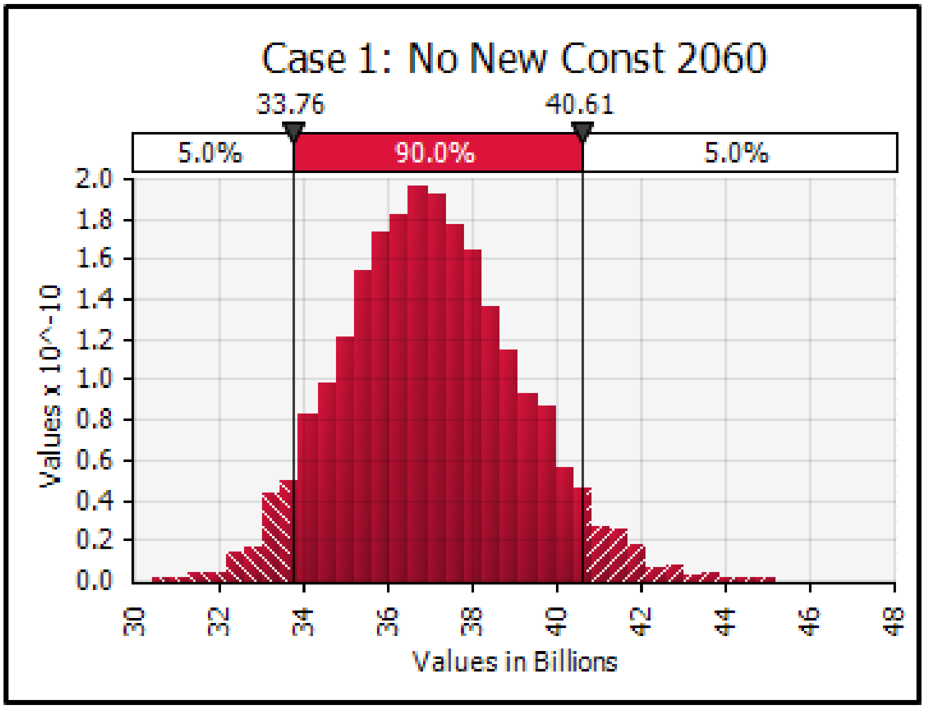
Summary Statistics for Case 4a: Y12 to PX (IP) 2060			
Statistics		Percentile	
Minimum	$28,601,898,531	**5%**	$31,546,901,025
Maximum	$41,730,046,635	**10%**	$32,095,588,113
Mean	$34,338,505,620	**15%**	$32,501,110,125
Std Dev	$1,780,525,864	**20%**	$32,828,869,203
Variance	3.17027E+18	**25%**	$33,116,564,019
Skewness	0.252744303	**30%**	$33,385,183,566
Kurtosis	3.127558836	**35%**	$33,592,795,521
Median	$34,274,142,190	**40%**	$33,819,406,839
Mode	$33,574,635,904	**45%**	$34,051,471,548
Left X	$31,546,901,025	**50%**	$34,274,142,190
Left P	5%	**55%**	$34,498,018,665
Right X	$37,374,908,605	**60%**	$34,719,196,478
Right P	95%	**65%**	$34,949,609,371
Diff X	$5,828,007,580	**70%**	$35,178,152,252
Diff P	90%	**75%**	$35,489,204,832
#Errors	0	**80%**	$35,793,252,748
Filter Min	Off	**85%**	$36,142,217,230
Filter Max	Off	**90%**	$36,671,725,942
#Filtered	0	**95%**	$37,374,908,605

SIMULATION RESULTS FOR 2060 NPV CASE 4B NO D&D: PANTEX (OP)



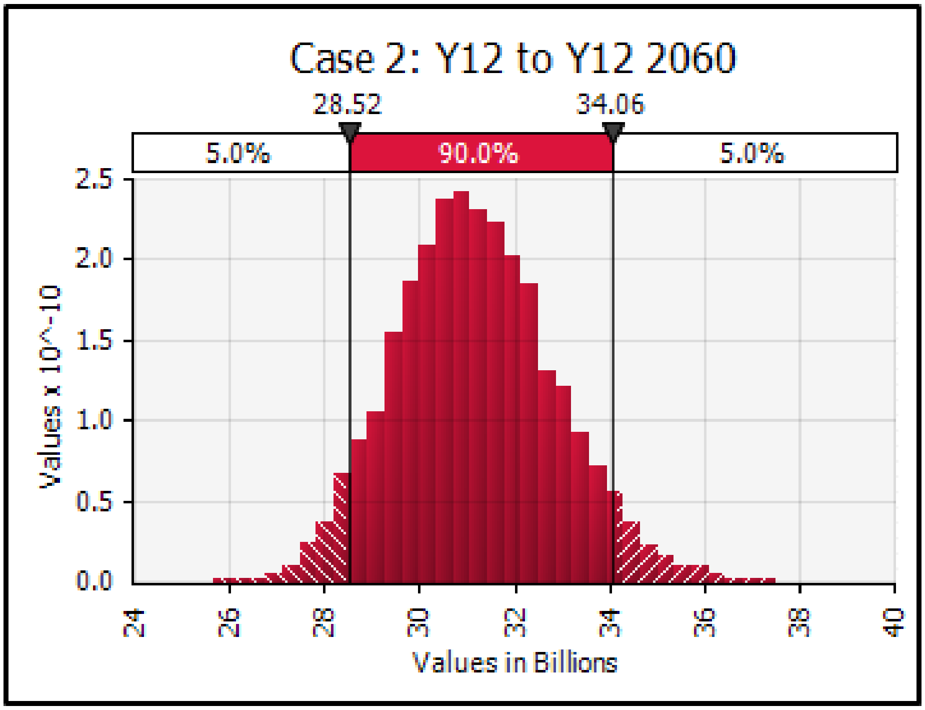
Summary Statistics for Case 4b: Y12 to PX (OP) 2060			
Statistics		**Percentile**	
Minimum	$27,774,398,216	**5%**	$30,408,110,027
Maximum	$40,095,024,817	**10%**	$30,929,500,327
Mean	$33,036,595,761	**15%**	$31,283,470,696
Std Dev	$1,683,346,678	**20%**	$31,614,199,368
Variance	2.83366E+18	**25%**	$31,877,763,184
Skewness	0.242006167	**30%**	$32,115,686,389
Kurtosis	3.101706509	**35%**	$32,326,771,509
Median	$32,989,236,502	**40%**	$32,541,456,282
Mode	$32,747,327,126	**45%**	$32,763,926,074
Left X	$30,408,110,027	**50%**	$32,989,236,502
Left P	5%	**55%**	$33,186,953,905
Right X	$35,907,360,478	**60%**	$33,390,126,786
Right P	95%	**65%**	$33,624,310,140
Diff X	$5,499,250,451	**70%**	$33,856,880,533
Diff P	90%	**75%**	$34,112,171,724
#Errors	0	**80%**	$34,403,055,930
Filter Min	Off	**85%**	$34,786,534,385
Filter Max	Off	**90%**	$35,238,916,920
#Filtered	0	**95%**	$35,907,360,478

SIMULATION RESULTS FOR 2060 NPV CASE 1A CONSTRAINED CONSTRUCTION: NO NEW CONSTRUCTION AT Y-12



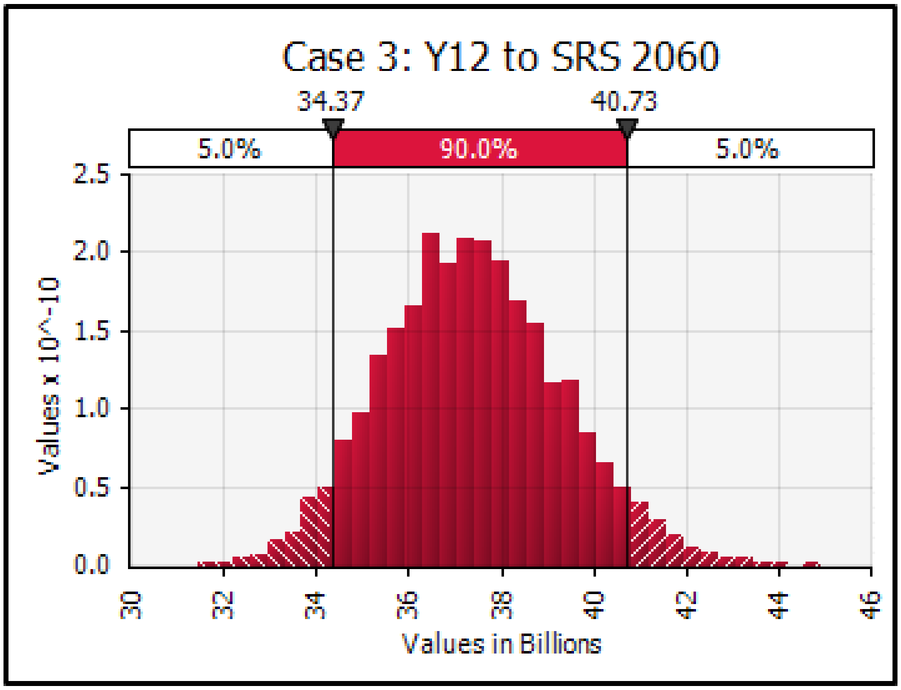
Summary Statistics for Case 1: No New Const 2060			
Statistics		**Percentile**	
Minimum	$30,430,944,901	**5%**	$33,764,666,289
Maximum	$46,057,688,887	**10%**	$34,416,576,180
Mean	$37,055,699,749	**15%**	$34,886,176,301
Std Dev	$2,096,851,200	**20%**	$35,266,605,066
Variance	4.39678E+18	**25%**	$35,605,279,414
Skewness	0.272842583	**30%**	$35,904,681,547
Kurtosis	3.121801639	**35%**	$36,175,132,183
Median	$36,959,827,780	**40%**	$36,440,104,966
Mode	$37,095,751,401	**45%**	$36,699,451,204
Left X	$33,764,666,289	**50%**	$36,959,827,780
Left P	5%	**55%**	$37,218,122,048
Right X	$40,613,603,210	**60%**	$37,490,120,484
Right P	95%	**65%**	$37,769,002,878
Diff X	$6,848,936,921	**70%**	$38,057,733,271
Diff P	90%	**75%**	$38,397,248,519
#Errors	0	**80%**	$38,792,067,073
Filter Min	Off	**85%**	$39,260,481,423
Filter Max	Off	**90%**	$39,804,331,185
#Filtered	0	**95%**	$40,613,603,210

SIMULATION RESULTS FOR 2060 NPV CASE 2A Y-12 CONSTRAINED NEW CONSTRUCTION



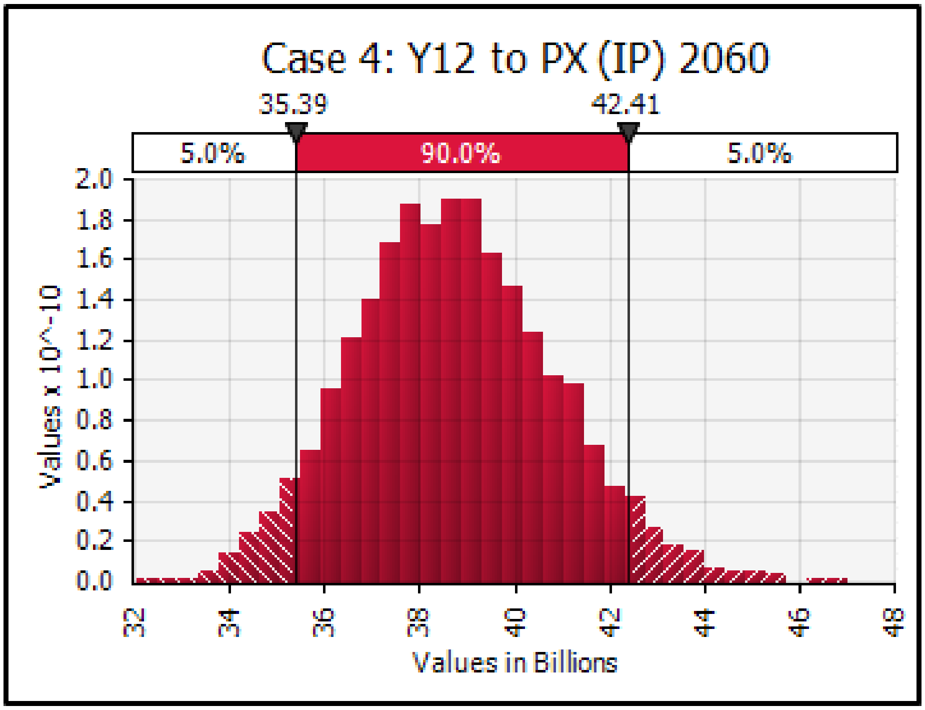
Summary Statistics for Case 2: Y12 to Y12 2060			
Statistics		**Percentile**	
Minimum	$25,683,146,617	**5%**	$28,521,074,837
Maximum	$38,615,781,368	**10%**	$29,069,785,202
Mean	$31,184,528,240	**15%**	$29,454,495,053
Std Dev	$1,681,014,334	**20%**	$29,754,221,941
Variance	2.82581E+18	**25%**	$30,020,624,422
Skewness	0.263133672	**30%**	$30,253,627,632
Kurtosis	3.132388321	**35%**	$30,477,836,908
Median	$31,108,400,067	**40%**	$30,696,710,847
Mode	$30,872,807,960	**45%**	$30,891,729,124
Left X	$28,521,074,837	**50%**	$31,108,400,067
Left P	5%	**55%**	$31,327,221,248
Right X	$34,058,888,766	**60%**	$31,546,846,555
Right P	95%	**65%**	$31,765,216,676
Diff X	$5,537,813,929	**70%**	$32,018,153,433
Diff P	90%	**75%**	$32,264,064,484
#Errors	0	**80%**	$32,549,974,323
Filter Min	Off	**85%**	$32,943,599,459
Filter Max	Off	**90%**	$33,368,529,116
#Filtered	0	**95%**	$34,058,888,766

SIMULATION RESULTS FOR 2060 NPV CASE 3A CONSTRAINED CONSTRUCTION SRS



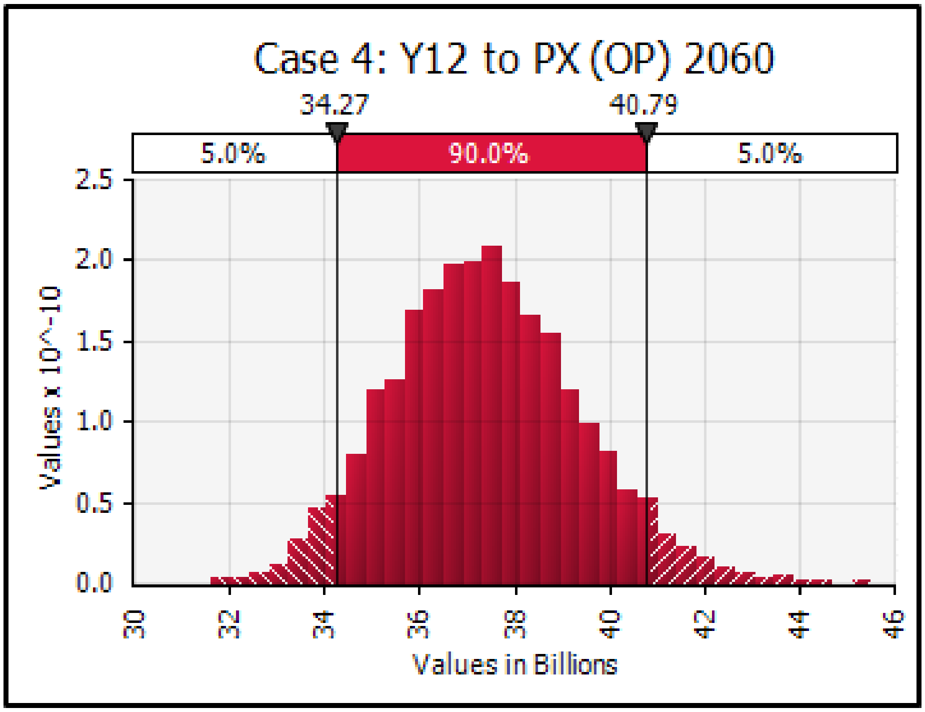
Summary Statistics for Case 3: Y12 to SRS 2060			
Statistics		**Percentile**	
Minimum	$31,437,745,145	**5%**	$34,366,818,553
Maximum	$44,947,530,419	**10%**	$34,960,041,687
Mean	$37,412,531,613	**15%**	$35,405,772,552
Std Dev	$1,930,778,843	**20%**	$35,775,325,481
Variance	3.72791E+18	**25%**	$36,091,879,970
Skewness	0.223688568	**30%**	$36,362,760,258
Kurtosis	3.054356237	**35%**	$36,596,861,459
Median	$37,338,045,664	**40%**	$36,854,260,600
Mode	$37,279,309,525	**45%**	$37,107,686,726
Left X	$34,366,818,553	**50%**	$37,338,045,664
Left P	5%	**55%**	$37,586,862,655
Right X	$40,726,343,994	**60%**	$37,829,240,070
Right P	95%	**65%**	$38,079,073,598
Diff X	$6,359,525,441	**70%**	$38,351,884,793
Diff P	90%	**75%**	$38,671,700,796
#Errors	0	**80%**	$39,003,325,692
Filter Min	Off	**85%**	$39,463,762,881
Filter Max	Off	**90%**	$39,921,004,769
#Filtered	0	**95%**	$40,726,343,994

SIMULATION RESULTS FOR 2060 NPV CASE 4A CONSTRAINED CONSTRUCTION: PANTEX (IP)



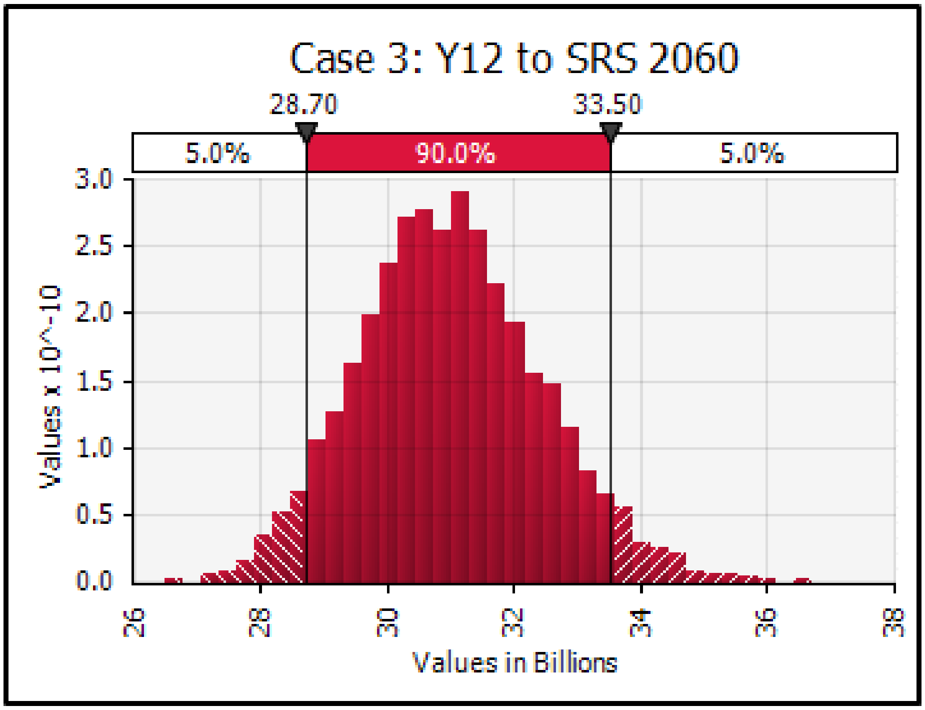
Summary Statistics for Case 4a: Y12 to PX (IP) 2060			
Statistics		Percentile	
Minimum	$32,071,865,484	5%	$35,392,869,167
Maximum	$47,446,686,873	10%	$36,067,360,370
Mean	$38,747,436,692	15%	$36,546,845,213
Std Dev	$2,131,944,124	20%	$36,953,295,266
Variance	4.54519E+18	25%	$37,282,740,166
Skewness	0.246780937	30%	$37,575,041,662
Kurtosis	3.113134306	35%	$37,852,032,402
Median	$38,676,070,371	40%	$38,120,649,266
Mode	$37,834,143,298	45%	$38,396,241,885
Left X	$35,392,869,167	50%	$38,676,070,371
Left P	5%	55%	$38,929,614,880
Right X	$42,409,111,860	60%	$39,200,518,535
Right P	95%	65%	$39,482,047,176
Diff X	$7,016,242,693	70%	$39,782,210,492
Diff P	90%	75%	$40,123,116,924
#Errors	0	80%	$40,507,762,617
Filter Min	Off	85%	$40,986,070,017
Filter Max	Off	90%	$41,527,033,996
#Filtered	0	95%	$42,409,111,860

SIMULATION RESULTS FOR 2060 NPV CASE 4B CONSTRAINED CONSTRUCTION PANTEX (OP)



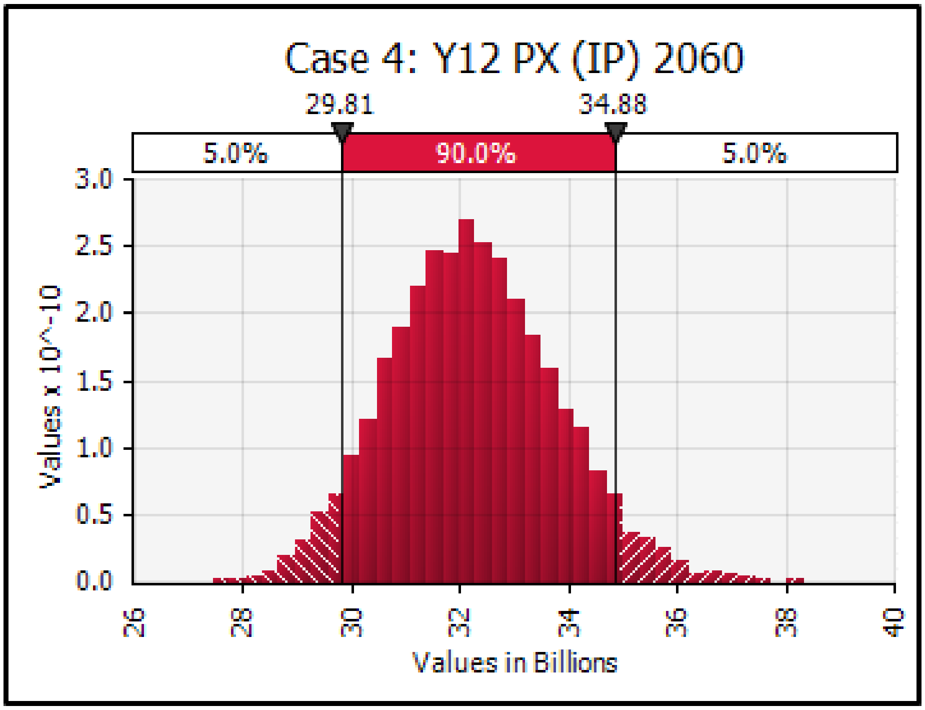
Summary Statistics for Case 4b: Y12 to PX (OP) 2060			
Statistics		Percentile	
Minimum	$30,790,646,028	**5%**	$34,274,231,980
Maximum	$45,530,710,171	**10%**	$34,922,614,963
Mean	$37,403,050,938	**15%**	$35,344,728,609
Std Dev	$1,980,323,527	**20%**	$35,730,278,341
Variance	3.92168E+18	**25%**	$36,043,387,110
Skewness	0.241392196	**30%**	$36,323,227,049
Kurtosis	3.106082442	**35%**	$36,590,686,048
Median	$37,334,321,766	**40%**	$36,818,053,075
Mode	$36,342,907,443	**45%**	$37,087,722,328
Left X	$34,274,231,980	**50%**	$37,334,321,766
Left P	5%	**55%**	$37,574,617,202
Right X	$40,793,752,336	**60%**	$37,814,779,050
Right P	95%	**65%**	$38,081,938,915
Diff X	$6,519,520,355	**70%**	$38,378,298,124
Diff P	90%	**75%**	$38,687,911,115
#Errors	0	**80%**	$39,032,427,241
Filter Min	Off	**85%**	$39,452,930,630
Filter Max	Off	**90%**	$40,008,795,091
#Filtered	0	**95%**	$40,793,752,336

SIMULATION RESULTS FOR 2060 NPV CASE 3A REDUCED S&M: SRS



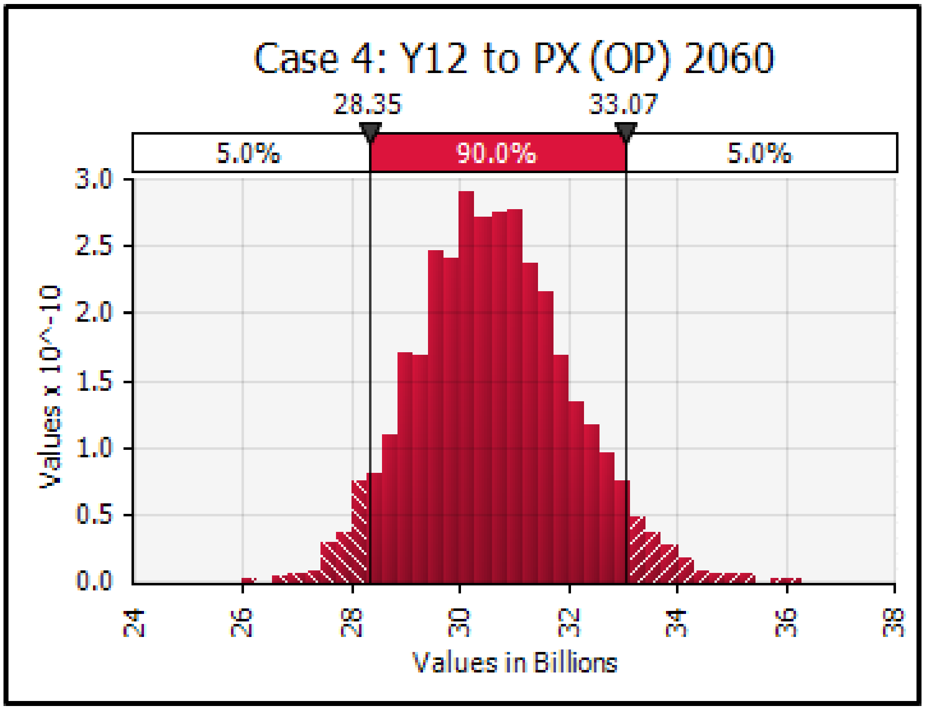
Summary Statistics for Case 3: Y12 to SRS 2060			
Statistics		**Percentile**	
Minimum	$26,476,564,606	**5%**	$28,704,048,618
Maximum	$36,710,353,252	**10%**	$29,172,978,583
Mean	$30,997,926,401	**15%**	$29,524,739,050
Std Dev	$1,445,588,868	**20%**	$29,769,807,359
Variance	2.08973E+18	**25%**	$29,998,813,220
Skewness	0.235994144	**30%**	$30,205,747,115
Kurtosis	3.077938066	**35%**	$30,387,815,360
Median	$30,950,532,724	**40%**	$30,579,591,772
Mode	$30,965,024,555	**45%**	$30,762,966,837
Left X	$28,704,048,618	**50%**	$30,950,532,724
Left P	5%	**55%**	$31,132,623,151
Right X	$33,497,070,626	**60%**	$31,304,499,998
Right P	95%	**65%**	$31,497,125,297
Diff X	$4,793,022,008	**70%**	$31,695,185,210
Diff P	90%	**75%**	$31,926,436,360
#Errors	0	**80%**	$32,189,477,810
Filter Min	Off	**85%**	$32,520,372,965
Filter Max	Off	**90%**	$32,877,440,897
#Filtered	0	**95%**	$33,497,070,626

SIMULATION RESULTS FOR 2060 NPV CASE 4A REDUCED S&M: PANTEX (IP)



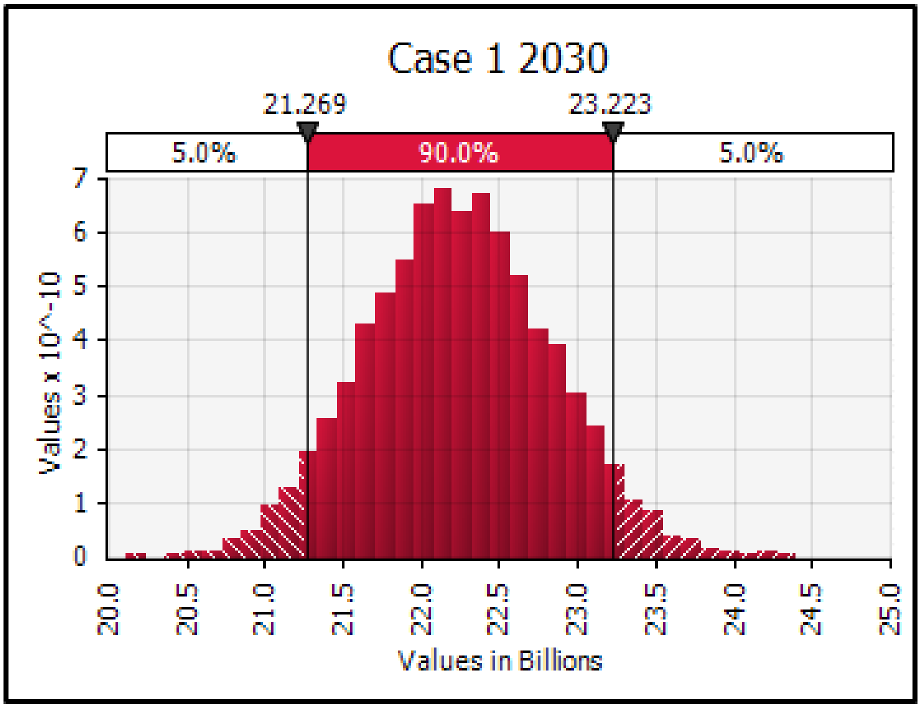
Summary Statistics for Case 4a: Y12 PX (IP) 2060			
Statistics		**Percentile**	
Minimum	$27,448,656,368	**5%**	$29,807,032,212
Maximum	$38,339,139,792	**10%**	$30,331,693,707
Mean	$32,253,424,935	**15%**	$30,654,137,812
Std Dev	$1,549,192,186	**20%**	$30,932,359,653
Variance	2.4E+18	**25%**	$31,189,475,090
Skewness	0.233421482	**30%**	$31,401,445,213
Kurtosis	3.095057282	**35%**	$31,602,016,115
Median	$32,187,671,875	**40%**	$31,794,933,300
Mode	$32,287,497,850	**45%**	$32,005,312,966
Left X	$29,807,032,212	**50%**	$32,187,671,875
Left P	5%	**55%**	$32,390,481,201
Right X	$34,880,720,003	**60%**	$32,587,378,561
Right P	95%	**65%**	$32,792,634,400
Diff X	$5,073,687,791	**70%**	$33,021,581,793
Diff P	90%	**75%**	$33,255,079,588
#Errors	0	**80%**	$33,532,623,927
Filter Min	Off	**85%**	$33,879,426,342
Filter Max	Off	**90%**	$34,268,573,763
#Filtered	0	**95%**	$34,880,720,003

Simulation Results For 2060 NPV Case 4b Reduced S&M: Pantex (OP)



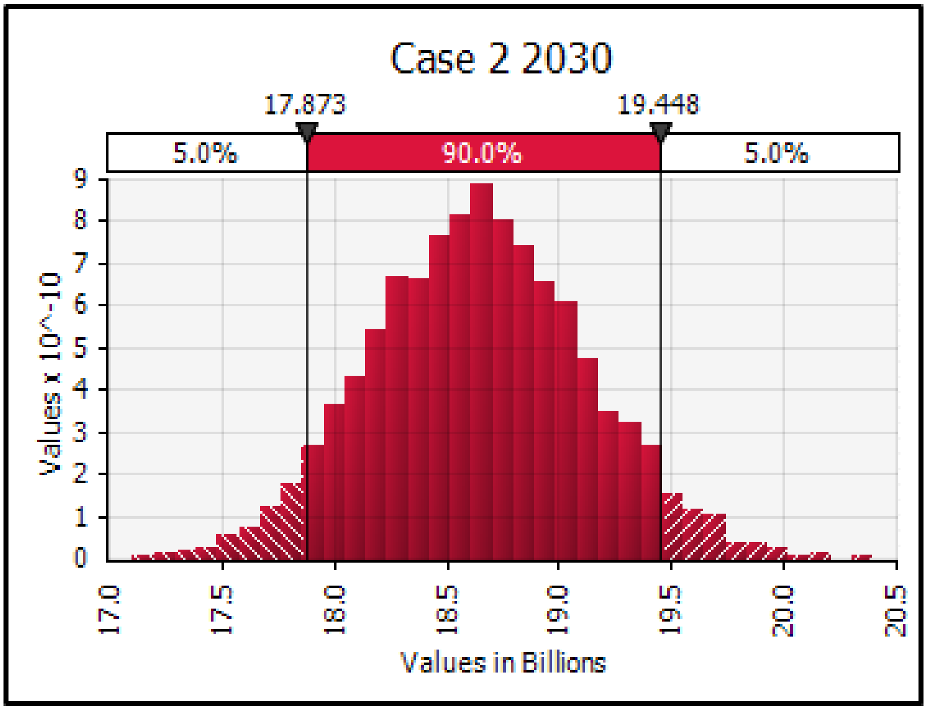
Summary Statistics for Case 4b: Y12 to PX (OP) 2060			
Statistics		**Percentile**	
Minimum	$25,989,725,183	**5%**	$28,347,385,818
Maximum	$36,313,558,473	**10%**	$28,851,387,380
Mean	$30,633,387,440	**15%**	$29,152,643,377
Std Dev	$1,428,904,106	**20%**	$29,446,217,926
Variance	2.04177E+18	**25%**	$29,652,561,516
Skewness	0.238408268	**30%**	$29,844,798,036
Kurtosis	3.111536072	**35%**	$30,051,528,712
Median	$30,582,158,763	**40%**	$30,221,239,336
Mode	$30,633,239,308	**45%**	$30,393,828,493
Left X	$28,347,385,818	**50%**	$30,582,158,763
Left P	5%	**55%**	$30,758,052,662
Right X	$33,065,270,763	**60%**	$30,937,590,056
Right P	95%	**65%**	$31,123,726,179
Diff X	$4,717,884,945	**70%**	$31,332,443,939
Diff P	90%	**75%**	$31,549,226,015
#Errors	0	**80%**	$31,797,781,102
Filter Min	Off	**85%**	$32,119,746,382
Filter Max	Off	**90%**	$32,506,157,487
#Filtered	0	**95%**	$33,065,270,763

SIMULATION RESULTS FOR 2030 NPV CASE 1A BASE CASE: Y-12 NO NEW CONSTRUCTION



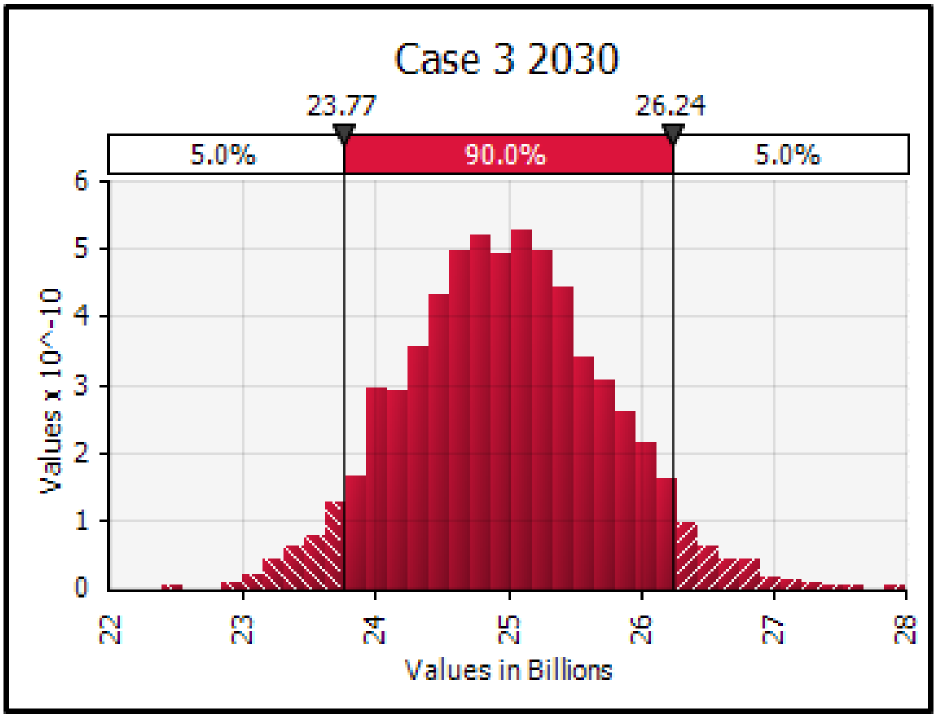
Summary Statistics for Case 1 2030			
Statistics		Percentile	
Minimum	$20,118,844,683	**5%**	$21,268,662,527
Maximum	$24,525,666,002	**10%**	$21,478,406,777
Mean	$22,241,813,377	**15%**	$21,624,760,691
Std Dev	$594,617,538	**20%**	$21,732,898,295
Variance	3.5357E+17	**25%**	$21,837,778,249
Skewness	0.079583703	**30%**	$21,930,680,739
Kurtosis	2.996758007	**35%**	$22,006,933,522
Median	$22,232,569,083	**40%**	$22,083,280,751
Mode	$22,333,931,502	**45%**	$22,157,897,405
Left X	$21,268,662,527	**50%**	$22,232,569,083
Left P	5%	**55%**	$22,311,852,131
Right X	$23,222,713,527	**60%**	$22,386,120,580
Right P	95%	**65%**	$22,459,701,004
Diff X	$1,954,051,001	**70%**	$22,545,117,974
Diff P	90%	**75%**	$22,637,642,464
#Errors	0	**80%**	$22,747,371,820
Filter Min	Off	**85%**	$22,864,085,752
Filter Max	Off	**90%**	$23,011,405,894
#Filtered	0	**95%**	$23,222,713,527

SIMULATION RESULTS FOR 2030 NPV BASE CASE 2A: Y-12 NEW CONSTRUCTION



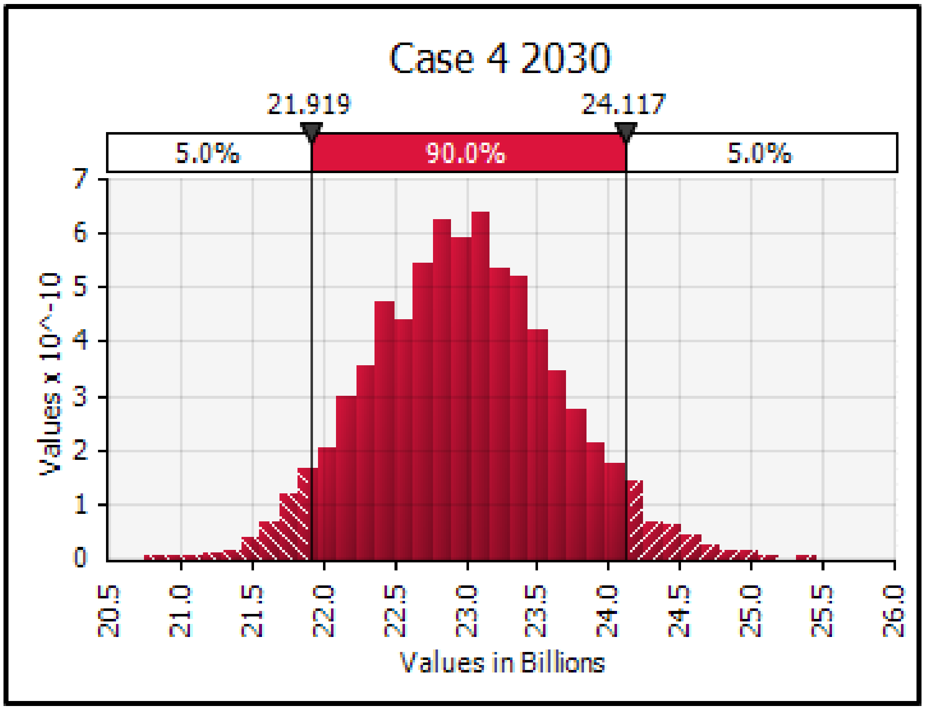
Summary Statistics for Case 2 2030			
Statistics		Percentile	
Minimum	$17,105,540,548	**5%**	$17,872,600,486
Maximum	$20,495,942,206	**10%**	$18,035,921,461
Mean	$18,649,521,612	**15%**	$18,148,172,476
Std Dev	$481,459,230	**20%**	$18,239,324,970
Variance	2.31803E+17	**25%**	$18,315,077,955
Skewness	0.106215976	**30%**	$18,389,360,727
Kurtosis	3.005882161	**35%**	$18,459,474,008
Median	$18,645,415,583	**40%**	$18,526,405,538
Mode	$18,649,548,424	**45%**	$18,586,887,189
Left X	$17,872,600,486	**50%**	$18,645,415,583
Left P	5%	**55%**	$18,700,358,768
Right X	$19,447,956,140	**60%**	$18,760,604,618
Right P	95%	**65%**	$18,824,131,066
Diff X	$1,575,355,654	**70%**	$18,893,140,136
Diff P	90%	**75%**	$18,967,127,141
#Errors	0	**80%**	$19,052,706,437
Filter Min	Off	**85%**	$19,144,599,321
Filter Max	Off	**90%**	$19,278,466,752
#Filtered	0	**95%**	$19,447,956,140

SIMULATION RESULTS FOR 2030 NPV
BASE CASE 3A: SRS



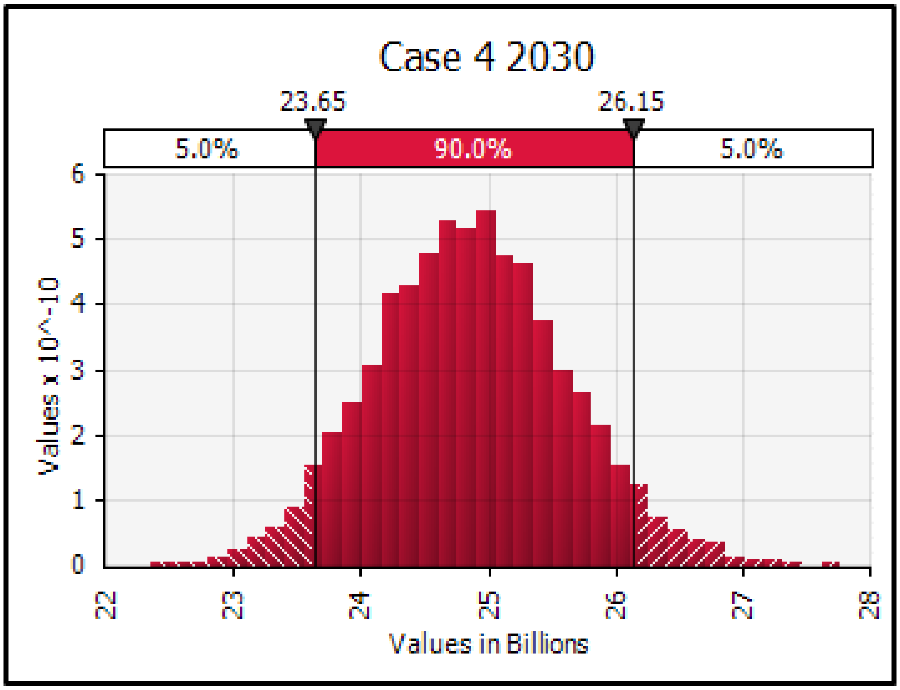
Summary Statistics for Case 3 2030			
Statistics		**Percentile**	
Minimum	$22,382,774,725	**5%**	$23,765,126,366
Maximum	$27,990,377,658	**10%**	$24,018,304,861
Mean	$24,987,709,271	**15%**	$24,188,444,953
Std Dev	$759,794,451	**20%**	$24,344,269,127
Variance	5.77288E+17	**25%**	$24,467,742,932
Skewness	0.116618149	**30%**	$24,580,662,736
Kurtosis	2.996820895	**35%**	$24,690,395,458
Median	$24,973,027,738	**40%**	$24,773,825,901
Mode	$24,821,912,671	**45%**	$24,874,013,212
Left X	$23,765,126,366	**50%**	$24,973,027,738
Left P	5%	**55%**	$25,079,226,766
Right X	$26,237,827,894	**60%**	$25,169,688,963
Right P	95%	**65%**	$25,267,566,842
Diff X	$2,472,701,528	**70%**	$25,373,613,411
Diff P	90%	**75%**	$25,483,557,774
#Errors	0	**80%**	$25,632,346,888
Filter Min	Off	**85%**	$25,780,261,416
Filter Max	Off	**90%**	$25,977,691,889
#Filtered	0	**95%**	$26,237,827,894

SIMULATION RESULTS FOR 2030 NPV
BASE CASE 4A: PANTEX (IP)



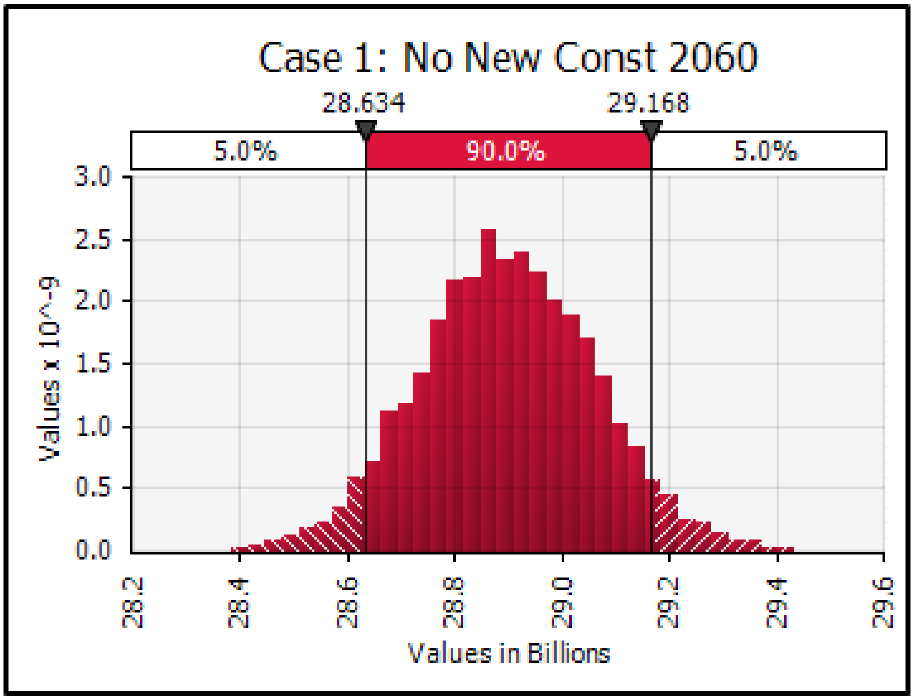
Summary Statistics for Case 4a 2030			
Statistics		**Percentile**	
Minimum	$20,756,025,239	**5%**	$21,919,003,515
Maximum	$25,592,215,593	**10%**	$22,154,836,669
Mean	$22,996,960,544	**15%**	$22,307,375,626
Std Dev	$660,140,873	**20%**	$22,429,290,572
Variance	4.35786E+17	**25%**	$22,537,133,533
Skewness	0.136390053	**30%**	$22,646,242,833
Kurtosis	3.032009515	**35%**	$22,741,022,164
Median	$22,992,824,566	**40%**	$22,823,405,961
Mode	$23,225,350,807	**45%**	$22,902,100,604
Left X	$21,919,003,515	**50%**	$22,992,824,566
Left P	5%	**55%**	$23,070,383,456
Right X	$24,117,123,567	**60%**	$23,147,294,529
Right P	95%	**65%**	$23,230,903,995
Diff X	$2,198,120,052	**70%**	$23,325,696,378
Diff P	90%	**75%**	$23,427,419,882
#Errors	0	**80%**	$23,542,046,160
Filter Min	Off	**85%**	$23,669,002,516
Filter Max	Off	**90%**	$23,858,160,126
#Filtered	0	**95%**	$24,117,123,567

SIMULATION RESULTS FOR 2030 NPV BASE CASE 4B: PANTEX (OP)



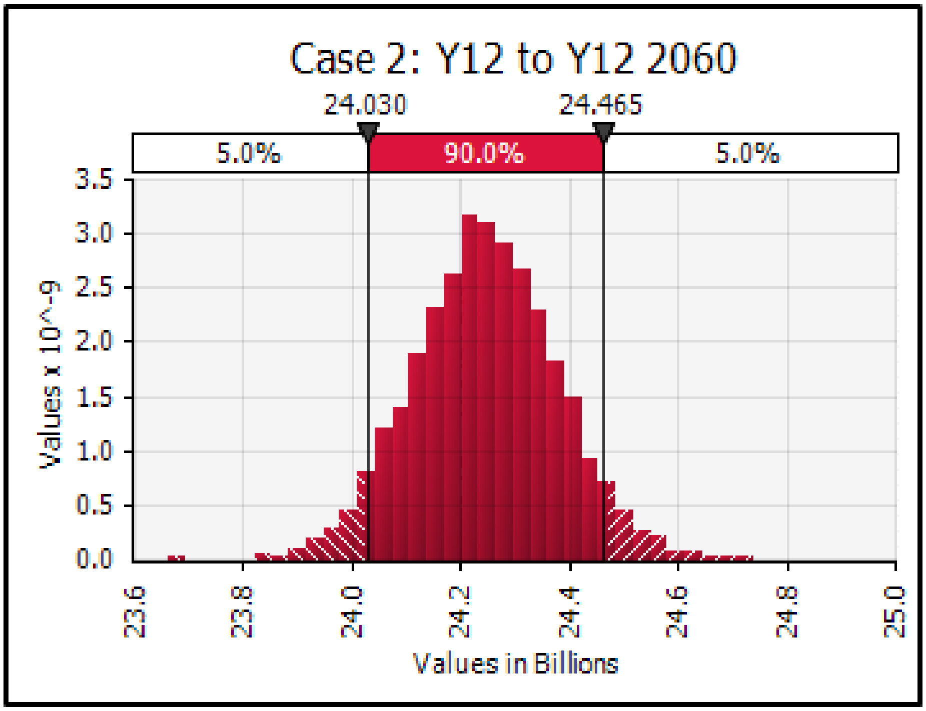
Summary Statistics for Case 4b 2030			
Statistics		**Percentile**	
Minimum	$22,354,799,529	**5%**	$23,645,508,351
Maximum	$27,771,589,379	**10%**	$23,912,462,933
Mean	$24,870,739,243	**15%**	$24,097,370,633
Std Dev	$757,363,298	**20%**	$24,232,353,909
Variance	5.73599E+17	**25%**	$24,352,453,830
Skewness	0.125082983	**30%**	$24,462,326,861
Kurtosis	3.057310862	**35%**	$24,562,296,712
Median	$24,862,280,754	**40%**	$24,668,990,459
Mode	$24,870,256,507	**45%**	$24,761,977,481
Left X	$23,645,508,351	**50%**	$24,862,280,754
Left P	5%	**55%**	$24,949,401,454
Right X	$26,150,531,906	**60%**	$25,045,640,445
Right P	95%	**65%**	$25,147,987,176
Diff X	$2,505,023,555	**70%**	$25,259,335,312
Diff P	90%	**75%**	$25,361,858,887
#Errors	0	**80%**	$25,496,353,965
Filter Min	Off	**85%**	$25,660,184,182
Filter Max	Off	**90%**	$25,858,067,730
#Filtered	0	**95%**	$26,150,531,906

SIMULATION RESULTS FOR 2060 NPV CASE 1A NO ESCALATION: Y-12 NO NEW CONSTRUCTION



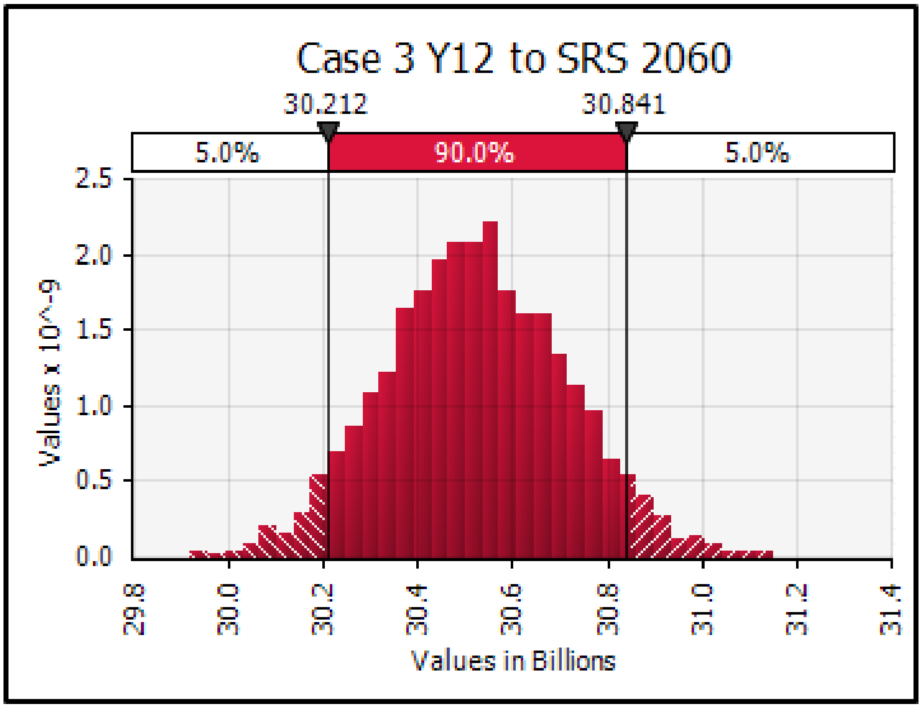
Summary Statistics for Case 1: No New Const 2060			
Statistics		Percentile	
Minimum	$28,385,694,752	5%	$28,634,023,850
Maximum	$29,495,585,409	10%	$28,690,978,558
Mean	$28,900,426,473	15%	$28,730,567,671
Std Dev	$162,868,228	20%	$28,763,700,395
Variance	2.65261E+16	25%	$28,790,815,691
Skewness	0.04936274	30%	$28,814,174,301
Kurtosis	2.948356722	35%	$28,837,260,147
Median	$28,897,910,828	40%	$28,857,024,923
Mode	$28,882,670,908	45%	$28,877,394,863
Left X	$28,634,023,850	50%	$28,897,910,828
Left P	5%	55%	$28,920,282,768
Right X	$29,168,234,773	60%	$28,940,084,156
Right P	95%	65%	$28,962,787,726
Diff X	$534,210,923	70%	$28,985,383,469
Diff P	90%	75%	$29,010,588,303
#Errors	0	80%	$29,039,096,138
Filter Min	Off	85%	$29,070,348,466
Filter Max	Off	90%	$29,109,847,614
#Filtered	0	95%	$29,168,234,773

SIMULATION RESULTS FOR 2060 NPV CASE 2A NO ESCALATION: Y-12 NEW CONSTRUCTION



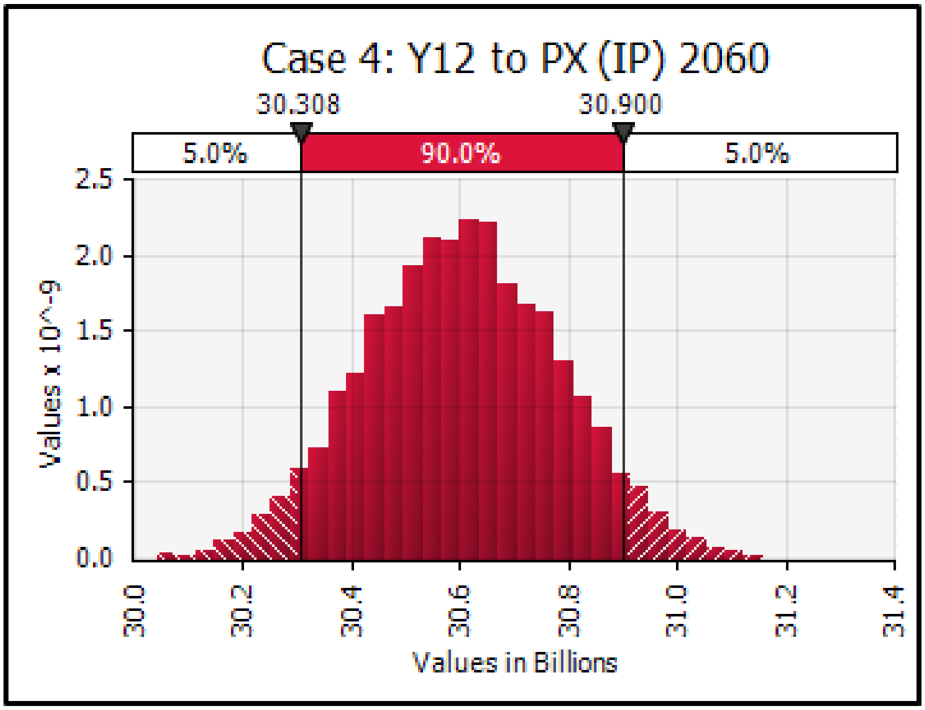
Summary Statistics for Case 2: Y12 to Y12 2060			
Statistics		Percentile	
Minimum	$23,661,706,050	**5%**	$24,030,492,742
Maximum	$24,804,428,876	**10%**	$24,075,109,684
Mean	$24,246,591,540	**15%**	$24,110,331,866
Std Dev	$132,182,115	**20%**	$24,136,936,599
Variance	1.74721E+16	**25%**	$24,158,319,091
Skewness	0.015622992	**30%**	$24,179,470,069
Kurtosis	3.205721634	**35%**	$24,197,481,899
Median	$24,246,098,248	**40%**	$24,213,897,502
Mode	$24,202,488,514	**45%**	$24,228,968,334
Left X	$24,030,492,742	**50%**	$24,246,098,248
Left P	5%	**55%**	$24,261,719,201
Right X	$24,464,582,866	**60%**	$24,278,741,629
Right P	95%	**65%**	$24,295,776,392
Diff X	$434,090,124	**70%**	$24,314,843,021
Diff P	90%	**75%**	$24,333,580,349
#Errors	0	**80%**	$24,357,055,854
Filter Min	Off	**85%**	$24,382,655,505
Filter Max	Off	**90%**	$24,412,642,464
#Filtered	0	**95%**	$24,464,582,866

SIMULATION RESULTS FOR 2060 NPV CASE 3A NO ESCALATION: SRS



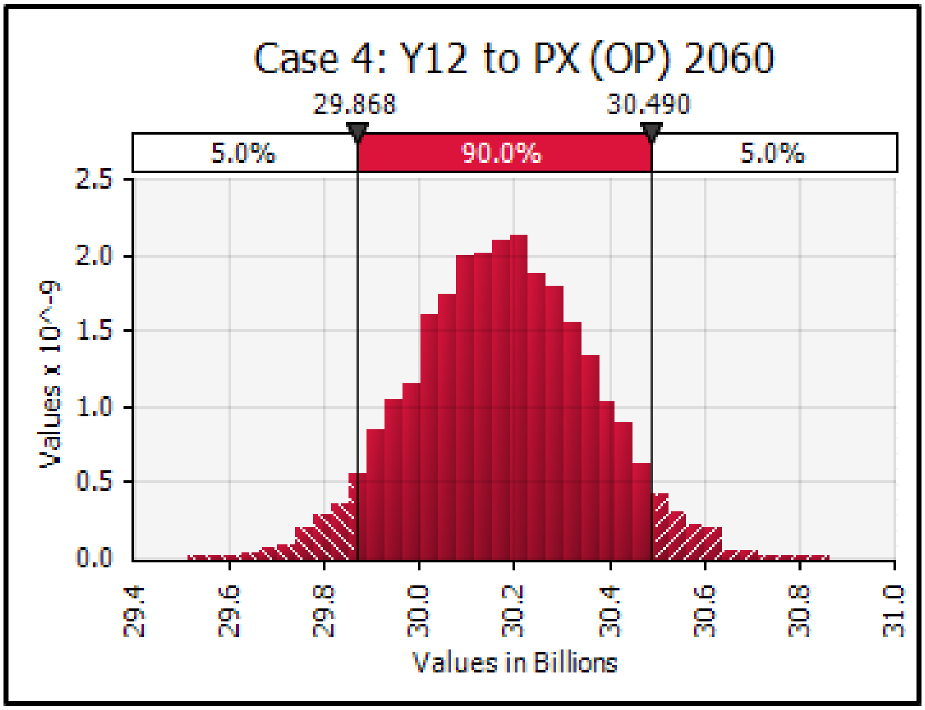
Summary Statistics for Case 3: Y12 to SRS 2060			
Statistics		Percentile	
Minimum	$29,920,527,531	**5%**	$30,211,742,158
Maximum	$31,225,388,720	**10%**	$30,278,727,601
Mean	$30,523,504,999	**15%**	$30,323,894,650
Std Dev	$191,618,954	**20%**	$30,362,671,895
Variance	3.67178E+16	**25%**	$30,392,840,858
Skewness	0.074743436	**30%**	$30,420,673,235
Kurtosis	2.940001916	**35%**	$30,447,633,246
Median	$30,520,308,936	**40%**	$30,471,292,025
Mode	$30,546,583,593	**45%**	$30,496,835,900
Left X	$30,211,742,158	**50%**	$30,520,308,936
Left P	5%	**55%**	$30,544,881,214
Right X	$30,841,442,286	**60%**	$30,566,381,650
Right P	95%	**65%**	$30,592,890,467
Diff X	$629,700,128	**70%**	$30,622,221,976
Diff P	90%	**75%**	$30,655,380,430
#Errors	0	**80%**	$30,686,791,284
Filter Min	Off	**85%**	$30,722,953,849
Filter Max	Off	**90%**	$30,770,904,215
#Filtered	0	**95%**	$30,841,442,286

SIMULATION RESULTS FOR 2060 NPV CASE 4A NO ESCALATION: PANTEX (IP)



Summary Statistics for Case 4a: Y12 to PX (IP) 2060			
Statistics		**Percentile**	
Minimum	$30,007,225,499	**5%**	$30,308,357,441
Maximum	$31,263,690,190	**10%**	$30,370,774,221
Mean	$30,603,661,813	**15%**	$30,415,760,625
Std Dev	$179,568,914	**20%**	$30,447,613,021
Variance	3.2245E+16	**25%**	$30,480,172,353
Skewness	0.008371206	**30%**	$30,508,836,586
Kurtosis	2.819833528	**35%**	$30,532,948,998
Median	$30,603,733,550	**40%**	$30,555,911,889
Mode	$30,554,316,639	**45%**	$30,578,693,884
Left X	$30,308,357,441	**50%**	$30,603,733,550
Left P	5%	**55%**	$30,626,711,419
Right X	$30,899,751,023	**60%**	$30,648,413,456
Right P	95%	**65%**	$30,671,704,076
Diff X	$591,393,581	**70%**	$30,699,202,019
Diff P	90%	**75%**	$30,728,339,055
#Errors	0	**80%**	$30,757,327,986
Filter Min	Off	**85%**	$30,792,654,847
Filter Max	Off	**90%**	$30,837,089,666
#Filtered	0	**95%**	$30,899,751,023

SIMULATION RESULTS FOR 2060 NPV CASE 4B NO ESCALATION: PANTEX (OP)



Summary Statistics for Case 4b: Y12 to PX (OP) 2060			
Statistics		Percentile	
Minimum	$29,515,039,071	**5%**	$29,867,507,769
Maximum	$30,865,636,283	**10%**	$29,934,403,204
Mean	$30,176,942,055	**15%**	$29,982,969,108
Std Dev	$189,509,615	**20%**	$30,016,527,489
Variance	3.59139E+16	**25%**	$30,048,456,087
Skewness	0.040400461	**30%**	$30,076,300,260
Kurtosis	3.012819727	**35%**	$30,101,934,500
Median	$30,177,484,008	**40%**	$30,127,577,151
Mode	$30,084,197,263	**45%**	$30,152,279,565
Left X	$29,867,507,769	**50%**	$30,177,484,008
Left P	5%	**55%**	$30,199,396,957
Right X	$30,489,724,466	**60%**	$30,222,508,909
Right P	95%	**65%**	$30,247,954,091
Diff X	$622,216,697	**70%**	$30,275,975,926
Diff P	90%	**75%**	$30,304,736,709
#Errors	0	**80%**	$30,337,898,728
Filter Min	Off	**85%**	$30,373,644,117
Filter Max	Off	**90%**	$30,421,119,110
#Filtered	0	**95%**	$30,489,724,466

Appendix E
Abbreviations

A/D	assembly/disassembly
AC	analytical chemistry
Be	Beryllium
BOP	balance-of-plant
CAIG	Cost Analysis Improvement Group
CAIRS	Computerized Accident/Incident Reporting System
CAT I/II	security category I and hazard category II
CCC	Complex Command Center (Y-12)
CD	critical decision
CHE	conventional high explosive
CMC	consolidated manufacturing complex
CMR	Chemistry and Metallurgy Research Facility (LANL)
CMRR-NF	Chemistry and Metallurgy Research Replacement Nuclear Facility (LANL)
CMRR-RLUOB	CMR Replacement Radiological Laboratory and Utility and Office Building (LANL)
CNPC	Consolidated Nuclear Production Center
CRF	Component Re-qualification Facility for SNM
CSA	canned subassembly
CTBT	Comprehensive Test Ban Treaty
CUC	Consolidated Uranium Center
D&D	decontamination and decommissioning
DBT	design basis threat
DoD	Department of Defense
DOE	Department of Energy
DP	NNSA Office of Defense Programs
DSB	Defense Science Board
DU	depleted uranium
ECF	Portal Entry Control Facility

EH	DOE Office of Environment, Safety, and Health
EIS	environmental impact statement
EM	DOE Office of Environmental Management
ER	environmental restoration
ESH	Environment, Safety, and Health
FAF	Federal Agent Facility
FIMS	Facilities Information Management System
FIRP	Facility Infrastructure Revitalization Program
FTE	full-time equivalent
GDP	Gaseous Diffusion Plant
gsf	gross square foot
HE	high explosives
HEPF	High Explosives Processing Facility
HETF	Hardened Engineering Test Facility (LLNL)
HEU	highly enriched uranium
HEUMF	Highly Enriched Uranium Materials Facility (Y-12)
HLW	high level waste
IBCA	independent business case analysis
IFDP	Integrated Facilities Disposition Project
IHE	insensitive high explosive
IP	inside PIDAS
IPT	integrated project team
KCRIMS	Kansas City Responsive Infrastructure Manufacturing and Sourcing Center
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LEP	life extension program
LLCE	limited life component exchange
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LSHT	large-scale hydrodynamic testing
M&A	management and administration
MC	materials characterization
MC&A	material control and accountability

METF	modern environmental test facilities
MFFF	Mixed Oxide Fuel Fabrication Facility (SRS)
MPF	materials processing facility
NCP	non-nuclear consolidation plan
NDE	non-destructive examination
NE	DOE/NNSA Office of Nuclear Energy
NE	nuclear energy
NEO	nuclear explosives operations
NEP	nuclear explosive package
NEPA	National Environmental Policy Act
NN	DOE/NNSA Office of Nuclear Nonproliferation
NNSA	National Nuclear Security Administration
NPV	net present value
NR	DOE/NNSA Office of Naval Reactors
NTS	Nevada Test Site
NTWG	Nuclear Transformation Working Group
NWC	nuclear weapons complex
NWCITF	Nuclear Weapons Complex Infrastructure Task Force
NWSP	nuclear weapon stockpile plan
O&M	operations and maintenance
OP	outside PIDAS
OPC	other project costs
ORNL	Oak Ridge National Laboratory
OST	NNSA Office of Secure Transportation (NA-15)
PCD	program control document
PDCF	Pit Disassembly and Conversion Facility (SRS)
PDRD	plant discretionary research and development
PEIS	programmatic environmental impact statement
PERT	program evaluation and review technique
PIDAS	Perimeter Intrusion Detection and Assessment System
PPY	pits per year
Pu	plutonium
QMU	quantification of margins and uncertainties

R&D	research and development
RCRA	Resource Conservation and Recovery Act
RLWTF	radioactive liquid waste treatment
RMA	radioactive materials area
ROD	record of decision
ROM	rough order of magnitude
RPV	replacement plant value
RRW	reliable replacement warhead
RWMC	Radioactive Waste Management Complex (NTS)
RWS and RANT	radioactive solid waste handling
S&M	surveillance and maintenance
SD	standard deviation
SEAB	Secretary of Energy Advisory Board
SIP	Security Improvement Project
SITS	Systems Integration Technical Support
SME	subject matter expert
SNL	Sandia National Laboratories
SNM	special nuclear material (includes Pu and U)
SPEIS	supplemental PEIS
SRS	Savannah River Site
TA	technical area
TEC	total estimated cost
TPC	total project cost
TRC	total recordable case rate
TRIPS	Transportation Resource Integrated Planning System
TRU	transuranic
U	uranium
UPF	Uranium Processing Facility
WAC	waste acceptance criteria
WCRRF	waste characterization, reduction, and repackaging
WFO	work for others
WIPP	Waste Isolation Pilot Plant
WR	war reserve

WRAP	waste receiving and processing
WSB	Waste Solidification Building
Y-12	Y-12 National Security Complex