UNITED STATES DEPARTMENT OF ENERGY
NATIONAL NUCLEAR SECURITY ADMINISTRATION

URANIUM PROCESSING FACILITY (UPF) PROJECT

Oak Ridge, Tennessee

Update to the U.S. Army Corps of Engineers Total Project Cost Cost Estimate and Cost Range

Prepared for:

United States Department of Energy

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Cat 2 Circumvention of Statute
Department of Energy review required before public release.
Name/Org: S. Wellbaum/YSO Date:_____
Guidance (if applicable) N/A

February 9, 2011
Revision 1 February 16, 2011

US Army Corps of Engineers ®
Huntington District

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Updated USACE Cost Estimate Report Change Record		
Revision No.	**Change**	**Issued/Approved Date**
Revision 0	Original Document	February 9, 2011
Revision 1	Incorporated YSO Comments	February 16, 2011

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ACRONYMS

AACEI – Association for the Advancement of Cost Engineering, International
ACWP – Actual Cost of Work Performed
AE – Architect Engineering
AER – Assembly Environmental Room
AIMS – Advanced Integrated Machining Systems
B&W – Babcock & Wilcox Company
CD – Critical Decision
CES – Cost-Estimating Spreadsheet
CFO – Chief Financial Officer
CLA – Construction Labor Agreement
CL – Confidence Level
CM – Construction Management
CM&E – Construction Material and Equipment
CS – Construction Specification
CSRA – Cost, Schedule Risk Analysis
CSS – Common Site Support
DAC – Design Analyses and Calculations
DOE – Department of Energy
DX – USACE Cost Center of Expertise –Walla Walla District
EAC – Estimate at Completion
EB – Electron Beam
ER – Engineer Regulation
ETC – Estimate to Complete
EU – Enriched Uranium
EUPMP – Enriched Uranium Purification and Metal Production
EVMS – Earned Value Management System
FFA – Facility Functional Areas
FPA – Facility Process Areas
FTE – Full Time Equivalent
FY – Fiscal Year
GAO – Government Accountability Office
G&A – General and Administrative
GFE – Government Furnished Equipment
HEUMF – Highly Enriched Uranium Materials Facility
IA – Interagency Agreement
ICE – Independent Cost Estimate
KV – Kilovolt
LI – Line Item
LLP – Long Lead Procurement
M&O - Management and Operating
M&S – Materials & Subcontracts
MCACES – Micro-Computer Aided Cost Estimating System
MII – the second generation of the Micro-Computer Aided Cost Estimating System software
MS – Microsoft
NMC&A – Nuclear Material Control and Accountability
NNSA – National Nuclear Security Administration
OM – Order of Magnitude
O&P – Overhead and Profit Markup
OMP – Oxide Material Production
OPC – Other Project Costs
ORR – Operational Readiness Review
OT – Overtime
P3 – Primavera Project Planner
PDRD – Plant Directed Research Development
PED – Preliminary Engineering and Design
PEMPED – Predictive Estimating Model for Project Engineering & Design [© 2008 Patrick Higgins]
PFD – Process Flow Diagrams
PMSO – Project Management support Office
PRD – Program Requirements Document
PT&C – Project Time and Cost
QE – Quality Evaluation
SDOR – Saltless Direct Oxide Reduction
SLPP – Summary Level Planning Packages
SME – Subject Matter Expert
SMP – Special Material Production
SOW – Scope of Work
SOX – Special Oxide Production
SR – System Requirement
SRD – System Requirement Document
SSI – Soil-Structure Interaction
STA - Shift Technical Advisor
TC&C – Turnings Cleaning & Conversion
TEC – Total Estimated Cost
TPC – Total Project Cost
UOM – Unit of Measure
UPB – Unit Price Book
UPF – Uranium Processing Facility
USACE – U.S. Army Corps of Engineers
WBS – Work Breakdown Structure
WP – Work Package
WPIF – Work Package Input Form
Y-12 – Y-12 National Security Complex
YSO – Y-12 Site Office

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Huntington District, under an Interagency Agreement, DE-AI152-10NA29775, with the Department of Energy (DOE) National Nuclear Security Administration (NNSA), is tasked to provide cost engineering services at the Y-12 National Security Complex (Y-12) in Oak Ridge, Tennessee. This agreement previously requested the development of the following products:

- A Total Project Cost (TPC) Independent Cost Estimate (ICE) and cost range for the Uranium Processing Facility (UPF) project, and reconciliation with the management and operating (M&O) contractors estimate, completed on and dated September 15, 2010
- A Technical and Cost Analysis Report incorporating risk register revisions and direction from the Y-12 Site Office (YSO) completed and dated November 17, 2010
- TPC Derivative Range Estimate and cost range for the UPF Project incorporating recommendations and direction from the YSO completed on and dated November 19, 2010

The ICE cited above established an independent government estimate for the UPF Project totaling $7.386B at the 85% confidence level (CL) with approximately 40% of the design being complete per Babcock & Wilcox Y-12, LLC (B&W) provided documentation. Subsequent to the USACE preparation of the ICE and the Derivative Range Estimate on November 19, 2010, YSO provided the ICE, reconciliation report, and other USACE work products to B&W, the site management and operating contractor (M&O), for their review and comment. There were several questions generated from that review which YSO asked USACE to disposition and resolve. To facilitate resolution of these questions, YSO requested USACE to engage in additional discussions with B&W in order to reach a mutual understanding of the respective approach and methodologies. Operating under the instructions contained in YSO Technical Direction Letter #5, December 15, 2010, USACE and B&W completed those discussions (January 12 to 18, 2011). There now exists a clearer USACE and B&W understanding of the UPF Project cost, schedule, and risk at this stage of UPF design maturity.

This report was prepared and developed in accordance with the statement of work Update of the Project Range Estimate for DOE NNSA'S Uranium Processing Facility at Oak Ridge, TN, Contract No. W912EF-09-D-0002, Huntington District – U. S. Army Corps of Engineers, Task Order No.CG5D (January 2011), Project Time and Cost, Inc of Atlanta, GA. This report includes the following:

- Main Report
- Assumptions
- Updated MCACES Version II (MII) Cost Estimate
- Updated Cost Estimate Data Spreadsheets
- Schedule and Critical Path
- Cost Estimate Methodologies with assumptions and constraints
- Updated Risk Register with cost and schedule risk models
- Cost Estimate Methodologies and Assumptions and Constraints
- Updated Cost Range Calculations Supporting Application of Contingency & Escalation
- Alternative Scenario Cost Range Calculations
- Quality Control Documentation

The updated USACE results for the UPF TPC cost estimate and cost range estimate are presented in this report. The updated USACE Total Project Cost is $6,835.8 million (with contingency at the 85% CL, escalation, and actual costs to date [March 2010]). The cost range varies from $6,472.2 million (50% CL) to $7,507.9 million (95% CL) with a project completion date of January 2023.

The development of the update to the TPC cost estimate and cost range incorporated:

- The generation of an MII cost estimate update, which incorporates the USACE TPC ICE reconciliation adjustments documented in the *Total Project Cost Independent Cost Estimate, Schedule, Cost & Schedule Risk Reconciliation Report, Revision 3* - November 19, 2010
- Modification of the MII cost estimate for WBS 1.07.02.09.50.30.10 Operational Readiness and 1.07.02.09.50.40.10 Project Integration (OPC) to:
  - Remove all B&W burdened positions and hours for crew training,
  - Adjust the crews for testing and readiness "capability demonstration" activities at the process level and
  - Transfer pre-operational testing to WBS 1.07.02.09.40.
- Development of a new resource-loaded Primavera 3 (P3) schedule while maintaining the original ICE schedule dates, logic, and durations for the remaining Title I preliminary design, Title II facility final design and engineering, and Title III construction and facility startup.
- Performance of a Cost and Schedule Risk Analysis (CSRA) to update risks and contingency analysis to establish contingencies for the TPC cost estimate update.
- Calculation of the updated TPC cost estimate at the 85% CL in conjunction with the calculation of the TPC cost range using the 50% and 95% CLs.
- Application of escalation using Y-12 furnished rates and inclusion of the year-to-date costs.

Incorporating reductions of $313.6 million for reconciliation and revised estimate adjustments, the updated USACE TPC estimate, without escalation and contingency, is $4,145.0 million as illustrated in Table ES-1.

Table ES-1. Updated Total Project Cost Estimate Detail - WBS 1.07.02.09 UPF Project ($M)

WBS	USACE ICE[3]	Adjustment	Updated USACE Estimate To Complete[3]	Actual Costs (March 21, 2010)	Updated USACE TPC Estimate
1.07.02.09 Uranium Processing Facility	**$4,241.4**	**($313.6)**	**$3,927.7**	**$217.2**	**$4,145.0**
1.07.02.09.10 Planning & Readiness - OPC	$70.4	$26.6 [1]	$97.0	$64.6	$161.6
1.07.02.09.20 UPF Design (PED)	$311.2	$0	$311.2	$152.6	$463.8
1.07.02.09.30 UPF Project Execution (LI) Procurement, Construction & Title III	$233.2	$46.0 [1]	$279.3	$0.0	$279.3
1.07.02.09.40 SLPP (LI) Procurement, Construction & Title III	$2,242.4	$295.6 [1,2]	$2,538.0	$0.0	$2,538.0
1.07.02.09.50 SLPP Planning & Readiness (OPC)	$1,384.2	($681.9)[1,2]	$702.3	$0.0	$702.3

[1] Reconciliation Adjustment
[2] Revised Estimate
[3] Without Contingency & Escalation
Note: Totals are not exact due to rounding.

When compared to the B&W TPC estimate of July 2011, the updated USACE cost estimate (without contingency and escalation) still shows some significant variances, as illustrated in Table ES-2. The M&O estimate includes several cost line items covering activities associated with engineering support of the project design effort, ranging from computations through procurement oversight under WBS 1.07.02.09.30. These efforts clearly relate to the facility, building systems, process support systems, or process area design and the M&O should address these efforts under work breakdown structure (WBS) 1.07.02.09.20 UPF Design (PED).

For elements of WBS 1.07.02.09.40 SLPP (LI) Procurement, Construction & Title III and 1.07.02.09.50 SLPP Planning & Readiness (OPC), the level of effort detailed in the updated USACE cost estimate remains significantly higher than the level of effort presented in the B&W TPC Estimate. The complexity and level of effort detailed in the labor hour estimates in the updated USACE cost estimate reflect the technical opinion of the USACE subject matter experts (SME) that substantially more effort will be required to complete the individual tasks than is presented in the B&W TPC estimate. This is based on the SMEs experience with the Enriched Uranium Operations Wet Chemistry and Life Extension Program component production process restart efforts in Building 9212. In general, crew sizes, and therefore the man-hours presented in the B&W TPC estimate, are believed to be 50% to 70% low given the SMEs understanding of the scope and complexity of work. In general, B&W used a tops-down estimating methodology for this WBS (i.e. staffing plan distribution) whereas the USACE ICE used a bottoms-up activity based estimating approach, which provides results that are more realistic.

Table ES-2. USACE and M&O Cost Estimate Comparison – WBS 1.07.02.09 UPF Project ($M)

WBS	M&O Estimate[1]	Updated USACE Estimate To Complete[1]	Cost Variance	Cost Variance (%)
1.07.02.09 Uranium Processing Facility	**$3,107.4**	**$3,927.7**	**$820.3**	**20.9**
1.07.02.09.10 Planning & Readiness - OPC	$98.2	$97.0	($1.2)	(1.3)
1.07.02.09.20 UPF Design (PED)	$272.3	$311.2	$38.9	12.5
1.07.02.09.30 UPF Project Execution (LI) Procurement, Construction & Title III	$327.2	$279.3	($47.9)	(17.2)
1.07.02.09.40 SLPP (LI) Procurement, Construction & Title III	$2,088.5	$2,538.0	$449.5	17.7
1.07.02.09.50 SLPP Planning & Readiness (OPC)	$321.3	$702.3	$381.1	54.3

[1] Does not include $217.2 million actual costs through March 2010
Note: Totals are not exact due to rounding.

The updated USACE TPC estimate contingency for the UPF Project is approximately $1,501.8 million at the 85% CL or about 38.2 % of the base cost estimate of $3,927.7 million.

The key cost risk drivers identified through sensitivity analysis are *Funding Profile/Project Priority*, *Operations Staff Availability for Readiness*, *Preoperational Testing Issues*, and *New Technology Readiness Levels*, which contribute about 23.7%, 16.4%, 13.2%, and 11.0% respectively to the statistical cost variance. The key schedule risk drivers identified through sensitivity analysis are *Funding Profile/Project Priority* and *Preoperational Testing Issues*, which contribute about 37.5% and 12.8% respectively to the statistical schedule duration variance.

A breakdown of updated USACE cost estimate total contingency for the UPF project by Federal and M&O contractor components at the 85% confidence limits is presented in Table ES-3.

Table ES-3. Updated Total Project Cost Estimate Federal and M&O Contingency at 85% Confidence Level ($M)

Confidence Level And Risk Owner	Contingency ($)	% Total Contingency
85% CL		
Federal-Headquarters	$469.6	31.3
Federal-YSO	$215.0	14.3
M&O Contractor	$817.2	54.4

For the updated cost range, the updated USACE cost estimate spend plans were generated for all Level 3 WBS elements and escalation was applied. These were summed for all Level 3 WBS elements at the 50% CL to determine the lower end of the TPC cost range. Similarly, the escalated spend plans (based on the $4,291.1 million upper end of the cost accuracy uncertainty range) are summed for all Level 3 WBS elements at the 95% CL to determine the upper end of the TPC Estimate to Complete (ETC) cost range. The TPC ETC cost range is $6,255.0 to $7,290.7 million. To this range, the UPF Project actual costs of work performed to date of $217.2 million (March 21, 2010) are added. This results in an overall TPC cost range for the UPF Project of $6,472.2 to $7,507.9 million. The TPC cost range is summarized in Table ES-4.

Table ES–4. Updated Cost Range Summary ($M)

Cost Item	Cost Range		
	Range Lower Boundary (50% Confidence Level)	Updated USACE Cost Estimate (85% Confidence Level)	Range Upper Boundary (95% Confidence Level)
MII Cost Estimate	$3,927.7		
Cost Accuracy Uncertainty	-		$363.4
Cost Accuracy Uncertainty Range	$3,927.7		$4,291.1
Contingency	$1,205.6	$1,501.8	$1,689.4
% of Cost Accuracy Uncertainty Range	30.7%	38.2%	39.4%
Subtotal - Cost Accuracy Uncertainty Range and Contingency	$5,133.3	$5,429.5	$5,980.5
Escalation	$1,121.7	$1,189.1	$1,310.2
% of Cost Accuracy Uncertainty Range and Contingency	21.9%	21.9%	21.9%
Subtotal - Cost Accuracy Uncertainty Range with Contingency and Escalation	$6,255.0	$6,618.6	$7,290.7
Actual Cost of Work Performed (as of March 2010)	$217.2	$217.2	$217.2
Total	$6,472.2	$6,835.8	$7,507.9

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1.0 UPF PROJECT OVERVIEW

1.1 Introduction

The Uranium Processing Facility (UPF) project is a major system acquisition for the Department of Energy (DOE) National Nuclear Security Administration (NNSA) at the Y-12 National Security Complex (Y-12) in Oak Ridge, Tennessee. The UPF is being designed and constructed to ensure the long-term viability, safety, and security of enriched uranium (EU) processing. The UPF will support the nation's nuclear weapons stockpile, provide uranium fuel feed to the U.S. Navy, provide for disposition of excess EU materials, and provide space for development programs requiring EU materials. The goals and objectives of the UPF are to:

- Ensure the long-term capability for and reliability of EU operations through consolidation and replacement of deteriorating, end-of-life facilities with a modern manufacturing facility;
- Enhance the health and safety of workers and the public by upgrading noncompliant facilities and by replacing administrative controls with engineered controls to manage risks related to worker safety, criticality safety, fire protection, and environmental compliance; and
- Accomplish essential upgrades to security necessary to carry out mission-critical activities based on implementation of the NNSA Graded Security Protection Policy.

The NNSA Y-12 Site Office (YSO) is responsible for providing oversight of the UPF Project, which is currently being managed by a site management and operating (M&O) contractor, Babcock & Wilcox Y-12 (B&W) LLC through a Work Authorization Document. Bechtel National is a corporate partner within B&W and leads the UPF effort. On July 15, 2010, B&W submitted an updated design schedule, cost estimate, risk analysis and their version of a cost range to YSO. Additionally, B&W reported that this update represented a UPF design complete status of approximately 40%.

The UPF Project is currently preparing to submit the first Critical Decision 2/3 (CD-2/3A) package, which will cover the performance baseline/start of construction for the initial phase of the project, which consists of site preparation and certain long-lead procurements. Subsequently, the UPF Project will pursue a second CD-2/3 decision, which will establish the full project performance baseline and, authorize building construction, and Phase I of equipment installation. Eventually, the UPF Project will also pursue a CD-3 decision for Phase II of equipment installation and the remaining line-item scope necessary to achieve CD-4.

1.2 Background

YSO has established an Interagency Agreement, DE-AI152-10NA29775, for cost engineering services with the U.S. Army Corps of Engineers (USACE) Huntington District. Under this agreement, YSO tasked USACE to assist YSO in developing a government position for future budgetary requests by developing an Independent Cost Estimate (ICE) for the UPF Project, reconciling the Total Project Cost (TPC) ICE to B&W's cost estimate, and providing additional cost engineering support upon request. To accomplish this, USACE established the USACE Team, including both Federal (USACE) and contractor (Project Time & Cost, Inc. (PT&C) and Pro2Serve) resources. The team is comprised of subject matter experts (SME) in

the fields of cost engineering; scheduling; cost and schedule risk analysis (CSRA); and the design, construction, start-up, and operation of nuclear material processing facilities.

On March 29, 2010, the USACE Team began the development of a TPC ICE for the UPF Project. The original tasking for the TPC ICE consisted of two phases. Phase I developed a cost estimate for site preparation and long-lead procurement (the scope of the first CD-2/3 package); Phase II developed a cost estimate and a cost range estimate for the remaining scope of the project. For each phase, the USACE Team developed a cost estimate (using MII, the second generation of USACE's Micro–Computer Aided Cost Estimating System (MCACES)) and a schedule (using Primavera Project Planner (P3)). Additionally, the USACE Team developed a Cost and Schedule Risk Analysis (CSRA), which identified and quantified project risks and developed project cost and schedule contingencies using guidance from the USACE Cost Engineering Directory of Expertise. Phase I was completed in early July 2010; Phase II was completed in August 2010. The Phase I point estimate was included as an integral part of the Phase II cost range. For the remainder of this report, the references to the TPC ICE refer to the Phase II cost and schedule estimate results.

During August and September 2010, the USACE Team reconciled the TPC ICE to the estimate package prepared by B&W. The purpose of the TPC ICE reconciliation was to assist YSO in determining the reasonableness of the B&W TPC cost estimate, schedule, contingency, and cost range for the UPF Project through a comparative analysis. During reconciliation, the USACE Team:

- Examined the cost estimating approaches and methodologies used by B&W and compared these approaches and methods to those used by USACE,
- Performed a direct comparison between the estimates at multiple work breakdown structure (WBS) levels, identified variances, and
- Conducted topical review meetings with B&W staff.

Because of potential procurement sensitivities, the USACE Team conducted the reconciliation process without revealing the results of the TPC ICE to B&W. This complicated the analysis, in that it precluded open unrestricted discussions with B&W.

The results of the reconciliation were included in the USACE reconciliation report, which proposed additions to, subtractions from, and transfers between various WBS elements in both the B&W and the USACE estimates. Additionally, the USACE Team identified differences in the cost estimating approaches used.

In October 2010, YSO requested that the USACE Team perform technical and cost analyses of the TPC ICE to quantify the impacts of the following changes as directed by YSO. These included:

- Removing labor categories that were direct-charged in the USACE estimate, which the M&O captures within the expense-funded overhead applied to Planning and Readiness activities;
- Removing actual training time that was direct-charged in the USACE estimate, which the M&O includes in B&W 's divisional direct-labor rates;
- Moving Pre-Operational Testing from Planning and Readiness to Facility Construction; and
- Updating the CSRA to reflect YSO-directed changes to the cost/schedule cost contributions to UPF cost contingency from all NNSA/Federal risks and a select set of contractor risks.

In November 2010, YSO requested that the USACE Team develop another range estimate for the UPF Project cost. The generation of the Derivative Range Estimate involved four elements:

- Establishing a reconciled cost estimate for the UPF Project. The reconciled cost estimate was the result of the reconciliation between the TPC ICE cost estimate and the B&W contractor TPC estimate and incorporated the changes identified in October 2010 (before contingency and escalation are applied);
- Developing spend plans for the reconciled cost estimate based on the resource-loaded schedule;
- Using the October 2010 CSRA results to establish cost and schedule contingency; and
- Integrating the reconciled cost estimate and the associated spend plans within USACE's cost range methodology to estimate cost uncertainty, apply the appropriate contingency from the October 2010 CSRA, calculate escalation, and add actual cost to date. These four elements resulted in the development of the Derivative Range Estimate.

The Derivative Range Estimate as developed included revised cost range upper boundaries at the 85% and 95 % confidence levels and two sets of escalation rates – one using escalation rates provided to the USACE Team in April 2010 by B&W and one using escalation rates provided by the DOE Office of Cost Analysis (CF-70). This estimate reflected changes and analysis as directed by YSO, and did not reflect a wholly "USACE-owned" reconciled cost estimate and range.

In December 2010, YSO tasked USACE to participate in additional discussions to address comments and questions generated by B&W on the USACE cost and schedule estimates. Subsequent to USACE's preparation of the Derivative Range Estimate, YSO provided B&W access to the TPC ICE, the reconciliation report, and other products for review and comment. This enabled more open and unrestricted discussions between USACE and B&W while still maintaining the independent integrity of the USACE effort.

The focus of these discussions was on discovery—eliminating assumptions regarding the approaches used by both B&W and USACE—so that all participants (YSO, B&W, and USACE) had a common understanding of how both estimates were constructed and developed. The primary goal of these discussions was to identify the common elements of the two estimates and to document the basis for differences between them.

This report incorporates the results of these discussions along with all previous changes into an update of the USACE TPC cost estimate and cost range.

2.0 COST ESTIMATE UPDATE APPROACH

2.1 Purpose and Scope

The purpose of the TPC cost estimate update is to assist the YSO federal management team in the determination of the reasonableness of the July 15, 2010 M&O contractor TPC cost estimate, schedule, CSRA, and cost range for the UPF Project. In addition, the TPC cost estimate update will assist YSO in establishing their independent financial position for future budgetary requests.

The TPC cost estimate update scope addresses UPF Project efforts encompassing:

- A CD-2/3 for early site preparation construction and long-lead procurement items with the required project integration, Title III engineering, construction management, and indirect support for those limited activities.
- A CD-2/3 full project performance baseline, addressing start of building construction (building shell and installation of building services) and Phase 1[1] equipment installation. Building construction will include the main processing building and all support facilities. Phase 1 equipment installation will consist of utilities equipment installation and some processing equipment. Project integration, Title III engineering, construction management, and indirect support required for these activities are included.
- A CD-3 request for Phase 2[2] equipment installation includes the remainder of facility and process equipment procurement, installation, testing, and readiness/startup activities to achieve CD-4. Project integration, Title III engineering, construction management, and indirect support required for these activities are included.

2.2 Technical Approach

2.2.1 Process

The USACE Team, composed of both USACE federal employees and federal resources (PT&C and Pro2Serve), includes subject matter experts (SME) in nuclear facility construction, uranium process design/installation/testing, and nuclear weapon component manufacturing as well as expert cost estimators and schedulers.

On December 20, 2010, YSO provided USACE with the following three documents that detailed B&W's review of the USACE TPC ICE:

- UPF/USACE Reconciliation, dated December, 15, 2010
- Review of the USACE ICE and Reconciliation, Executive Summary, dated December 17, 2010
- USACE Review Questions, dated December 20, 2010

Multiple meetings occurred with YSO, B&W, and the USACE Team between January 12, 2011 and January 18, 2011. The meetings focused on the questions and comments identified by B&W in the documents cited above and allowed the participants to discuss the methodologies and approaches used in the development of specific sections of their respective estimates. The approaches and methodology used in the development of the USACE TPC ICE were reviewed during these meetings in order to provide further understanding of the UPF Project commissioning, startup and testing, and risk assessment.

2.2.2 Design Basis

The project scope used for the update to the TPC cost estimate is contained in the following primary UPF Project documents:

[1] From *Proposed Critical Decision Strategy for the Uranium Processing Facility Project*, WP-PM-801768-A004 (January 2010), this phase reference relates to the UPF Project installation of utilities equipment and some processing area equipment.
[2] From *Proposed Critical Decision Strategy for the Uranium Processing Facility Project*, WP-PM-801768-A004 (January 2010), this phase reference relates to the UPF project facility installation of equipment and the remaining process area equipment

- Architectural drawings (A2E801768D500 through A2E801768D 503; A2E801768W500 through A2E801768w503)
- CAP-SS-5/29/07-98111 UPF Concrete Placement Schedule and Construction Execution, Doc. No. WP-CM-80 1768-AOO 1, Rev. 0
- Civil Drawings (C2E801768A001 to C2E801768A365)
- Construction Specifications (such as CS-EC-801768-321200-A001; CS-EE-801768-260500-A001, CS-EP-801768-400501.00-A001))
- Construction Work Plan (WP-CM-801768-A001)
- Design Analyses and Calculations (DAC-EC-801768-A001 to A)40))
- Design Criteria (DE-PE-801768-A001 through DE-PE-801768-A050)
- Electrical Drawings (E2E801768A051 through E2E801768A096 and E2E801768A118 Rev. D thru A130 Rev. D)
- Equipment Fact Sheets(DS-EM-801768-A001 through DS-EM-801768-A241)
- Guidance letters on the Highly Enriched Uranium Materials Facility (HEUMF) fire water supply (COL-NNSA-YSO-PM-801768-A038) and 9/15 MeV X-ray radiography (COL-NNSA-HQ-PM-801768-A006)
- Grading Worksheets (GWS-ES-9801768-FOUND-A002)
- Job Equipment Specifications (JS-EI-801768-A001, JS-EI-801768-A001-A002)
- Medium- And Low-Voltage One-Line Diagrams
- *Preliminary Project Execution Plan for the Uranium Processing Facility*, Project Number 06-0-140-5, June 2007
- Process Flow Diagrams (J2E801768A200 through J2E801768A216)
- Project Design Criteria (DE-PE-801768-AOO1 through DE-PE-801768-A050)
- *Quality Assurance Plan for the Uranium Processing Facility*, PL-PJ-801768-A004, Rev. 3
- Retaining Wall Specifications & Drawings (S2E810768D001 through D005)
- *Scope Book for the Y-12 National Security Complex Uranium Processing Facility*, RP PA-801768-A001, Rev. 1
- Security Door Drawings (A2E801768D500 through W503)
- Site Piping Diagrams (P2D801768A200 through P2D801768A010)
- Site Preparation and Utility Design Packages
- *Storm Water Pollution Prevention Plan*, PL-EC-801768-A003, Rev. 0
- *System Requirements Document/or Uranium Processing Facility (U)*, SR-PE-801768-A001(SRD)
- FY 10 TPC Range Estimate Notebooks (TPC-EG-801768-A001 through TPC-EG-801768-A265, and TPC-EG-801768-PIDAS A013)
- Underground Utility Drawings (D2E801768A114)
- UPF Concrete Placement Schedule and Construction Execution Plan
- UPF Specifications (such as CS-EC-801768-024116-A001, CS-EE-801768-260500.00-A001

- *Uranium Processing Facility Program Requirements Document (U),* DOE/ORO-2171 (PRD);
- *Uranium Processing Facility Project Assumptions (U),* RP-PJ-801768-A016, REV. 3
- Uranium Processing Facility Commissioning Management Plan – Readiness, Startup and Transition, PL-PJ-801768-A009
- Utility Process Flow Diagrams and Piping & Instrumentation Diagrams

2.2.3 Reconciliation Basis

The following M&O TPC cost estimate, schedule, CSRA, and cost range information (actual document and computer file nomenclature) collectively constitute the basis for reconciliation to the TPC ICE cost estimate, schedule, CSRA, and cost range.

Cost Estimate:

- Escalated Detail Report Data.xls
- UPF Line Item Export 8–10–10 with Escalation and Contigency.xls
- UPF Line Item Export 8–10–10 without Escalation and Contigency.xls
- UPF Line Item Export 8–10–10.xls
- Project Value File PVF Templ 06–09–10a 6–9–2010
- PVF Template 06-09-2010a.pdf
- Labor Rates 06–09–2010a.pdf
- Overheads 06–09–2010a.pdf
- Latest Labor rates.xlsx
- Escalation Rate Comparison.xlsx
- CCN200652841 Rev 2 Escalation Calculations 11-21-09.pdf
- OPC Task Analysis Input Rev 2 March 10
    - Basis of Estimate Product Cert Assy NPE added.docx
    - Basis of Estimate Product Cert EU Metal NPE added.doc
    - Basis of Estimate Product cert QE NPE added.doc
    - Basis of Estimate Sheet-UPF Readiness Range Estimate 3-2010-R2-Signed Raulston.pdf
    - Non-Manual Estimate 01192010 YSO OPC.doc
    - Non-Manual estimate - QA3-18-10 OPC.docx
    - Non-Manual estimate Process Modeling 1of3 Rev 1.doc
    - Non-Manual estimate Process Modeling 2of3 Rev 1.doc
    - Non-Manual estimate Process Modeling 3of3 Rev 1.doc
    - Non-Manual Estimate- Production - Assembly Rev 1.doc
    - Non-Manual Estimate- Production - Chem Process Rev 1.doc
    - Non-Manual Estimate- Production - Disassembly Rev 1.doc

- Non-Manual Estimate- Production - Facility Rev 1.doc
- Non-Manual Estimate- Production - Metalworking Rev 1.doc
- Non-Manual Estimate- Production - Project Support Rev 1.doc
- Non-Manual Estimate- Production - Quality Evaluation Rev 1.doc
- Non-Manual Estimate- Production - SOX Rev 1.doc
- Non-Manual Estimate- Production Rev 1 - EUPMP.doc
- Non-Manual estimate_Maint_Hutson_Cold Ops-Readiness_Rev.1.doc
- Non-Manual estimate_Maint_Hutson_LOE_Rev.1.doc
- Non-Manual estimate_Maint_Hutson_PAMS_Rev. 1.doc
- OPC Non-Manual basis of estimate_Robert Hubbard Startup Feb 2010.docx
- OPC Non-Manual estimate 03-16-10 Operations IT Task Analysis Rev 2.doc
- OPC Non-Manual project management estimate template.doc
- OPC Project Services Non-Manual basis of estimate Sabbe Feb-10- 2010_Rev 0.docx
- OPC Task Analysis Blake Cleghorn Project Controls.docx
- Owen OPC Non-Manual estimate Placeholder (2).doc

- FY2010 TPC Range Estimate Notebooks (TPCC–EG–801768–A001 through A004, TPC–EG–801768–A001r001, –A002r00 through –A261r000, –A262r001, –A263r001, TPC–EG–801768–A264 Book 1r000 through Book 5r000, and TPC–EI–801768–A001r000)
- Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006, July 2010
- Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007, July 2010

Schedule

- M&O P3 Schedule TPC5 dated July 22, 2010

Risk and Contingency Analysis:

- Uranium Processing Facility Risk Analysis Report, RA–PJ–801768–A002, Rev. 3, July 2010
- CD–23Cost Risk Template 6–30–10.pdf
- FY10 TPC Contingency Compilation 7–1–2010.pdf
- FY10 TPC Contingency Curve 7–1–2010.pdf
- FY10 TPC Contingency vs. Probability of Success 7–1–2010.pdf
- FY10 TPC Schedule Contingency 7–1–2010.pdf
- OPC Cost Calculations 6–30–10.pdf
- Range Estimate Cost Risk Calculation 6–30–10.pdf
- TP Cost Risk Calculations 6–30–10_85%_Rev1.pdf
- TP NNSA Risks 6–30–10_85%_Rev1.pdf
- TP Schedule Risk Calculations 6–30–10_85%_Rev1.pdf

Cost Range

- PM-YSO Roll-out 20100719 Rev1.ppt

2.2.4 Planning Basis

No changes were made to the USACE ICE schedule or milestones for the update cost estimate. The project schedule utilized as a basis for the update to the TPC cost estimate is the initial project schedule provided during the TPC ICE kickoff meeting (March 29, 2010) as modified by the USACE TPC ICE analysis. As indicated later in this report, schedule activities, durations, and scheduling logic for the USACE schedule used for the updated cost estimate were not revised because:

(1) The level of work content or the complexity of operations to accomplish the safety basis development and implementation, procedure development and training, cold operations and dry runs, development and implementation of support programs, and confirming operational readiness activities did not change,
(2) The crew productivity levels did not change, and
(3) Only modest reductions were made to the respective crews (removing burdened and common support personnel).

Two key assumptions, provided as guidance by the YSO, which affected the schedule, were:

- The initial CD2/3 package submittal to YSO was rescheduled from Jun 2010 to Sep 2010.
- FY2011 Line Item (LI) funding was constrained to $10 million for site preparation and $0 million for Long Lead Procurements (LLP).

When applied, these assumptions caused the following impact:

- Delay beginning site preparation until Aug 2011 to facilitate efficient use of end of year FY2011 funds, and
- Delay beginning of LLP until January 2012 to accommodate a possible congressional continuing resolution in early FY 2012.

Based on the FY 2011 funding constraint and the USACE TPC ICE schedule development, the project milestone schedule used for the TPC cost estimate update is depicted in Table 1. UPF TPC Project Milestone Schedule. Table 1 includes a list of key project milestones provided by YSO at the initial kick-off meeting labeled Current Milestone Dates and the final schedule utilized in the development of this updated cost estimate. A detailed schedule can be found in Appendix D of this report.

Table 1. UPF TPC Project Milestone Schedule

Milestone	Current Milestone Dates	USACE ICE Milestones[1,2,3]
CD-1 Approval	7/28/2007 (actual)	7/28/2007 (actual)
CD-2/3 Site Preparation & Long-Lead Procurement Submission	06/2010	**9/15/2010**
CD-2/3 Performance Baseline, Approval for Site Preparation & Long-Lead Procurement	9/2010	3/31/2011
Start Site Preparation Start Long-Lead Procurement	10/2010 10/2010	**8/3/2011** **01/02/2012**
CD-2/3 Performance Baseline, Building & Phase 1 Equipment Installation Submittal	2/2012	5/7/2012
CD-2/3 Performance Baseline, Building & Partial Equipment Installation) Approval	7/2012	9/24/2012
Start Building Excavation		**12/19/2012**
Complete Site Preparation	12/2012	**10/10/2013**
CD-3 Balance of Construction Submittal	07/2013	12/28/2013
Start Main Building Construction		**3/14/2014**
Design Completion		**9/29/2015**
CD-3 Balance of Construction Approval	12/2013	4/28/2014
Complete Long-Lead Procurement	3/2016	**8/26/2015**
Complete Main Building Construction	11/2016	**9/8/2017**
Start Equipment Install		**10/17/2016**
Complete Equipment Installation		**2/14/2019**
All Construction Complete	12/2016	**2/14/2019**
Readiness/Start-up Initiates		**10/20/2017**
Complete All Readiness - Contractor ORR		**8/19/2021**
Start NNSA ORR		**8/23/2021**
Complete NNSA ORR	2	**12/30/2022**
CD-4 Approval	08/2018	**1/2/2023**
CD-4 Approval (schedule contingency)		**3/13/2026**

[1] Revised Milestone dates related to CD2/3 and CD-4 Extensions in Red
[2] Impacted milestone dates related to FY2011 funding constraint in Blue
[3] USACE ICE schedule milestone dates in Green

2.2.5 Total Project Cost Estimate Update Methodology

The activities involved in the generation of this update to the TPC cost estimate and cost range were as follows:

- Generation of an MII cost estimate update, which incorporates the USACE TPC ICE reconciliation adjustments documented in the *Total Project Cost Independent Cost Estimate, Schedule, Cost & Schedule Risk Reconciliation Report, Revision 3* - November 19, 2010 for WBS elements 1.07.02.09.10; 1.07.02.09.20; 1.07.02.09.30; & 1.07.02.09.40

- Review and modification, as appropriate, to the MII cost estimate for WBS 1.07.02.09.50.30.10 Operational Readiness and 1.07.02.09.50.40.10 Project Integration – OPC to:
  - Remove all burdened positions,
  - Remove hours for crew training,
  - Perform additional analysis of the respective crews for the readiness activities (safety basis, procedures/training, pre-operational testing, cold ops/dry runs, confirming operational readiness, and program support) at the process level and adjust as required, and
  - Transfer pre-operational testing to 1.07.02.09.40.
  - The development of a new resource-loaded Primavera 3 (P3) schedule while maintaining the original ICE schedule dates, logic, and durations for the remaining Title I preliminary design, complete Title II facility design and engineering, and Title III construction and facility startup. (see Section 2.2.4 Planning Basis)
- Re-examination of the CSRA to update risks and contingency analysis as appropriate for the above changes, to establish contingencies for the TPC cost estimate update in accordance with USACE Cost Engineering Directory of Expertise CSRA Guidance.
- Calculation of the updated TPC cost estimate i.e. a cost estimate at the 85% confidence level
- Calculation of the TPC cost range using the 50% and 95% confidence levels.
- Application of escalation using DOE CFO rates, Y-12 rates and inclusion of the year-to-date costs.

As with all USACE cost estimates prepared under the current YSO agreement, this update was prepared using the MII software. The USACE cost estimate update for this project was prepared and documented at a level of detail that reflects the current stage of the design. Association for the Advancement of Cost Engineering International (AACEI) Class 3 or 4 estimates were developed using bottoms-up estimating methods. The methodology used to develop the cost estimates was in alignment with USACE Cost Estimating Best Practices, the Government Accountability Office (GAO) Cost Estimating and Assessment Guide (GAO-09-3SP, March 2009), recommendations from GAO report *DOE, Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects* (GAO-10-199), and AACEI guidelines.

The detailed estimate methodology including the use of standardized cost estimating spreadsheets; labor (craft and professional) rates, Tennessee use tax (sales tax), productivity factors, M&O contractor overheads and mark-ups; and general, escalation, labor rates, shift work, and overtime, glove box, electrical site work, construction material and equipment assumptions and constraint are detailed in Appendix E.

2.2.6 Assumptions, Constraints and Guidance

YSO provided the following assumptions, constraints, and guidance concerning the UPF Project scope:

- In accordance with the Program Requirements Document (Revision 4), complete the design of the rolling and forming area. No equipment for this area will be purchased, installed, or tested
- In accordance with the Program Requirements Document (Revision 4), three casting furnaces and two casting knockout glove box sections are required.
- Incorporate the UPF electrical substation, all support facilities, and control system backbone.

- B&W continues as the prime contractor.
- The prime contractor will utilize a general contractor for the site preparation work.
- The general contractor may utilize subcontractors, but the number of tiers of subcontractors was not specified.

A crosswalk of UPF Project assumptions to the USACE Team assumptions utilized for the updated USACE cost estimate, including key reference sources provided by B&W and project direction provided by the YSO is provided in Appendix A.

2.2.7 Work Breakdown Structure

The M&O WBS and WBS Dictionary address execution of CD-2/3 Project Engineering and Design (PED); LLP and site preparations; CD-3/4 Title III construction/equipment installation; and facility first use testing, operational testing and startup, operational readiness, and project closeout. The M&O WBS/WBS Dictionary nomenclature, hierarchy, and associated descriptions are the basis for the ICE and the TPC cost estimate update and cost range. Additional work scope and terminology were incorporated into the M&O's WBS level 9 and below during the initial ICE effort.

The WBS (see Figure 1 below) utilized for the development of the USACE cost estimate is organized through five major branches:

- 1.07.02.09.10 addresses the Planning & Readiness – OPC - the support work effort and cost not identified with the Total Estimated Cost (TEC), for execution of Preliminary Engineering and Design (PED) and for the CD-2/3 start of LLP and site preparations.
- 1.07.02.09.20 addresses UPF PED - the work effort and cost for execution of the design of the UPF structure and all the support services and security requirements for the facility (balance of plant, processing facility, information technology, and security systems); and scope of work encompassing the major processing areas: (1) assembly, disassembly, quality evaluation, (2) EU metalworking, (3) chemical processing, and (4) process support.
- 1.07.02.09.30 addresses UPF Project Execution Procurement, Construction & Title III - the work effort and cost for execution of the requested CD-2/3 for start of site preparations and the LLP of facility and process area items, including the Title III engineering to support LLP and site preparations.
- 1.07.02.09.40 addresses SLPP Procurement, Construction & Title III - the work effort and cost for execution of the Title III Engineering to support procurement and construction of the UPF. This includes life-cycle integration throughout procurement, construction, and Title III activities.
- 1.07.02.09.50 SLPP Planning & Readiness – OPC - the support work effort and cost not identified with the TEC, for execution of building construction, equipment installation and first use testing, operational testing and startup, and operational readiness of UPF.

For the TPC cost estimate update, the USACE Team WBS structure was derived from data supplied by the M&O contractor to define the major WBS elements down to WBS level 9. The USACE Team further subdivided the WBS structure created by the M&O contractor to include WBS levels 10, 11 and the Work Package Levels.

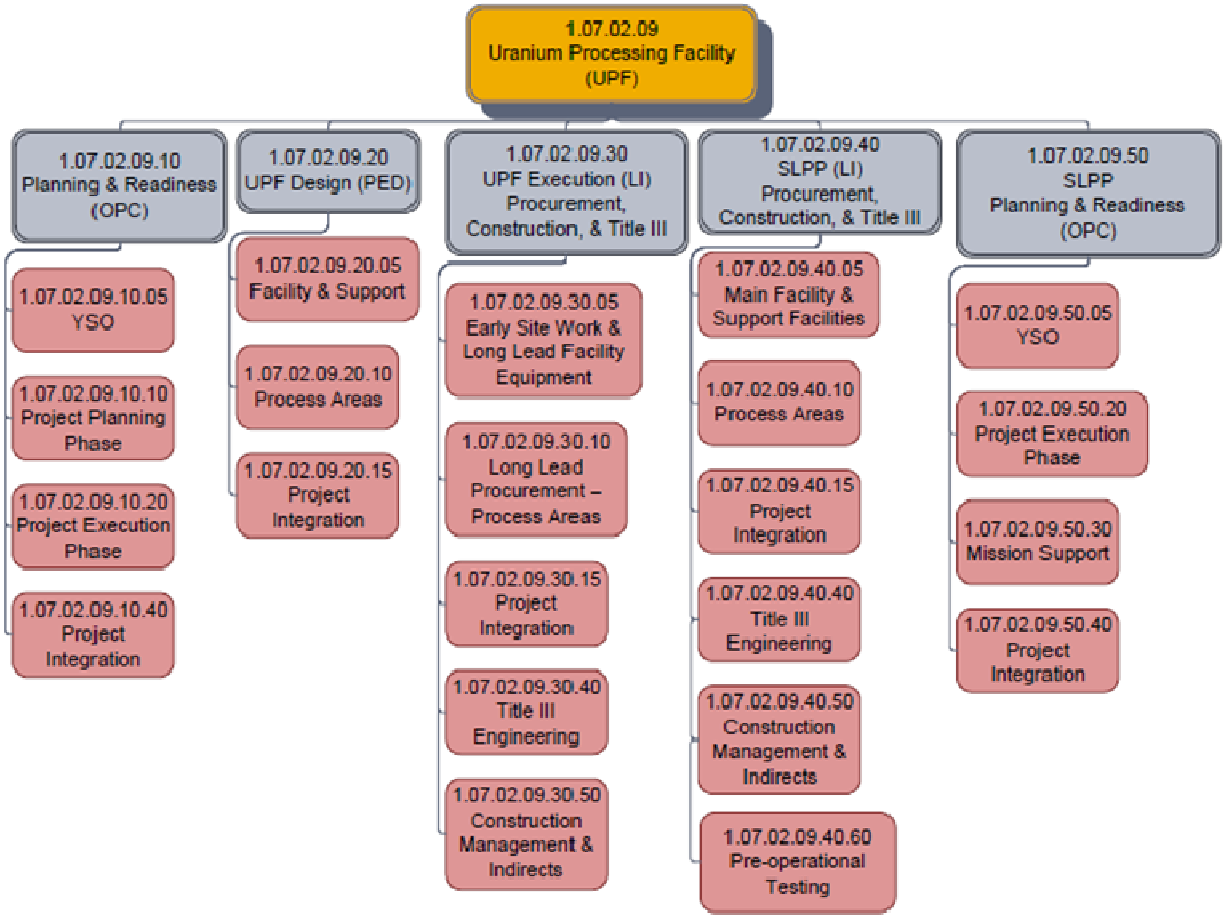

Figure 1. USACE UPF Work Breakdown (Levels 1, 2 & 3)

At each work package level, project scope information was supplied by the M&O contractor to create project specific tasks and assign logical activities to describe the scope of work. Project activities were developed in sufficient detail to support estimating and scheduling purposes for Order of Magnitude (OM), parametric, and detailed cost estimates as required based on the current level of scoping information. The USACE cost estimate WBS and WBS Dictionary are detailed within the MII estimate in Appendix B.

The primary additions and changes to the M&O WBS are:

- Product Certification – outlined in a separate WBS
- Analytical Services – outlined in a separate WBS
- Nuclear Material Control and Accountability (NMC&A) – equipment procurement, installation, testing, and readiness added in a separate WBS
- Switchyard – Site preparation, procurement, construction, and testing added
- Security Certification – readiness activities added

3.0 USACE UPF Project Schedule

3.1. Schedule Methodology

The schedule for WBS 1.07.02.09.10 Planning & Readiness – OPC, and WBS 1.07.02.09.20 UPF Design (PED) was developed using the Primavera Project Planner (P3) software as follows:

- YSO support, systems engineering, and project functional support activity definition and sequencing, with activity dependencies, were developed using the UPF WBS/Dictionary, the cost books, the architectural report, and the available drawings and activity delineation provided the M&O contractor.
- Preliminary and final design activity definition and sequencing, with activity dependencies, were developed using the UPF WBS/Dictionary, the cost books, the architectural report, and from the available drawings and activity delineation provided by the M&O contractor.
- The net work time weighted average percent complete for systems engineering and project functional support, and preliminary and final design of the UPF structure, all the building and process support services and security requirements for the facility, and the major processing areas: (1) assembly, disassembly, quality evaluation, (2) EU metalworking, (3) chemical processing, and (4) process support were computed. Based on the weighted average percent complete for these activities, remaining activity durations were developed.
- Based on SME evaluations of project documentation on UPF structures, building systems, process services, and processing areas, remaining preliminary and final design durations were reviewed, established, or modified.
- The project schedule was generated from the activity set and scheduling milestone constraints were applied.

The FY2011 funding constraints For WBS 1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III, and WBS 1.07.02.09.50 UPF SLPP Planning & Readiness, the schedule was prepared using Oracle's Primavera Project Planner (P3) scheduling software application. P3 schedule activities were developed from the technical scope as outlined in the ICE WBS (Appendices A, B, and C) and the design basis (Section 2.2.2). Schedule activity sequencing and durations were then developed with input from the technical SMEs. Based on SME evaluations of project documentation on UPF structures, building systems, process services, and processing areas procurement, construction, installation, testing, cold operations/dry runs and start up, the activity sequencing and durations were reviewed, established, or modified

3.2 Schedule Assumptions and Constraints

The schedule assumptions and constraints were:

- The overall schedule was initially based on a CD-2/3 (Site Prep and Long-lead Items) package submittal to YSO on September 15, 2010, approval of this package in March 2011, and Project Completion (CD-4) in September 2020.
- Title I Preliminary design is underway on all the UPF structures, all the support services and security requirements for the facility, and the major processing areas.
- Title II design on all the UPF structure, all the support services and security requirements for the facility, and major processing areas commences with the CD-2/3 Performance Baseline, Building & Partial Equipment Installation approval date of 9/24/2012.

- Identified WBS changes:
  - 1.07.02.09.20.05.10.50 Tunnel – Designated the Connector. Final design was moved and is included under Processing Facility WBS 1.07.02..09.20.05.20
  - 1.07.02.09.20.05.30.30 Computing Applications - Final design is included under Project Functional Support - OPC WBS
  - 1.07.02.09.20.05.30.40 IT System Integration - Final design is included under Project Functional Support - OPC WBS
  - 1.07.02.09.20.05.40.20 Alarm Systems - Final design is included under Building Services WBS1.07.02. .09.20.05.20.20.10
  - 1.07.02.09.20.05.40.40 Central Alarm Station - Final design is included under Building Services WBS 1.07.02..09.20.05.20.20.10
- Glovebox final design will conclude with generation of the fabrication drawings, extending final design to 8/26/2015.
- Funding for the UPF Project is limited to $115 million in FY 2011. This total is distributed as $105 million to preliminary engineering and design and $10 million to site preparation and $0 million to LLP. Funding is assumed unconstrained for FY 2012 and beyond.
- The FY 2011 funding constraint was interpreted to:
  - Delay start of site preparation until August 2011, to allow for efficient use of funding near the completion of FY2011
  - Delay the start of LLP until January 2012, to allow for possible congressional continuing resolution for NNSA funding in early FY2012
- The duration for development of the glove box fabrication drawings is assumed four weeks plus one additional week for each linear foot of glove box length. Thus, for an eight-foot glove box, twelve weeks would be required to develop the glove box fabrication drawings.
- The 1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III schedule is based on a CD-2/3 Performance Baseline, Building & Partial Equipment Installation) submission on 5/7/2012 (approval 9/24/2012), a CD-3 Balance of Construction Submittal on 12/28/2013 (approval 4/27/2014), and Project Completion (CD-4) in September 2020.
- The glove box fabrication durations and sequencing by fabricator is assumed as shown in Figure 2.

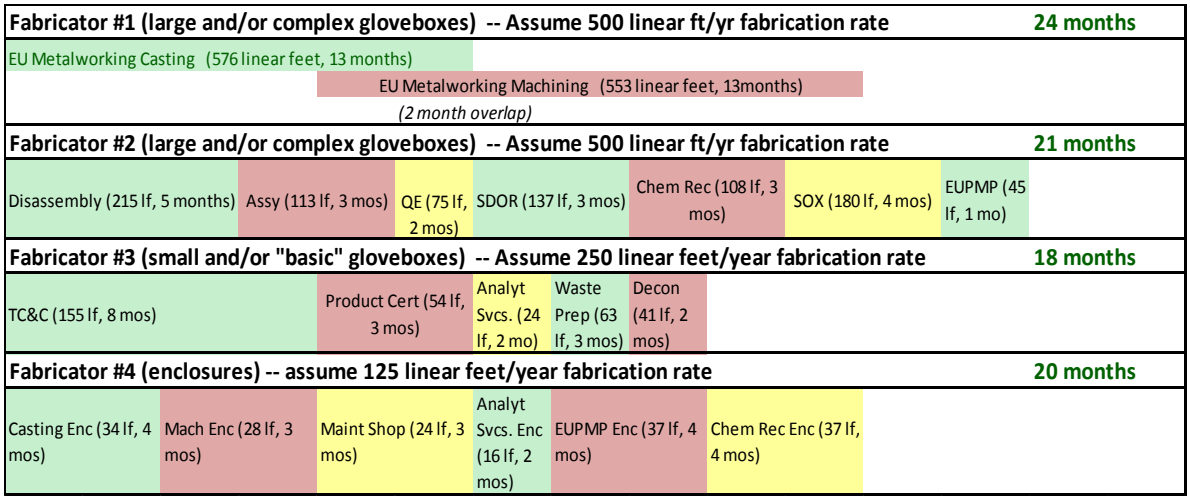

Figure 2. Glovebox Fabrication Durations and Sequencing by Fabricator

- The process areas equipment installation will not start until the process services from its respective utility level services have been completed and dropped into the respective process area.
- The installation of services and equipment follows the following sequence through the building: Machining → Casting → Disassembly → Assembly → Quality Evaluation → Product Certification → Analytical Services → Chemical Recovery → Calcination & Leaching/Furnaces & Repackaging → EU Metal Purification & Metal Production → Saltless Direct Oxide Reduction. This was done to facilitate internal security requirements being functional prior to installation of equipment.
- Nine contractor ORRs will be conducted for the facility and the process areas, which will be followed by the NNSA ORR.
- The process areas readiness activities for each process area were allowed to start after installation of equipment and services was complete in each process area.
- A single, phased NNSA ORR will be conducted for the facility and each process area. The NNSA ORR for the process areas will not start until the NNSA facility ORR is completed.
- The NNSA facility ORR starts after all building services, process services and process area readiness is complete.

3.3 Schedule Summary

The UPF Phase II ICE schedule for WBS 1.07.02.09.10 Planning & Readiness - OPC (Appendix D) displays the remaining preliminary and final design phase, site preparation, construction phase, and project functional support activities over a 3 year and 11 month period from April 2010 through March 2014.

Incorporating the FY 2011 funding constraint, the schedule for WBS 1.07.02.09.20 UPF Design (PED) (Appendix D) displays the remaining preliminary and final design activities over a 5 year and 5 month period from April 2010 through September 2015. For UPF facilities, building systems, and most process services the completion of design is driven by the facility construction start date of October 2014, or the major building system/process services equipment procurement start date of March 2014, and covers a 4 year and 5 month period from October 2010 through March 2015. The process area major equipment design completion is driven by the major equipment procurement start date of March 2014, the completion of Long Lead Procurement date of August 2015, and covers a 5 year and 5 month period from April 2010 through September 2015.

The schedule for WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III, displays the site preparation and long leads procurement activities over a 4 year and 11 month period from September 2010 through August 2015. Site preparation activities cover a period of 2 years and 2 months from August 2011 through October 2013. LLP activities cover a 3 year and 8 months from January 2012 through August 2015.

The schedule for WBS 1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III (Appendix D) displays for the planned work scope for a CD-2/3 full project performance baseline, addressing start of building construction (building shell and installation of building services), Phase 1 equipment installation, and a CD-3 Phase 2 equipment installation. This includes:

- The UPF building construction activities, including the procurement, installation, test and turnover of all building systems and process services, over a 6 year and 6 month period from March 2012 through October 2018.

- The process area equipment procurement, installation, test, and turnover activities overlap the UPF building construction and cover a 6 year and 1 month period from December 2012 through February 2019.

The schedule for WBS 1.07.02.09.50 UPF SLPP Planning & Readiness cost estimate (Appendix D) displays the UPF facility, building systems, process services and process area safety basis; procedures/training; cold operations/dry runs; confirming operational testing/operations to confirm readiness prior to NNSA ORR, and participation in the NNSA ORR:

- The UPF facility, building systems, and process services activities cover a 1 year and 1 month period from October 2018 to November 2019.
- The UPF process area activities over lap the UPF facility, building systems, and process services and cover a 3 year and 10 month period from October 2017 through August 2021. The assembly/disassembly/QE process area activities drive the August 2021 date.
- The NNSA building services, process services, process area, and security certification covers a 1 year and 4 month period from August 2021 through January 2023.

The USACE UPF Project Schedule is detailed in Appendix D.

The CSRA defined 38.5 months as the required schedule contingency (float) needed in the schedule to achieve the desired level of schedule execution within the 85% CL (see Section 5.3).

4.0 Updated Total Project Cost Estimate

The purpose of this section is to describe in detail the update to each WBS element costs that have changed from the original USACE ICE submittal. The cost updates to each WBS element are summarized at Level 5 of the WBS.

4.1 WBS 1.07.02.09.10 Planning & Readiness (OPC)

The 1.07.02.09.10 WBS element encompasses the UPF Project support for Project Engineering Design and for the CD-2/3 for start of long-lead procurement and site preparation, with the CD-2 performance baseline established for this scope and the CD-3 limited to long-lead procurement and site-preparation construction.

4.1.1 WBS 1.07.02.09.10 Planning & Readiness (OPC) Cost Estimate Update Methodology

The project support efforts for project engineering design, long-lead procurement, and site preparation are a level of effort denoted by a uniform set of work performance rates over a pre-defined period of time.

WBS 1.07.02.09.10.05 Project Management Support Office (PMSO) YSO addresses oversight support through preparation of DOE/NNSA planning documents; review and approval of project documentation prepared by the contractor; and interface with DOE and NNSA Headquarters offices to obtain project reviews, approvals, and budgets. The USACE ICE Team estimated this as a level of effort using UPF Project Earned Value Management System (EVMS) performance data (as of March 21, 2010), showing this activity at 52% complete, and a factor algorithmic cost estimation approach. The factor algorithmic cost

estimation approach used the mean of the annual OPC to PED funding ratio, with parameters derived from historical DOE project data with similar project characteristics. The M&O estimated their level of effort based on knowledge of the current YSO support contract scope. No specific work scope documentation was provided by the M&O or YSO for this effort to the USACE ICE Team. During topical discussions held during reconciliation, the USACE Team agreed to the M&O estimate for this level of effort. The M&O had access to the PMSO Support Contract and scope projections, which upon review the USACE ICE Team considered reasonable. In the update to the USACE cost estimate, the TPC ICE was adjusted by $14,739,573 to include additional cost for YSO oversight support.

WBS 1.07.02.09.10.40.10.10 Project Functional Support – OPC addresses the M&O direct staff support activities not associated with specific tasks during PED, LLP, and site preparations. OPC activities are primarily management, estimating, and integration. The USACE ICE Team estimated this as a level of effort using UPF Project EVMS data (as of March 21, 2010), showing this activity at 47% complete, and a factor algorithmic cost estimation approach. The factor algorithmic cost estimation approach used the mean of the annual OPC to PED funding ratio, with parameters derived from historical DOE project data with similar project characteristics. The M&O estimated this based on a projection of the OPC support by functional organizations during PED phase (project management, operations, security; environment, safety, & health; procurement, construction, engineering, quality assurance, startup, and project services.) No specific work scope documentation was provided by the M&O or YSO for this effort to the USACE ICE Team. During topical discussions held during reconciliation, the USACE Team agreed with the M&O scope and estimate for this level of effort, which upon review the USACE ICE Team considered reasonable. The TPC ICE was adjusted by adding $11,876,796 for additional cost for Project Functional Support.

In the update to the USACE cost estimate, the TPC ICE was adjusted by adding $14,739,573 to include YSO oversight support and $11,876,796 for additional project functional support for a total of $26,616,369. During topical discussions held during reconciliation, the USACE Team agreed to the M&O estimate for this level of effort.

4.1.2 WBS 1.07.02.09.10 Planning & Readiness (OPC) Cost Estimate Summary

The updated WBS 1.07.02.09.10 Planning & Readiness (OPC*)* Estimate to Complete, without escalation and contingency, incorporating the $26,616,369 adjustment for the YSO and project support discussed, is $97,000,649. Adding the actual costs through March 21, 2010 of $64,648,839 generates an Estimate at Completion (EAC) of $161,649,489 for WBS 1.07.02.09.10 Planning & Readiness (OPC). Table 2 provides a WBS 1.07.02.09.10 updated TPC estimate; Table 3 illustrates the relative comparison to the M&O estimate. The complete MII cost estimate for WBS 1.07.02.09.10 is documented in Appendices B and C.

Table 2. Updated Total Project Cost Estimate - 1.07.02.09.10 Planning & Readiness (OPC)

WBS ELEMENT	USACE Estimate To Complete	Reconciliation Adjustment	Updated USACE Estimate To Complete	Actual Costs (March 21, 2010)	Updated USACE Estimate At Completion
1.07.02.09.10 Planning & Readiness - OPC	$70,384,280	$26,616,369	$97,000,649	$64,648,839	$161,649,489
1.07.02.09.10.05 YSO	$1,988,619	$14,739,573	$16,728,192	$966,040	$17,694,232
1.07.02.09.10.10 Project Planning Phase	$0	$0	$0	$30,457,260	$30,457,260
1.07.02.09.10.20 Project Execution Phase	$26,026,238	$0	$26,026,238	$12,643,138	$38,669,376
1.07.02.09.10.40 Project Integration	$42,369,423	$11,876,796	$54,246,219	$20,582,401	$74,828,621

Table 3. Cost Estimate Comparison – WBS 1.07.02.09.10 Planning & Readiness (OPC)

WBS	M&O Estimate to Complete[1]	USACE Updated Estimate to Complete	Cost Variance ($)	Cost Variance (%)
1.07.02.09.10 Planning & Readiness – OPC	$98,225,190	$70,384,280	($27,840,910)	(39.6)
Adjustments		$26,616,369		
Revised Total	$98,225,190	$97,000,649	($1,224,541)	(1.3)

[1] *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006*, July 2010, *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007*, July 2010, and *UPF Line Item Export 8-10-10 with Escalation and Contingency.xls.*

4.2 WBS 1.07.02.09.20 UPF Design (Project Engineering and Design)

The UPF Project WBS 1.07.02.09.20 UPF Design (Project Engineering and Design [PED]), consist of three WBS sub elements 1.07.02.09.20.05 Facility and Support, 1.07.02.09.20.10 Process Areas, and 1.07.02.09.20.15 Project Integration. These encompass preliminary and final design of the UPF structures, project integration, all the support services, and security requirements for the facility, and the major processing areas: (1) assembly, disassembly, quality evaluation, (2) EU metalworking, (3) chemical processing, and (4) process support.

4.2.1 WBS 1.07.02.09.20 UPF Design Cost Estimate Update Methodology

The USACE ICE Team estimated UPF Project WBS elements 1.07.02.09.20.05 Facility and Support, Preliminary and Final Design; 1.07.02.09.20.10 Process Area, Preliminary and Final Design; and 1.07.02.09.20.15 Project Integration related to PED using a parametric model. This parametric model estimate used the M&O schedule activity *percent complete* (as of March 2010), a net work time weighted average *percent complete* by major WBS level, and the associated M&O actual costs to date at each respective WBS level. Then assuming the preliminary and final design activity was a Level of Effort activity, which has a linear resource cost, the estimated remaining *estimate to complete* (ETC) and an EAC

at each preliminary and final design WBS level was generated. This was modified based on subject matter expert professional judgment for specific elements of the preliminary and final design. A defined project management/integration crew, facility design crew, and process design crew, each with the M&O site labor rates, were used to calculate preliminary and final design man–hours and cost to complete at each respective WBS level. These were then summed with the actual costs to date, to generate the final EAC, and then summed to higher WBS elements for the project ETC and EAC costs. Reference the *URANIUM PROCESSING FACILITY (UPF) PROJECT, Phase II: Total Project Cost Independent Cost Estimate, Schedule, Cost & Schedule Risk Assessment, Revision 2* (September 15, 2010) report for a discussion of the USACE ICE Team estimated project design level of completion.

4.2.2 WBS 1.07.02.09.20 UPF Design Cost Estimate Summary

No updates or changes were made to the USACE TPC for WBS 1.07.02.09.20 UPF Design (PED) Estimate to Complete. The USACE estimate for the PED Estimate to Complete, without escalation and contingency, is $311,197,760. Adding the actual costs through March 21, 2010 of $152,570,054 generates an Estimate at Completion of $463,767,814 for 1.07.02.09.20 UPF Design (PED). Table 4 provides a WBS 1.07.02.09.20 TPC estimate; Table 5 illustrates the relative comparison to the M&O estimate. The complete MII cost estimate for WBS 1.07.02.09.20 is documented in Appendices B and C.

Table 4. Updated Total Project Cost Estimate -1.07.02.09.20 UPF Design (PED)

WBS ELEMENT	Updated USACE Estimate To Complete	Actual Costs (March 21, 2010)	Updated USACE Estimate At Completion
1.07.02.09.20 UPF Design (PED)	**$311,197,760**	**$152,570,054**	**$463,767,814**
1.07.02.09.20.05 Facility And Support	**$123,670,814**	**$34,644,769**	**$158,315,583**
1.07.02.09.20.05.10 Balance Of Plant	$7,578,072	$4,683,905	$12,261,977
1.07.02.09.20.05.10.10 Site Preparation	$4,871,576	$3,896,608	$8,768,184
1.07.02.09.20.05.10.20 Process Support Facilities	$1,514,716	$195,101	$1,709,817
1.07.02.09.20.05.10.40 Power Supply	$208,343	$359,764	$568,107
1.07.02.09.20.05.10.45 Substation	$933,799	$67,308	$1,001,107
1.07.02.09.20.05.10.50 Tunnel	$49,638	$165,124	$214,762
1.07.02.09.20.05.20 Processing Facility	$108,940,686	$29,840,633	$138,781,319
1.07.02.09.20.05.20.10 Building (UPF Main Building)	$29,064,301	$8,702,826	$37,767,127
1.07.02.09.20.05.20.20 Building Services	$24,554,590	$10,632,980	$35,187,570
1.07.02.09.20.05.20.30 Process Services	$21,237,003	$2,332,257	$23,569,260
1.07.02.09.20.05.20.40 Facility Support Common Activities	$33,784,774	$8,172,570	$41,957,344
1.07.02.09.20.05.20.50 HEUMF Connector	$300,018	$0	$300,018
1.07.02.09.20.05.30 Information Technology	$2,802,662	$13,514	$2,816,176
1.07.02.09.20.05.30.20 It Communication Systems	$2,802,662	$8,334	$2,810,996
1.07.02.09.20.05.30.30 Computing Applications	$0	$2,590	$2,590
1.07.02.09.20.05.30.40 IT Systems Integration	$0	$2,590	$2,590
1.07.02.09.20.05.40 Security Systems	$4,349,394	$106,717	$4,456,111
1.07.02.09.20.05.40.10 PIDAS	$2,806,462	$20,899	$2,827,361
1.07.02.09.20.05.40.20 Interior Alarm Systems (IDAS)	$0	$451	$451

WBS ELEMENT	Updated USACE Estimate To Complete	Actual Costs (March 21, 2010)	Updated USACE Estimate At Completion
1.07.02.09.20.05.40.30 Security Posts And Access Control	$1,539,362	$78,361	$1,617,723
1.07.02.09.20.05.40.40 Central Alarm System	$3,570	$7,006	$10,576
1.07.02.09.20.10 Process Areas	**$105,630,699**	**$64,126,926**	**$169,757,625**
1.07.02.09.20.10.10 Assembly, Disassembly, QE	$15,168,448	$7,580,177	$22,748,625
1.07.02.09.20.10.10.10 Assembly	$4,550,630	$3,201,636	$7,752,266
1.07.02.09.20.10.10.20 Disassembly	$5,005,808	$2,042,835	$7,048,643
1.07.02.09.20.10.10.30 Quality Evaluation	$5,612,010	$2,335,706	$7,947,716
1.07.02.09.20.10.20 EU Metalworking	$27,969,436	$12,685,003	$40,654,439
1.07.02.09.20.10.20.10 Casting	$10,622,254	$4,110,350	$14,732,604
1.07.02.09.20.10.20.20 Rolling & Forming	$3,217,408	$2,065,615	$5,283,023
1.07.02.09.20.10.20.30 Machining	$10,202,032	$4,352,851	$14,554,883
1.07.02.09.20.10.20.40 Turnings Cleaning & Conversion	$3,927,742	$2,156,187	$6,083,929
1.07.02.09.20.10.30 Chemical Processing	$32,802,042	$19,553,755	$52,355,797
1.07.02.09.20.10.30.10 EU Purification & Metal Production	$13,137,989	$7,471,311	$20,609,300
1.07.02.09.20.10.30.20 Chemical Recovery	$12,245,479	$7,848,545	$20,094,024
1.07.02.09.20.10.30.30 Special Oxide Production	$7,418,574	$4,233,899	$11,652,473
1.07.02.09.20.10.40 Process Support	$29,690,773	$24,307,991	$53,998,764
1.07.02.09.20.10.40.10 Product Certification	$6,053,776	$2,758,711	$8,812,487
1.07.02.09.20.10.40.50 Analytical Services	$3,073,462	$2,763,721	$5,837,183
1.07.02.09.20.10.40.70 Process Support Common Activities	$20,563,535	$18,785,559	$39,349,094
1.07.02.09.20.15 Project Integration	**$81,896,247**	**$53,798,359**	**$135,694,606**
1.07.02.09.20.15.10 Project Integration	$81,896,247	$53,798,359	$135,694,606
1.07.02.09.20.15.10.10 Project Functional Support	$70,311,605	$49,027,001	$119,338,606
1.07.02.09.20.15.10.20 Construction Management	$1,905,654	$960,171	$2,865,825
1.07.02.09.20.15.10.30 Plant Support- PED	$500,045	$484,961	$985,006
1.07.02.09.20.15.10.50 Design Support - PED	$9,178,943	$3,326,226	$12,505,169

Table 5. Cost Estimate Comparison - WBS 1.07.02.09.20 UPF Design (PED)

WBS	M&O Estimate[1]	Updated USACE Estimate	Cost Variance ($)	Cost Variance (%)
1.07.02.09.20 UPF Design (PED)	$272,279,717	$311,197,760	$38,918,043	12.5

[1.] *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006,* July 2010, *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007,* July 2010, and *UPF Line Item Export 8-10-10 with Escalation and Contingency.xls.*

Of note, in WBS 1.07.02.09.30.40.91.10.10 Title III Engineering, the M&O estimate is based on 83 individual cost line items covering a wide range of activities associated with engineering support of the project design effort, ranging from computations through procurement oversight. Analysis of the 83 individual line items suggests that many of these items do not belong in WBS 1.07.02.09.30.40.91.10.10, but instead should be placed in WBS 1.07.02.09.20 (design) since these clearly relate to the facility, building systems, process support systems, or process area design (approximately $35,464,884.). Examples of these activities include Piping Isometric Diagrams, Design Description System, Fire Protection System, Isometric Drawings - Facility Piping, Piping & Instrumentation Diagrams. This rationale is based on:

- The definitions of PED found in:
  - DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets
  - DOE G 413.3–1, Managing Design and Construction Using Systems Engineering for Use with DOE O 413.3A
  - DOE G 430.1–1 Appendix A, Dictionary
  - DOE G 430.1–1 Chapter 25, Guidelines for Engineering, Design, and Inspection Costs
  - DOE G 430.1–1 Chapter 3, Stages of Project Development
  - DOE G 430.1–1 Chapter 6, Project Functions and Activities Definitions for Total Project Cost
- The M&O WBS dictionary definition of WBS 1.07.02.09.30.40.91.10.10, which is expected to include field engineering services only, not design, installation, or readiness activities.

The USACE estimate for WBS 1.07.02.09.20 UPF Design (PED) included this additional $35,464,884 design effort.

4.3 WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III

The UPF Project WBS 1.07.02.09.30, UPF Project Execution (LI) Procurement, Construction & Title III, addresses the limited scope of the CD–2/3 request for long–lead procurement and site preparations construction.

4.3.1 WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III Cost Estimate Update Methodology

The updates to WBS 1.07.02.09.30 consist of the following cost estimate reconciliation adjustments:

- WBS 1.07.02.09.30.05.10.10.94 and WBS 1.07.02.09.30.05.10.10.95: Under the following areas – 1.07.02.09.30.05.10.10.94.01, Spoil & Disposal Areas, Haul Road, Wetlands; 1.07.02.09.30.05.10.10.94.02, Demolition, Removal & Relocate ; 1.07.02.09.30.05.10.10.94.10, Access, Road Re–Route; 1.07.02.09.30.05.10.10.94.15, Interim Rough–Grading; 1.07.02.09.30.05.10.10.94.19, Building Excavation & Storm Drain Profiles – the TPC ICE included construction installation activities (installation, area preparation, excavation, placement, and erosion control, clearing, grubbing and grading) in addition to the procurement activities. These activities belong under WBS 1.07.02.09.30.05.10.10.95. In the update to the USACE cost estimate, $10,999,813 was subtracted from WBS 01.07.02.09.30.05.10.10.94 Permanent Plant Materials, Procurement and added to WBS 1.07.02.09.30.05.10.10.95 Construction Installation.
- WBS 1.07.02.09.30.05.10.10.95 Construction Installation. The update to the USACE cost estimate incorporated the USACE estimate - $11,121,047 - for the Bear Creek Road Extension (reference: *Phase II: Total Project Cost Independent Cost Estimate, Schedule, Cost & Schedule Risk Assessment Revision 1, Addenda Revision 1* – September 21, 2010) to WBS 1.07.02.09.30.05.10.10.95 Construction Installation.
- WBS 1.07.02.09.30.10.50.10.94 Assembly Government Furnished Equipment (GFE) Procurement – For the AER EB Welder per specification JS–EM–801768–A003, the USACE Team assumed NQA–1 qualified equipment at $ 11,997,181 based on a historical FY2005 estimate (escalated to FY2011). Based on vendor follow–up discussion, this equipment should be about $3,525,000 per unit. In the update to the USACE cost estimate, $6,542,144 was subtracted from WBS 1.07.02.09.30.10.50.10.94 Assembly Government Furnished Equipment (GFE) Procurement.
- During extensive discussions with the M&O during the development of the USACE ICE and as indicated in the M&O WBS dictionary, the following WBS elements were to include only the procurement of glovebox fabrication drawings. No design effort was to be included. The USACE Team agrees that some work effort will be required for translation of final design drawings to fabrication shop drawings. The M&O calculates the cost for design and review of the gloveboxes, as a percent of the estimated purchase price of the respective glovebox line. In general, this percentage ranges from 33 to 69%. For the following WBS elements, the USACE estimate was increased to accept the design and review cost as a higher percent of the procured value of the gloveboxes such that this additional work effort is included in the procurement of glovebox fabrication drawings:
  - WBS 1.07.02.09.30.10.50.20.94 Disassembly GFE Procurement – In the update to the USACE cost estimate, $1,172,913 was added for translation of design final drawings to fabrication shop drawings.
  - WBS 1.07.02.09.30.10.60.10.94 Casting GFE Procurement In the update to the USACE cost estimate, $5,831,552 was added for translation of design final drawings to fabrication shop drawings.
  - WBS 1.07.02.09.30.10.60.30.94 Machining GFE Procurement –In the update to the USACE cost estimate, $798,046 was added for translation of design final drawings to fabrication shop drawings.
  - WBS 1.07.02.09.30.10.60.40.94 Turnings Cleaning & Conversion GFE Procurement – In the update to the USACE cost estimate, $813,551 was added for translation of design final drawings to fabrication shop drawings.
  - WBS 1.07.02.09.30.10.80.50.94 Analytical Services GFE Procurement – In the update to the USACE cost estimate, $500,000 was added for translation of design final drawings to fabrication shop drawings.

- WBS 1.07.02.09.30.10.80.70.94 Analytical Certification GFE Procurement - TPC ICE assumed procurement of 3,000 gloveports at $1500 each. The M&O estimate includes 3,252 gloveports. In the update to the USACE cost estimate, the M&O gloveport count was utilized (at $1,500 each) and $378,000 was added to WBS 1.07.02.09.30.10.80.70.94 Analytical Certification GFE Procurement.
- WBS 1.07.02.09.30.15.90.10.20 Project Audits, Assessments, and Reviews – The TPC ICE does not include any costs for independent reviews. In the update to the USACE cost estimate, $12,000,000 was added to WBS 1.07.02.09.30.15.90.10.20 Project Audits, Assessments, and Reviews, as an allowance for labor for 4 independent reviews at $3,000,000/review.
- WBS 1.07.02.09.30.50.92.10.51 Temporary Construction Facilities – The field trailers are estimated to cost $5.6 million in the M&O estimate. The TPC ICE did not adequately address the rental or purchase of these field trailers. The M&O estimate appears to be based on purchase of the trailers. In the update to the USACE cost estimate, $735,000 was added to WBS 1.07.02.09.30.50.92.10.51, for the purchase of 25 trailers at $29,400 each (vendor quote).
- WBS 1.07.02.09.30.50.92.10.54 Field Non–Manual – The TPC ICE addressed a minimal level of effort estimate for FY2012 and FY2013 addressing staff for procurement, project services, and quality assurance. “In the update to the USACE cost estimate, $10,344,578 was added to WBS 1.07.02.09.30.50.92.10.54 Field Non–Manual to include additional functional support for project services and quality assurance, and to include support for environmental compliance, industrial hygiene, and construction management.
- WBS 1.07.02.09.30.50.92.10.55 Field Manual – Other Costs – The TPC ICE is a subcontract lump sum, and lacks the specific detail of the M&O estimate. The M&O estimate is relatively detailed, and is based on specific site knowledge of activities that routinely occur. After examination of the M&O detail, $8,877,725 was added to WBS 1.07.02.09.30.50.92.10.55 Field Manual – Other Costs, to include the activities addressed in the M&O estimate in the update to the USACE cost estimate.

4.3.2 WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III Cost Estimate Summary

The above adjustments add $46,030,269 to the USACE estimate update for WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III. The updated TPC cost estimate for 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III, without escalation and contingency, is $279,251,114. Table 6 provides WBS 1.07.02.09.30 TPC updated estimate; Table 7 provides the detailed cost summary at the primary WBS levels under WBS 1.07.02.09.30; Table 8 illustrates the relative comparison to the M&O estimate. The complete MII cost estimate for WBS 1.07.02.09.30 is documented in Appendices B and C.

Table 6. Updated Total Project Cost Estimate - WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III

WBS	Updated USACE Estimate	Adjustments
1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III	**$233,220,845**	**TPC ICE**
1.07.02.09.30.05.10.10.94 Permanent Plant Materials, Procurement	($10,999,813)	**Reconciliation Adjustments**
1.07.02.09.30.05.10.10.95 Construction Installation	$10,999,813 $11,121,047	
1.07.02.09.30.10.50.10.94 Assembly GFE Procurement	($6,542,144)	
1.07.02.09.30.10.50.20.94 Disassembly GFE Procurement	$1,172,913	
1.07.02.09.30.10.60.10.94 Casting GFE Procurement	$5,831,552	
1.07.02.09.30.10.60.30.94 Machining GFE Procurement	$798,047	
1.07.02.09.30.10.60.40.94 Turnings Cleaning & Conversion GFE Procurement	$813,551	
1.07.02.09.30.10.80.50.94 Analytical Services GFE Procurement	$500,000	
1.07.02.09.30.10.80.70.94 GFE Procurement	$378,000	
1.07.02.09.30.15.90.10.20 Project Audits, Assessments, And Reviews	$12,000,000	
1.07.02.09.30.50.92.10.51 Temporary Construction Facilities	$735,000	
1.07.02.09.30.50.92.10.54 Field Non-Manual	$10,344,578	
1.07.02.09.30.50.92.10.55 Field Manual - Other Costs	$8,877,725	
Reconciliation Adjustments - Subtotal	$46,030,269	
1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III	**$279,251,114**	**Updated USACE Cost Estimate**

Table 7. Updated Total Project Cost Estimate Detail – WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III

WBS Element	Updated USACE Estimate	% Of WBS
1.07.02.09.30 Site Preparation & Long Lead Items	**$279,251,114**	
1.07.02.09.30.05 Facility & Support	**$107,566,231**	**38.5**
1.07.02.09.30.05.10 Balance Of Plant	$94,733,138	
1.07.02.09.30.05.20 Processing Facility	$12,833,094	
1.07.02.09.30.10 Long Lead Items, Process Areas	**$70,716,367**	**25.3**
1.07.02.09.30.10.50 Assembly, Disassembly, QE	$16,651,838	
1.07.02.09.30.10.60 EU Metalworking	$33,526,390	
1.07.02.09.30.10.70 Chemical Processing	$3,033,466	
1.07.02.09.30.10.80 Process Support	$17,504,673	
1.07.02.09.30.15 Project Integration	**$29,515,172**	**10.6**
1.07.02.09.30.40 Title III Engineering	**$25,516,954**	**9.2**
1.07.02.09.30.50 Construction Management & Indirects	**$45,936,390**	**16.4**

Table 8. Cost Estimate Comparison - WBS 1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III

WBS	M&O Estimate[1]	Updated USACE Estimate	Cost Variance ($)	Cost Variance (%)
1.07.02.09.30 UPF Project Execution Procurement, Construction & Title III	$327,172,083	$233,220,845	($93,951,238)	(40.28)
Adjustments		$46,030,269		
Revised Total	$327,172,083	$279,251,114	($47,920,969)	(17.16)

1. *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006*, July 2010, *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007*, July 2010, and *UPF Line Item Export 8-10-10 with Escalation and Contingency.xls*.

4.4 WBS 1.07.02.09.40 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction & Title III

The UPF Project WBS 1.07.02.09.40 represents the planned work scope for a CD-2/3 full project performance baseline, addressing start of building construction (building shell and installation of building services) and Phase 1 equipment installation. Building construction will include the main processing building and all support facilities. Phase 1 equipment installation will consist of utilities equipment installation and some processing equipment. In addition, the planned work scope for a CD-3 phase 2 for equipment installation encompassing the remainder of facility and process equipment procurement,

installation, and testing is addressed. Included is project integration, Title III engineering, construction management, and indirect support required for these activities.

4.4.1 WBS 1.07.02.09.40 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction & Title III Cost Estimate Update Methodology

The updates to WBS 1.07.02.09.40 consist of the following cost estimate reconciliation adjustments:

- WBS 1.07.02.09.40.05.20.20 Building and Process Services - the ICE labor estimate is approximately 767,628 hours, based on activity-based crew hours assigned. The ICE failed to account for procurement of permanent plant materials for construction and installation of the Building & Process Services. In the update to the USACE cost estimate, $41,434,975 was in material cost was added to WBS 1.07.02.09.40.05.20.20 Building and Process Services to match the total of the M&O's estimate.
- For the eight process areas, the TPC ICE material and required equipment were developed from the respective M&O equipment lists and bill of materials. The TPC ICE incorporated the need for a UPF Project team to visit the fabrication plants during glovebox fabrication and shipping to insure NQA-1 compliance. In addition, the TPC ICE incorporated a 15 percent markup to acquire critical spare parts. The combined markup for NQA-1 compliance and critical spares was approximately 53 percent. During topical discussions, the M&O indicated that such a markup is generally embedded in the equipment cost and is not applicable to Product Certification, EU Purification and Metal Production, Chemical Recovery and Special Oxide Production. The following WBS elements were modified to remove the NQA-1 and critical spare parts markup:
    - WBS 1.07.02.09.40.10.70.10 EU Purification and Metal Production - $32,674,277 (equipment cost) was subtracted from the TPC ICE WBS 1.07.02.09.40.05.70.10.94.
    - WBS 1.07.02.09.40.10.70.20 Chemical Recovery - $30,131,985 (equipment cost) was subtracted from the TPC ICE WBS 1.07.02.09.40.05.70.10.94.
    - WBS 1.07.02.09.40.10.70.30 Special Oxide Production - $18,073,554 (equipment cost) was subtracted from the TPC ICE WBS 1.07.02.09.40.05.70.10.94.
    - WBS 1.07.02.09.40.10.80.10 Product Certification - $12,107,235 (equipment cost) was subtracted from the TPC ICE WBS 1.07.02.09.40.10.80.10.94.
- WBS 1.07.02.09.40.50.92.10.54 Field Non–Manual - the USACE ICE Team estimate was based on the assumption that non-manual construction management consists of field superintendents, field engineers, and subcontract technical representatives, as well as construction management planning activities for the next phase of construction scope. This WBS element also includes functional support in the field provided by the procurement, quality control, project controls, and administrative functional organizations. Upon further discussion with the SMEs, the TPC ICE underestimated the cost for field engineers, and subcontract technical representatives, procurement, and quality control. In the update to the USACE cost estimate, $235,114,128 was added to WBS 1.07.02.09.40.50.92.10.54 Field Non–Manual for additional field engineers, subcontract technical representatives, and quality control.

The updated cost estimate for Pre-operational Testing was transferred from WBS 1.07.02.09.50 to WBS 1.07.02.09.40 detailed in Table 9.

Table 9. Pre-operational Testing Costs Transferred to WBS 1.07.02.09.40

Process	Transferred From WBS	Transferred To WBS	Costs Transferred
Facility	1.07.02.09.50.30.10.10.40	1.07.02.09.40.60.10.20	$29,395,018
Security	1.07.02.09.50.30.10.15.40	1.07.02.09.40.60.15.20	$5,878,714
Disassembly/Dismantlement	1.07.02.09.50.30.10.20.40	1.07.02.09.40.60.20.20	$3,221,703
Quality Evaluation	1.07.02.09.50.30.10.30.40	1.07.02.09.40.60.30.20	$14,796,449
EU Metal Working	1.07.02.09.50.30.10.40.40	1.07.02.09.40.60.40.20	$5,171,395
Assembly	1.07.02.09.50.30.10.50.40	1.07.02.09.40.60.50.20	$7,438,868
Product Certification	1.07.02.09.50.30.10.55.40	1.07.02.09.40.60.55.20	$2,758,777
Special Oxide	1.07.02.09.50.30.10.60.40	1.07.02.09.40.60.60.20	$3,750,269
Chemical Recovery	1.07.02.09.50.30.10.70.40	1.07.02.09.40.60.70.20	$15,179,927
EU Metal Purification	1.07.02.09.50.30.10.80.40	1.07.02.09.40.60.80.20	$12,250,665
Analytical Services	1.07.02.09.50.30.10.85.40.	1.07.02.09.40.60.85.20	$11,543,133
Nuclear Material Control & Accountability	1.07.02.09.50.30.10.99.04	1.07.02.09.40.60.99.20	$635,902
		Total	$112,020,820
Note: WBS Elements In Red Are WBS Numbers Added By The USACE Team			

4.4.2 WBS 1.07.02.09.40 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction & Title III Cost Estimate Summary

The USACE estimate update for WBS 1.07.02.09.40 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction & Title III, without escalation and contingency, is $2,537,959,094. Table 10 provides WBS 1.07.02.09.40 TPC updated estimate; Table 11 provides the detailed cost summary at the primary WBS levels under WBS 1.07.02.09.40; Table 12 illustrates the relative comparison to the M&O estimate. The complete MII cost estimate for WBS 1.07.02.09.40 is documented in Appendices B and C.

Table 10. Updated Total Project Cost Estimate - WBS 1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III

WBS	Updated USACE Estimate	Adjustments
1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III	**$2,242,376,222**	**TPC ICE**
1.07.02.09.40.05.20.20 Building and Process Services	$41,434,975	**Reconciliation Adjustments**
1.07.02.09.40.10.70.10 EU Purification and Metal Production	($32,674,277)	
1.07.02.09.40.10.70.20 Chemical Recovery	($30,131,985)	
1.07.02.09.40.10.70.30 Special Oxide Production	($18,073,554)	
1.07.02.09.40.10.80.10 Product Certification	($12,107,235)	

WBS	Updated USACE Estimate	Adjustments
1.07.02.09.40.50.92.10.54 Field Non–Manual	$235,114,128	
Reconciliation Adjustments - Subtotal	$183,562,052	
Transfer of Pre-operational Testing	$112,020,820	
1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III	**$2,537,959,094**	**Updated USACE Cost Estimate**

Table 11. Updated Total Project Cost Estimate Detail - WBS 1.07.02.09.40 UPF SLPP Procurement, Construction & Title III Cost Estimate Summary

WBS Element	Updated USACE Estimate	% of WBS
1.07.02.09.40 SLPP Procurement & Construction Title III	**$2,537,959,094**	
1.07.02.09.40.05 Facility & Support	**$524,333,889**	**20.7**
1.07.02.09.40.05.10 Balance Of Plant	$27,851,462	
1.07.02.09.40.05.10.10 Site Preparation	$9,921,838	
1.07.02.09.40.05.10.20 Support Facilities	$6,717,268	
1.07.02.09.40.05.10.30 Switchyard	$11,212,356	
1.07.02.09.40.05.20 Process Facility	$428,748,877	
1.07.02.09.40.05.20.10 UPF Buildings	$193,252,497	
1.07.02.09.40.05.20.20 Building & Process Services	$229,407,198	
1.07.02.09.40.05.20.50 HEUMF Connector	$6,089,182	
1.07.02.09.40.05.30 Information Technology	$25,268,210	
1.07.02.09.40.05.30.20 IT Communications Systems	$25,268,210	
1.07.02.09.40.05.40 Security Systems	$42,465,339	
1.07.02.09.40.05.40.10 PIDAS	$13,104,512	
1.07.02.09.40.05.40.20 Interior Alarm Systems	$24,466,312	
1.07.02.09.40.05.40.30 Security Posts And Access Controls	$4,894,515	
1.07.02.09.40.10 Process Areas	**$830,851,126**	**32.7**
1.07.02.09.40.10.50 Assembly, Disassembly, & Quality Evaluation	$161,696,181	
1.07.02.09.40.10.50.10 Assembly	$64,034,444	
1.07.02.09.40.10.50.20 Disassembly	$50,280,316	
1.07.02.09.40.10.50.30 Quality Evaluation	$47,381,421	
1.07.02.09.40.10.60 EU Metalworking	$319,936,759	
1.07.02.09.40.10.60.10 Casting	$140,742,629	

WBS Element	Updated USACE Estimate	% of WBS
1.07.02.09.40.10.60.30 Machining	$116,602,893	
1.07.02.09.40.10.60.40 Turnings Cleaning & Conversion	$62,591,237	
1.07.02.09.40.10.70 Chemical Processing	$174,273,070	
1.07.02.09.40.10.70.10 EU Metal Purification & Metal Production	$66,412,882	
1.07.02.09.40.10.70.20 Chemical Recovery	$74,514,318	
1.07.02.09.40.10.70.30 Special Oxide Production	$33,345,870	
1.07.02.09.40.10.80 Process Support	$174,945,116	
1.07.02.09.40.10.80.10 Product Certification	$98,042,373	
1.07.02.09.40.10.80.50 Analytical Services	$53,464,967	
1.07.02.09.40.10.80.99 Nuclear Material Control & Accountability	$23,437,776	
1.07.02.09.40.15 Project Integration	**$285,811,601**	**11.3**
1.07.02.09.40.40 Title III Engineering	**$258,927,300**	**10.2**
1.07.02.09.40.50 Construction Management & Indirects	**$526,014,358**	**20.7**
1.07.02.09.40.60 Pre-Operational Testing	**$112,020,820**	**4.4**

Table 12. Cost Estimate Comparison – WBS 1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III

WBS	M&O Estimate[1]	Updated USACE Estimate	Cost Variance ($)	Cost Variance (%)
1.07.02.09.40 UPF Project SLPP Procurement, Construction & Title III	$2,088,460,845	$2,242,376,222	$153,915,377	6.9
Adjustments		$295,582,872		
Revised Total	$2,088,460,845	$2,537,959,094	$449,498,249	17.7

[1.] *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006*, July 2010, *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007*, July 2010, and *UPF Line Item Export 8-10-10 with Escalation and Contingency.xls*.

The level of effort detailed in the updated USACE cost estimate remains significantly higher than the level of effort presented in the B&W TPC Estimate. The labor hour estimates detailed in the updated USACE cost estimate reflects an SME technical opinion (based on experience from Enriched Uranium Operations Wet Chemistry and Life Extension Program component production process restart efforts in Building 9212) that substantially more effort is required to complete the individual tasks than is presented in the B&W TPC Estimate. In general, crew sizes, and therefore the effort hours presented in the B&W TPC estimate, are believed to be 50% to 70% low given the SME understanding of the scope of work for equipment installation, construction testing, and pre-operational testing.

4.5 WBS 1.07.02.09.50 UPF Summary Level Planning Packages (SLPP) Planning & Readiness

The 1.07.02.09.50 WBS element encompasses the UPF Project support for UPF facility, building systems, process services, and process area procurement, construction/installation/test and turnover, Title III Engineering, Readiness/Startup efforts, and project closure. Specifically, these activities address:

- YSO oversight of these efforts
- M&O direct staff to:
  - Maintain project documentation and plans which keep a record of the evolution of the preliminary facility and process designs into the final designs. These designs and plans will be used to procure or manufacture components, fabricate subsystems, and prepare the site for facility construction.
  - Provide project management, cost estimates (including life cycle cost and estimates at completion) and integration.
  - Maintain and operate a project controls system, implemented in accordance with the contractor requirements specified in DOE O 413.3A, Chg. 1.
  - Provide direct and subcontract support for such activities as development of engineering procedures, conduct of facility and criticality safety analyses and studies, including preparation of the Preliminary Documented Safety Analysis for the identified long-lead items.
  - Provide IT services – information technology (IT) computing applications, IT system integration, and maintenance of IT computing applications included the effort needed to execute requirements definition, system design, development, testing, software quality assurance (SQA), and cyber security documentation activities required to deploy certified software applications for all facility process areas.
  - Provide functional organizational support (Operations, Safeguards and Security ES&H (Industrial Hygiene, Worker Safety and Health, Radiological Control, Transportation Management, Environmental Compliance, Sustainable Design, Fire Protection Engineering), Procurement, Construction, Engineering, QA, Startup, Project Services, Maintenance/Utility Services, Emergency Services) which support procedure development and training, cold operations and dry runs, preoperational testing, development and implementation of support programs (such as configuration management), and confirming operational readiness
  - All actions and documentation required to bring the UPF to a state of readiness to meet DOE O 425.1 requirements. Includes sub elements of safety basis development and implementation, procedure development and training, cold operations and dry runs, development and implementation of support programs, and confirming operational readiness
  - Complete all requirements for project closeout prior to CD-4

4.5.1 WBS 1.07.02.09.50 UPF SLPP Planning & Readiness Cost Estimate Update Methodology

The updates to WBS 1.07.02.09.50 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction and Title III, included the following cost estimate reconciliation adjustment:

- WBS 1.07.02.09.50.05 PMSO YSO – The ICE estimated this as a Level of Effort using the 1.07.02.09.10.05 PMSO YSO UPF Project EVMS data (as of March 21, 2010) to extrapolate a cost to complete assuming a linear relationship between percent work complete and cost. No specific

scope was provided by the M&O or YSO for this effort. During topical discussions held during reconciliation, the USACE Team agreed to the M&O estimate for this level of effort. In the update to the USACE cost estimate, $39,754,136 was added to WBS 1.07.02.09.50.05 PMSO YSO for additional staff support.

For WBS 1.07.02.09.50.30 Mission Support (a sub level of WBS 1.07.02.09.50 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction and Title III), a series of standardized Cost Estimating Spreadsheets (CES) were developed in MS Excel. These spreadsheets utilized SME generated common safety basis and procedures/training, cold operations/dry runs, pre-operational testing, program support, confirming operational readiness, and NNSA Operational Readiness crews. These common crews were used universally throughout the estimate and modified as required for each individual process based on the process complexity. Individual activities were input directly into MII.

Each of the CES data sheets (originally developed during the ICE) was re-examined to:

- Remove labor categories that were direct-charged in the USACE estimate, but that are captured within the B&W expense-funded overhead applied to Planning and Readiness activities;
- Remove actual training time that was direct-charged in the USACE estimate, but that is included in B&W 's divisional direct-labor rates;
- Remove resources already accounted for in WBS 1.07.02.09.50.40 UPF staffing levels through the site overhead rate
- Re-size each of the UPF project common crews in WBS 1.07.02.09.50.40 to a minimal size based on SME professional judgment regarding the minimum man-hours required to perform the safety basis and procedures/training, cold ops/dry runs, pre-operational testing, program support and confirming operational readiness activities for each process area.
- Resize the each of the Y-12 Operations crews to address only single shift operations during cold operations/dry runs, pre-operational testing, program support, confirming operational readiness, and NNSA operational readiness review activities for each process area. This is based on the USACE assumption that the additional Y-12 Operations crews to address second shift operations for each process in UPF, together with the resources required to accomplish each demonstration, will be provided by the Y-12 site and funded separately from other NNSA programmatic activities (such as Readiness in Technical Base and Facilities and/or Directed Stockpile Work).

The WBS 1.07.02.09.50 Pre-operational Testing activities were moved to WBS 1.07.02.09.40 (see Table 9), and then the estimate was recalculated following the costing methodology detailed in Appendix E.

4.5.2 WBS 1.07.02.09.50 UPF SLPP Planning & Readiness Cost Estimate Summary

The updated USACE cost estimate for WBS 1.07.02.09.50 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction and Title III, without escalation and contingency, is $702,329,463. Table 13 provides WBS 1.07.02.09.50 TPC updated estimate and Table 14 illustrates the relative comparison to the M&O estimate. The complete MII cost estimate for WBS 1.07.02.09.50 is documented in Appendices B and C.

Table 13. Updated Total Project Cost Estimate Detail - WBS 1.07.02.09.50 UPF Summary Level Planning Packages (SLPP) Planning & Readiness

WBS Element	Updated USACE Estimate	Percent Of WBS
1.07.02.09.50 SLPP Planning & Readiness	**$702,329,463**	
1.07.02.09.50.05 SLPP YSO Oversight	**$49,764,585**	**7.1**
1.07.02.09.50.20 Project Execution Phase	**$73,141,762**	**10.4**
1.07.02.09.50.30 Mission Support	**$200,474,342**	**28.5**
1.07.02.09.50.30.10 Operational Readiness	$200,474,342	
1.07.02.09.50.30.10.10 Facility	$45,051,176	
1.07.02.09.50.30.10.15 Security Systems	$17,694,504	
1.07.02.09.50.30.10.20 Disassembly/Dismantlement	$5,289,905	
1.07.02.09.50.30.10.30 Quality Evaluation	$14,574,723	
1.07.02.09.50.30.10.40 EU Metalworking	$7,304,728	
1.07.02.09.50.30.10.50 Assembly	$11,637,907	
1.07.02.09.50.30.10.55 Product Certification	$9,260,884	
1.07.02.09.50.30.10.60 Special Oxide	$6,067,706	
1.07.02.09.50.30.10.70 Chemical Recovery	$29,278,712	
1.07.02.09.50.30.10.80 EU Metal Purification & Metal Production	$22,295,220	
1.07.02.09.50.30.10.85 Analytical Services	$19,225,864	
1.07.02.09.50.30.10.90 Startup Authorization	$8,901,494	
1.07.02.09.50.30.10.95 Security Certification	$2,465,355	
1.07.02.09.50.30.10.99 Nuclear Material Control & Accountability	$1,426,164	
1.07.02.09.50.40 Project Integration	**$378,948,774**	**54.0**
1.07.02.09.50.40.10 Project Integration OPC	$328,752,640	
1.07.02.09.50.40.20 Project Controls - OPC	$29,396,151	
1.07.02.09.50.40.30 Project Closeout - OPC	$20,799,983	

Table 14. Cost Estimate Comparison – WBS 1.07.02.09.50 UPF Summary Level Planning Packages (SLPP) Planning & Readiness

WBS	M&O Estimate[1]	Updated USACE Estimate	Cost Variance ($)	Cost Variance (%)
1.07.02.09.50 UPF Project Summary Level Planning Packages (SLPP) Procurement, Construction and Title III	$321,252,296	$1,384,204,184	$1,062,951,888	76.8
Adjustments		($681,874,721)		
Revised Total	$321,252,296	$702,329,463	$381,077,167	54.3

[1.] *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006*, July 2010, *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007*, July 2010, and *UPF Line Item Export 8-10-10 with Escalation and Contingency.xls.*

The level of effort detailed in the updated USACE cost estimate remains significantly higher than the level of effort presented in the B&W TPC Estimate. The complexity and level of effort detailed in the updated USACE cost estimate reflects an SME technical opinion (based on experience from Enriched Uranium Operations Wet Chemistry and Life Extension Program component production restart efforts in Building 9212) that substantially more effort is required to complete the individual tasks than is presented in the B&W TPC Estimate. It is the belief of the USACE Team that the indicated costs in the B&W TPC estimate are consistently less (approximately 50%) of that required to perform the defined scope given the complexity of the UPF Facility for cold operations/dry runs, pre-operational testing, program support, confirming operational readiness, and NNSA operational readiness review activities.

4.6 WBS 1.07.02.09 UPF Project

The UPF is a major-system acquisition project for the DOE NNSA. This level consolidates 1.07.02.09.10 Planning and Readiness (OPC), 1.07.02.09.20UPF Design (PED), 1.07.02.09.30 UPF Project Execution (LI) Procurement, Construction & Title III, 1.07.02.09.40SLPP (LI) Procurement, Construction & Title III, and 1.07.02.09.50 SLPP Planning & Readiness (OPC). This section summarizes the totals from the details in the previous five sections and provides the overall estimate to complete the work in FY 2011 dollars. This cost does not include escalation or contingency.

4.6.1 WBS 1.07.02.09 UPF Project Cost Estimate Summary

The updated USACE cost estimate to complete for WBS 1.07.02.09 UPF Project, without escalation and contingency, is $3,927,738,080. When actual costs to date of $217,218,893 are included, the updated USACE TPC cost estimate is $4,144,956,973. Table 15 provides the updated TPC Estimate Detail, and Table 16 illustrates the relative comparison to the M&O estimate. The complete MII cost estimate for the update to the TPC cost estimate is documented in Appendices B and C.

Table 15. Updated Total Project Cost Estimate - WBS 1.07.02.09 UPF Project

WBS	USACE ICE (Without Contingency & Escalation)	Adjustment	Updated USACE Estimate To Complete	Actual Costs (March 21, 2010)	Updated USACE TPC Estimate
1.07.02.09 Uranium Processing Facility	**$4,241,383,291**	**($313,645,211)**	**$3,927,738,080**	**$217,218,893**	**$4,144,956,973**
1.07.02.09.10 Planning & Readiness - OPC	$70,384,280	$26,616,369[1]	$97,000,649	$64,648,839	$161,649,488
1.07.02.09.20 UPF Design (PED)	$311,197,760	$0	$311,197,760	$152,570,054	$463,767,814
1.07.02.09.30 UPF Project Execution (LI) Procurement, Construction & Title III	$233,220,845	$46,030,269[1]	$279,251,114	$0	$279,251,114
1.07.02.09.40 SLPP (LI) Procurement, Construction & Title III	$2,242,376,222	$295,582,872[1,2]	$2,537,959,094	$0	$2,537,959,094
1.07.02.09.50 SLPP Planning & Readiness (OPC)	$1,384,204,184	($681,874,721)[1,2]	$702,329,463	$0	$702,329,463

[1] Reconciliation Adjustment
[2] Revised Estimate

Table 16. Cost Estimate Comparison – WBS 1.07.02.09 UPF Project

WBS	M&O Estimate[2]	Updated USACE Estimate To Complete[1]	Cost Variance ($)	Cost Variance (%)
1.07.02.09 Uranium Processing Facility	**$3,107,390,130**	**$3,927,738,080**	**$820,347,950**	20.9
1.07.02.09.10 Planning & Readiness - OPC	$98,225,190	$97,000,649	($1,224,541)	(1.3)
1.07.02.09.20 UPF Design (PED)	$272,279,717	$311,197,760	$38,918,043	12.5
1.07.02.09.30 UPF Project Execution (LI) Procurement, Construction & Title III	$327,172,082	$279,251,114	($47,920,968)	(17.2)
1.07.02.09.40 SLPP (LI) Procurement, Construction & Title III	$2,088,460,845	$2,537,959,094	$449,498,249	17.7
1.07.02.09.50 SLPP Planning & Readiness (OPC)	$321,252,296	$702,329,463	$381,077,167	54.3

[1] Does not include $217.2 million actual costs through March 2010
[2.] *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume I, Basis of Estimate, RP–PC–801768–A006*, July 2010, *Uranium Processing Facility Total Project Cost (TPC) Range Estimate Volume II, Estimate Summary, RP–PC–801768–A007*, July 2010, and *UPF Line Item Export 8-10-10 with Escalation and Contingency.xls*

5.0 COST AND SCHEDULE RISK ANALYSIS

The Cost and Schedule Risk Analysis (CSRA) process for this updated USACE cost estimate follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering DX). The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Oracle Crystal Ball software application. The risk analysis results serve several functions, one being the establishment of reasonable contingencies reflective of various levels of confidence to accomplish the project work successfully within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results are appropriately interpreted.

Risk analysis results support decision-making and risk management as the project progresses through planning and implementation. To recognize its benefits fully, cost and schedule risk analysis must be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes. In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects
- ER 1110-2-1302, Civil Works Cost Engineering
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works
- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX

- Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007

5.1 Methodology

5.1.1 Identify and Assess Risk Factors

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from subject matter experts (SMEs) representing all relevant technical disciplines and project/organizational functional areas should be obtained using creative processes such as brainstorming, facilitated risk assessment meetings and interviews. In practice, a combination of professional judgment from subject matter experts and empirical data from similar projects is desirable and was considered.

Formal risk identification and analysis meetings and interviews for the UPF Project CSRA were conducted with Federal project personnel, ICE team SMEs, the Deputy Federal Project Director, and Federal Project Director. The risk identification and analysis process involved capable and qualified representatives from multiple project team disciplines and functions, including:

- Project Management
- Cost Engineering
- Civil Engineering
- Electrical Engineering
- Nuclear Engineering
- Site Preparation, Site Utilities, Process Support and Administration Facilities
- Building Systems and Operations Support Systems
- Information Systems, Information Technology Hardware, Communications Systems, and Computing Applications
- Environment, Safety and Health
- Facility Safety
- Facility Security Systems and Building Alarm Systems
- Radiography
- EU Chemical Processing
- EU Metallurgical Operations
- Material and Product Certifications, Analytical Services, and Nuclear Material Control and Accountability
- Assembly/Disassembly of Canned Subassemblies and Quality Evaluation

Additionally, numerous informal interviews were conducted with the ICE project team SMEs throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis and risk assessment.

Project-specific risk rating guidelines were developed to ensure consistency and comparability of risks assessed during formal risk meetings and interviews. Rating guidelines were developed for risk impacts and probability of occurrence using risk matrix categories provided in USACE CSRA guidance. Figure 3 presents the USACE CSRA risk matrix. Rating guidelines for assessment of probability of risk occurrence and risk impact are presented in Tables 17 and 18, respectively.

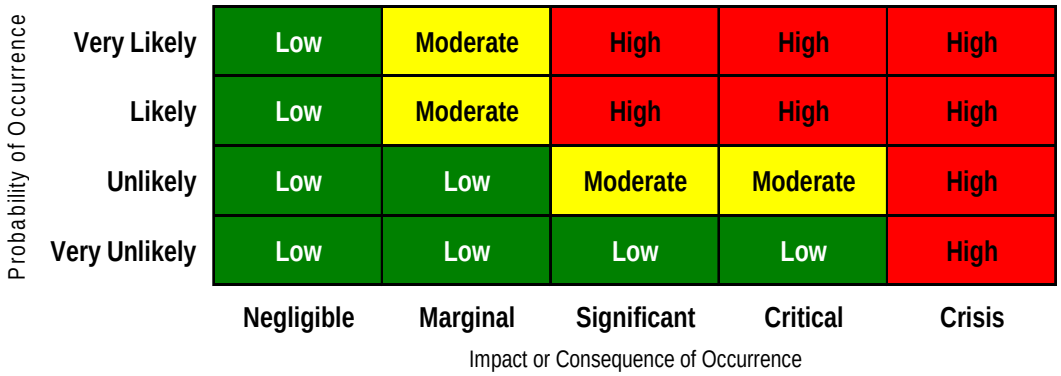

Figure 3. USACE CSRA Risk Matrix

Table 17. Probability Rating Guidelines

Probability Rating	Qualitative Guideline	Quantitative Guideline
Very Unlikely	You would be surprised if this happened.	>0% - 10%
Unlikely	Less likely to happen than not.	>10% - 40%
Likely	More likely to happen than not.	>40% - 70%
Very Likely	You would be surprised if this did not happen.	>70% - 90%*
* The impact of risks with a probability greater than 90% will be included in the baseline.		

Table 18. Impact Rating Guidelines

Impact Rating	Cost Impact Guideline	Schedule Impact Guideline
Negligible	<$1 million	< 1 month
Marginal	$1 million - <$10 million	1-3 months
Significant	$10 million - <$50 million	>3-6 months
Critical	$50 million - $100 million	>6-12 months
Crisis	>$100 million	>12 months

5.1.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts were represented by probabilistic distribution functions (density functions) for inputs into the Crystal Ball software application. The probabilistic distribution functions are used to describe the characteristic population (tendencies) of the risk factor inputs. The following elements of each risk factor were addressed in the risk factor quantification process:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

Risk factor quantification focused on the various project elements as presented in the UPF Project Phase II ICE and listed in Section 3.1 (Project Scope). This was done because it was recognized that the various features carry differing degrees of risk as related to cost, schedule, design complexity and design progress.

The resulting product from risk factor identification, assessment and quantification was captured within a risk register for both cost and schedule risk concerns. The risk register is presented in Appendix F.

5.1.3 Analyze Cost Estimate and Schedule Contingency

Contingency was analyzed using the Crystal Ball software application. *Monte Carlo* analysis was performed by applying the risk factors (quantified as probability density functions) to the estimated cost and schedule elements identified in the risk register. Contingencies were calculated by evaluating the risks identified for the UPF Project CSRA. The Crystal Ball cost model and schedule model are electronic files. The cost model and schedule model are provided as Appendix F.

For the cost estimate, contingency was calculated as the difference between the cost forecast at various confidence level (CL) intervals and the base cost estimate. The base cost estimate is the most likely cost estimate less any assumed contingency. The base cost estimate does not include escalation to the mid-point of construction.

For the schedule, contingency was calculated as the difference between the duration forecast at various CL intervals and the base schedule duration. The duration contingency was then used to estimate non-labor *hotel* costs (see next paragraph) and calculate the additional time value of money impact of project delays that are included in the presentation of total cost contingency. The resulting time value of money, or added escalation risk, and non-labor hotel costs are added into the cost contingency amount to reflect USACE CSRA guidance for presenting the estimated cost for the fully funded project amount.

Hotel costs are fixed costs that are inherently incurred as a result of schedule delays. These fixed costs may include general site conditions, rents, project management, supervision and administration, and elements of home office or field office overhead.

Total contingency (reflecting cost and schedule impacts) was allocated to Federal – Headquarters, Federal – YSO, and M&O risk owners based on the dollar-weighted relative risk as quantified by *Monte Carlo* simulation. Standard deviation was used as the owner-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of total project contingency being allocated to the risk owner with a relatively higher estimated cost uncertainty.

Similarly, total contingency (reflecting cost and schedule impacts) was allocated to WBS Level 2 elements based on the dollar-weighted relative risk of each WBS element as quantified by *Monte Carlo* simulation. Standard deviation was used as the WBS element-specific measure of risk for contingency allocation purposes. Allocation of contingency to WBS Level 2 elements was further refined based on professional judgment.

For the UPF Project CSRA, the Y-12 Site Office requested that contingency information be developed for the 85% CL. Use of the 85% CL as a decision criteria is a risk adverse approach, whereas the use of 50% CL would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking.

5.2 KEY ASSUMPTIONS AND LIMITATIONS

Key assumptions and limitations are those that are most likely to affect the determinations of contingency presented in the CSRA significantly. The key assumptions and limitations are important to

help ensure that project leadership and other decision makers understand the steps, logic, and decisions made in the risk analysis, as well as any resultant implications on the use of outcomes and results.

The following list identifies the key risk analysis assumptions and limitations within the context of the UPF Project CSRA. For each item, the context is first provided and then followed by the key assumption or limitation.

1. Effectiveness of Future Risk Management: The probability or impact of risks identified in the risk register may be affected by future risk response activities (*e.g.*, mitigation, transfer, acceptance, or avoidance). No assumption is made that future, uncertain risk response activities performed by unknown contractors or DOE personnel will be successful. The CSRA reflects the uncertain nature of future risk management effectiveness.
2. Unknown Decisions or Decision Makers: The CSRA was prepared using a framework to generate contingency information that is appropriate for use by DOE/NNSA decision makers for scheduling, budgeting, and project control purposes. The framework may generate results that are appropriate for use by a wide variety of decision makers or stakeholders; however, the assumed use of CSRA results is limited to scheduling, budgeting, and project control. Other uses by unknown decision makers may not be appropriate.
3. Dynamic Risks: Risk events are dynamic, not static, and should be evaluated regularly through all phases of design, construction, and startup. The CSRA is based on the identification and assessment of risks as of the date of this document. Reduced utility of CSRA results should be assumed if the likelihood or impact of risks changes over time.
4. Causal Relationships: With the exception of risk events identified as correlated in the risk register, it is assumed that the impacts of risks are independent and that the realization of one risk does not cause the realization of another. Significant variance of the risk model results from actual project costs and schedules may be experienced if significant causal relationships exist between risks assumed independent.
5. Conservation of Market Pricing Risk: The CSRA assumes that market-pricing risks are not created or destroyed but can only be transferred or shared *at a price* because of various contract acquisition strategies. As an example, it is assumed that a contractor will add a level of contingency to a fixed price bid, relative to a cost reimbursable bid, that is reflective of the risk transferred contractually from the Government to the contractor. Other aspects of contract acquisition strategies not related to market pricing, such as the management cost of modifications or claims, are not included in this assumption. Any contract acquisition strategy that actually transfers market-pricing risk to a contractor *at no cost* to the Government is not reflected in the CSRA.
6. *Unknown Unknown* and *Unknowable Risks*: The Cynefin Framework describes decision-making contexts, in part, by characteristic types of uncertainty. Simple, complicated, complex, and chaotic contexts within the framework are respectively associated with *known known*, *known unknown*, *unknown unknown* and *unknowable* uncertainties. The CSRA process focuses on *known known* and *known unknown* risks and is not intended to quantify the impacts of *unknown unknown* or *unknowable* risks. Significant variance of the risk model results from actual project costs and schedules may be experienced if *unknown unknown* or *unknowable* risks, as defined in the Cynefin Framework, are realized.

5.3 CSRA RESULTS SUMMARY

The updated USACE TPC estimate contingency for the UPF Project is approximately $1.5 billion at the 85% CL or about 38.2 % of the base cost estimate of $3.9 billion. This contingency analysis is based on

the risk register, provided in Appendix F, which includes federal – headquarters, federal – YSO and M&O contractor risks. All risks were considered in the contingency analysis since it is USACE CSRA policy to include all risks considered applicable to a project effort.

During an SME re-evaluation of the risk register, risk PPM-19 - Loss of Building 9212 Production (Federal) was determined to be a risk more appropriate to the NNSA Stockpile Stewardship Program since for loss of this critical production capability would affect major weapon program activities. Furthermore, depending on the specific weapon program activities affected, multiple NNSA production sites would also be impacted. This risk was removed from the risk register and assumed to be an NNSA Stockpile Stewardship Program programmatic risk.

In addition, the deliberations add a risk - TST-18 M&O Operations Staff Availability for Readiness (Second Shift) was added to address the risk of adequate Y-12 Operations staff, of the correct skill operations and number, being available on a timely basis to support preoperational testing and cold operations on a second shift.

Table 19 provides the total cost contingency for the UPF Project calculated at various CL intervals and rounded to the nearest thousand dollars. These results reflect contingencies based on both the cost and schedule risk analyses. Note again that use of 85% CL as a decision criteria is a risk adverse approach (whereas the use of 50% would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, an 85% CL results in greater contingency as compared to that at a 50% CL as shown below in Table 19.

About 23.1% of the total cost contingency is associated with schedule risk (*i.e.*, about 8.8 out of the 38.2 total percentage points) at 85% CL. Figure 4 provides a summary graph of the UPF Project Phase II risk analysis with Federal and M&O Contractor contingency components. It is important to note that these results reflect contingencies based on both the cost and schedule risk analyses.

Table 19. Updated Total Project Cost Estimate Total Contingency Summary

Confidence Level	Base Cost* + Contingency	Contingency	Contingency (%)
0% CL	$4,364,392,685	$405,999,000	10.3
05% CL	$4,634,978,974	$817,287,000	20.8
10% CL	$4,684,300,999	$891,490,000	22.7
15% CL	$4,720,537,858	$946,561,000	24.1
20% CL	$4,750,432,945	$992,062,000	25.3
25% CL	$4,776,933,053	$1,032,148,000	26.3
30% CL	$4,801,169,587	$1,068,764,000	27.2
35% CL	$4,823,889,294	$1,103,475,000	28.1
40% CL	$4,846,330,274	$1,137,932,000	29.0
45% CL	$4,868,261,840	$1,171,489,000	29.8
50% CL	$4,890,674,126	$1,205,550,000	30.7
55% CL	$4,912,926,246	$1,239,474,000	31.6
60% CL	$4,935,926,966	$1,274,587,000	32.5
65% CL	$4,960,557,891	$1,312,195,000	33.4
70% CL	$4,986,398,445	$1,351,880,000	34.4
75% CL	$5,014,429,622	$1,395,052,000	35.5
80% CL	$5,045,490,805	$1,443,404,000	36.7
85% CL	$5,083,140,526	$1,501,785,000	38.2
90% CL	$5,131,454,367	$1,576,434,000	40.1
95% CL	$5,203,464,157	$1,689,452,000	43.0
100% CL	$5,722,819,931	$2,523,708,000	64.3

**The base cost estimate (without $217.2M actual cost) is $3,927,738,080*

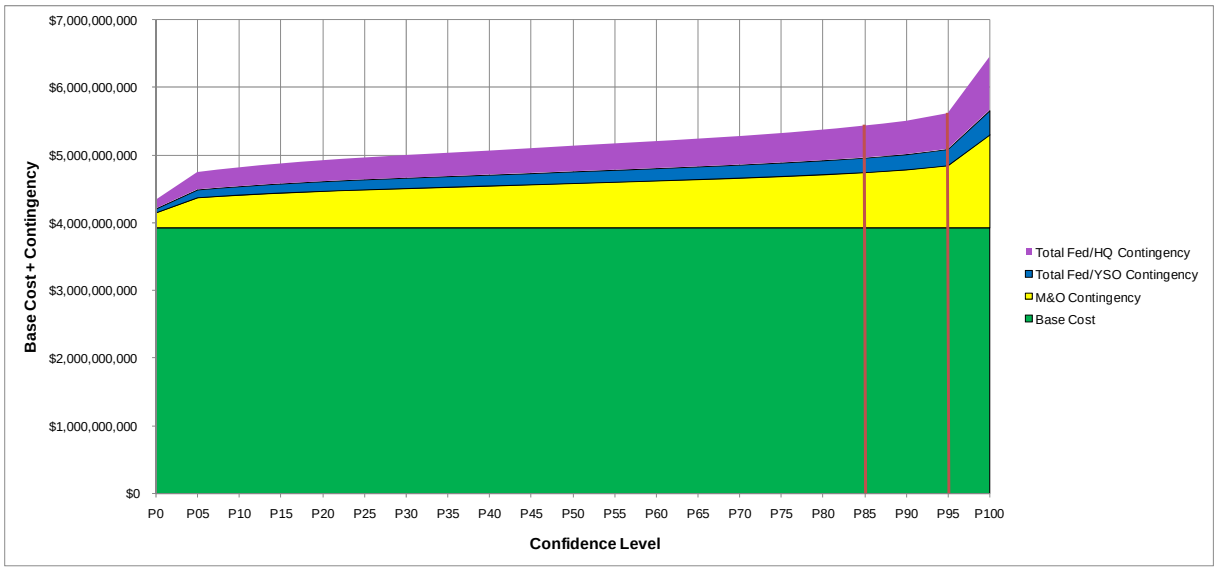

Figure 4. Updated Total Project Cost & Schedule Risk Analysis

The key cost risk drivers identified through sensitivity analysis are *Funding Profile/Project Priority, Operations Staff Availability for Readiness (Second Shift), Preoperational Testing Issues*, and *New Technology Readiness Levels, which* respectively contribute about 23.7%, 16.4%, 13.2% and 11.0% of statistical cost variance during *Monte Carlo* simulation. *Craft Labor Availability for Multiple Shifts, Design Agency Requirement Issues,* and *Contractor Claims* are also important cost risk drivers, which together contribute an additional 19.5% of statistical cost variance. Figure 5 presents a sensitivity analysis for cost risks.

The key schedule risk drivers identified through sensitivity analysis are *Funding Profile/Project Priority* and *Preoperational Testing Issues*, which respectively contribute about 37.5% and 12.8% of statistical schedule duration variance during Monte Carlo simulation. *Operations Staff Availability for Readiness (Second Shift), Testing Schedule Issues, Failure of Contractor Operational Readiness Review*, and *Inadequate Utility Infrastructure Funding* are also important schedule risk drivers, which together contribute an additional 22.7% of statistical schedule variance. Figure 6 presents a sensitivity analysis for schedule risks.

The required schedule contingency (float) needed in the schedule to achieve the desired level of schedule execution within the 85% CL is shown in Table 20.

Table 20. Schedule Contingency at 85% Confidence Level

Confidence Level and WBS Element	Contingency (months)	Project End Date	Contingency Based End Date
85% CL			
1.07.02.09.10 Planning & Readiness - OPC	1.2		
1.07.02.09.20 UPF Design (PED)	3.1		
1.07.02.09.30 Site Preparation & Long Lead Items	5.2		
1.07.02.09.40 SLPP Procurement & Construction Title III	14.2		
01.07.02.9.50 SLPP Planning & Readiness	14.8		
TOTAL	**38.5**	**1/2/2023**	**3/13/2026**

Table 21 presents the total cost risk contribution to contingency for the twenty (20) most significant risks, which have the largest contributions to cost contingency calculated at the 85% CL. The values presented in Table 21 are rounded to the nearest thousand dollars and reflect the impact of risk correlations.

Table 21. Twenty Largest Contributors to Cost Contingency at 85% Confidence Level

Risk	Contribution to Cost Contingency
	85% CL
PPM-1 Funding Profile/Project Priority (Fed/HQ)*	$273,830,000
TST-18 M&O Operations Staff Availability for Readiness (Second Shift)	$189,486,000
TST-5 Preoperational Testing Issues (M&O)	$152,513,000
DES-14 New Technology Readiness Levels (M&O)	$127,094,000
CON-3 Craft Labor Availability for Multiple Shifts (M&O)*	$50,838,000
DES-32 Design Agency Requirement Issues (M&O)	$47,372,000
PPM-10 Contractor Claims (M&O)	$35,817,000
DES-1 Level of Design Development (M&O)*	$31,196,000
DES-13 New Technology Implementation (M&O)	$20,797,000
CON-11 Large, Complex Project Experience (M&O)	$12,709,000
PPM-20 CM Contract Transition (Fed/YSO)	$12,709,000
DES-31 Storage Issues (M&O)*	$12,709,000
PPM-2 M&O Contract Transition (Fed/YSO)	$12,709,000
CA-3 NQA-1 Requirements (M&O)	$11,554,000
DES-47 “Near Real Time” Accountability Capability (M&O)	$11,554,000
CA-2 Availability of Domestic Specialty Vendors (M&O)	$11,554,000
PPM-18 Division of UPF Project in Sub-Projects (Fed/YSO)	$11,554,000
SS-21 Increased DNFSB Oversight (Fed/YSO)	$11,554,000
TST-4 Testing Schedule Issues (M&O)	$10,399,000
PPM-16 Integration between NCS, NMC&A and Production (M&O)	$9,243,000
Notes: Risks followed by an asterisk (*) are correlated with one or more other risks as indicated in the risk register.	

Observations concerning the ten most significant risks identified in the cost and schedule risk analysis are listed below. Detailed descriptions of each risk are provided in the CSRA risk register in Appendix F.

1. Risk PPM-1 Funding Profile/Project Priority (Federal)

   Description: The timing and level of project funding may not be sufficient to meet schedule requirements. Recent funding levels have been below the CD-1 funding profile. Low funding levels in the future may result in UPF reaching full production capacity significantly later than 2022. UPF and the Chemistry and Metallurgy Research Replacement (CMRR) Project are key funding priorities for NNSA. Significant cost growth of either project may result in a situation where constructing both projects with currently anticipated scopes is not feasible due to NNSA funding constraints. Significant delays to reaching full production capacity, construction phasing, or reduced functional capabilities may result if UPF is considered a lower priority than CMRR.

CSRA Analysis: Funding Profile/Project Priority is a significant threat to both cost and schedule during the project. It is associated with 23.7% of cost uncertainty during *Monte Carlo* simulation, as well as 37.5% of schedule duration uncertainty. It was modeled as a 40% chance of a cost increase of up to $300 million and a schedule delay of up to 36 months.

2. Risk TST-18 M&O Operations Staff Availability for Readiness (Second Shift)

Description: There is a risk that adequate Y-12 Operations staff, of the correct skill operations and number, will not be available on a timely basis to support preoperational testing and cold operations on a second shift. This second shift staff is not dedicated to UPF as they support existing Y-12 production and chemical operations and are funded from Readiness in Technical Base and Facilities, Operations of Facilities rather than from UPF project. Failure to implement a staffing approach, which provides dedicated resources to the existing operations as well as UPF preoperational testing and cold operations staffing requirements, will result in delays in the preoperational testing and cold operations schedule.

CSRA Analysis: The availability of the second shift operations staff for UPF readiness activities is a significant threat to both cost and schedule during the project. It is associated with 16.4% of cost uncertainty during *Monte Carlo* simulation, as well as 11.0% of schedule duration uncertainty. It was modeled as a 40% chance of a cost increase of up to $288 million and a schedule delay of up to 12 months.

3. Risk TST-5 Preoperational Testing Issues (M&O)

Description: Unexpected or unacceptable Preoperational Test Results will result in additional man-hours to evaluate the condition as well as additional man-hours to redesign, rework, and retest. If the System Level Preoperational Testing activities cannot be successfully completed because a new technology or major piece of equipment fails to meet its intended use (number of widgets per hour, quality of product, etc.), then significant redesign, rework, procurement and schedule delays will be incurred and mission expectations could be at risk. The lack of adequate numbers of calibrated Test Equipment, Spare Parts, and Consumables for testing will result in testing and project schedule delays. If Subcontracted or Construction Component Level Testing does not properly demonstrate and document Structures, Systems, and Components functionality per the specification, delays in Turnover could result. During Preoperational Testing activities, equipment failures due to bad design, incorrect installation, or failed equipment will result in the inability to complete testing as scheduled due to multiple minor equipment or new technology issues.

CSRA Analysis: Preoperational Testing Issues is a significant threat to both cost and schedule during the project. It is associated with 13.2% of cost uncertainty during *Monte Carlo* simulation, as well as 12.8% of schedule duration uncertainty. It was modeled as a 40% chance of a cost increase of up to $225 million and a schedule delay of up to 24 months.

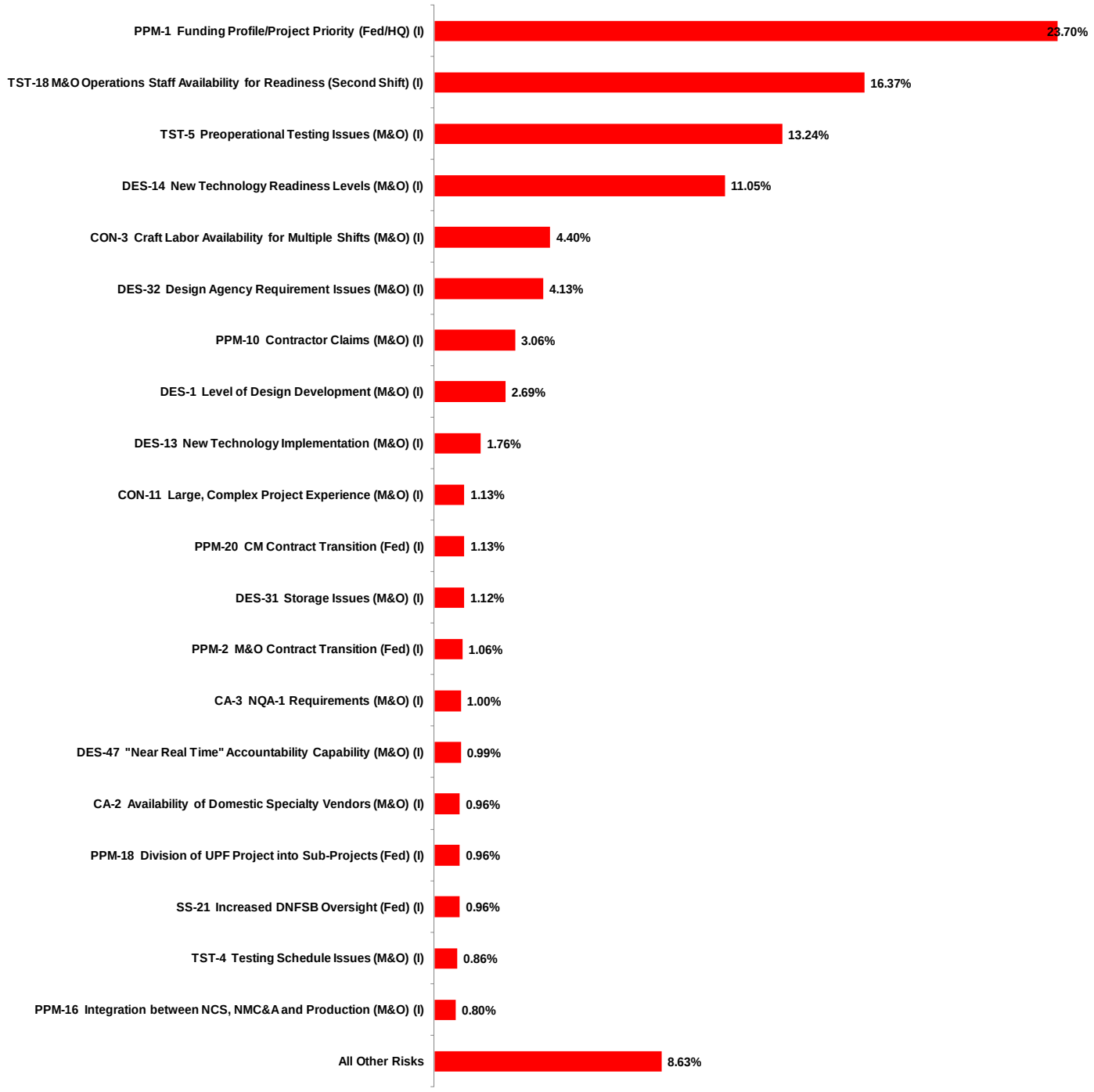

Figure 5. Sensitivity Analysis – Updated Total Project Cost Estimate Cost Risks

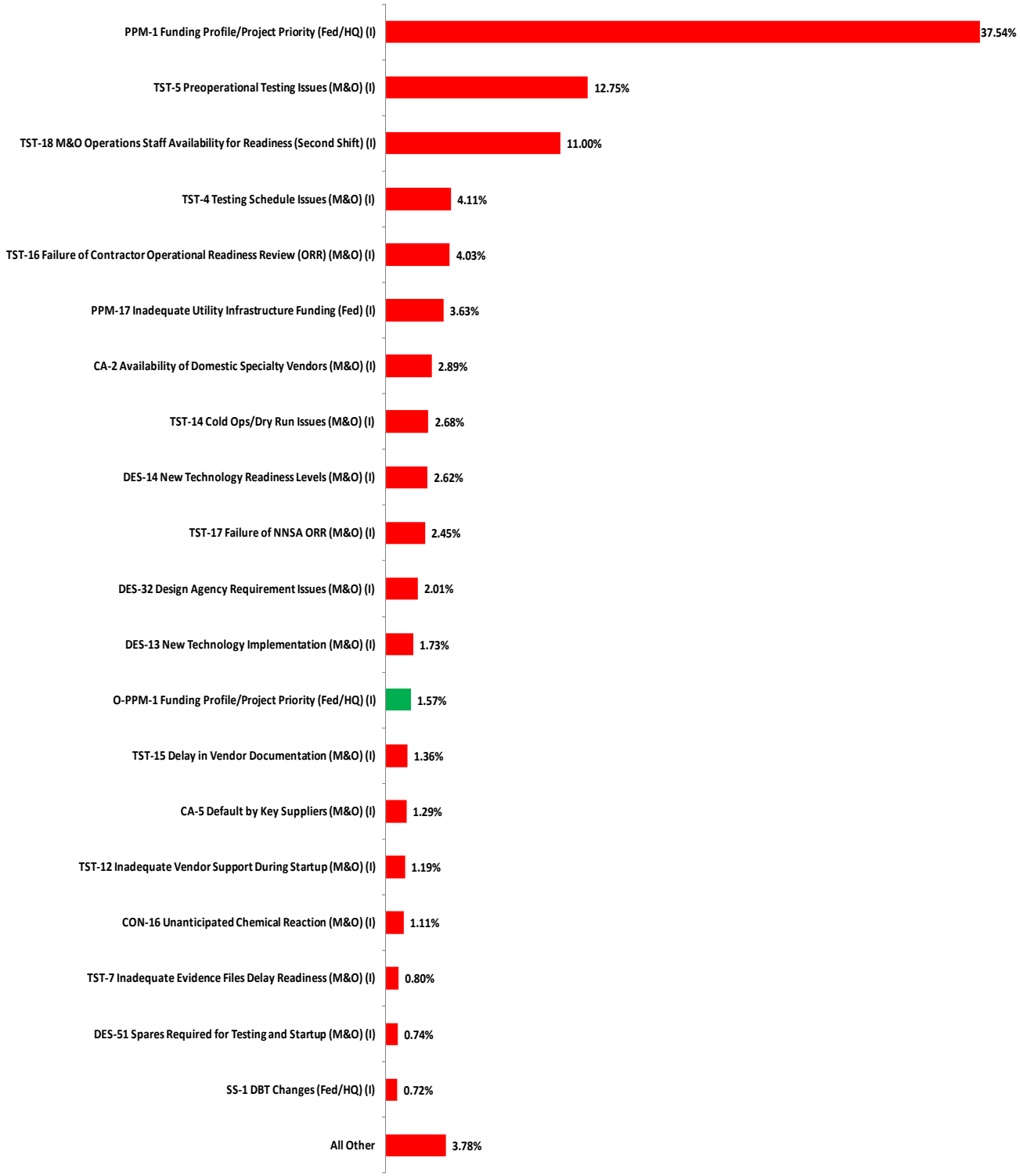

Figure 6. Sensitivity Analysis - Updated Total Project Cost Estimate Schedule Risks

4. Risk DES-14 New Technology Readiness Levels (M&O)

Description: If the technology readiness level (TRL) new technologies are inadequate for UPF insertion, then increased cost and schedule delays will be encountered at CD-2 and/or startup. Bulk Metal Oxidation, Infrared Heating, Alternate Processing of Pins, Microwave Casting, Saltless Direct Oxide Reduction (SDOR), and Primary Extraction Centrifugal Contactors technologies are currently at a TRL 6 or higher. Development efforts are underway to mature Special Casting, Agile Machining, Chip Management and Uranyl Nitrate Hexahydrate (UNH) Calcination to a TRL 6 or higher by CD-2. SDOR, UNH Calcination, Bulk Metal Oxidation, and Primary Contactors may be tested further with depleted uranium for validation and possible modification after they have been designed and fabricated for UPF allowing sufficient time to make modest changes the testing might reveal. A Technology Maturation Plan (TMP) is in place to document the requirements for obtaining a TRL 6 or higher for Special Casting, Agile Machining, Chip Management, and UNH Calcination. There is a risk that the project will be unable to procure an Advanced Integrated Machining System (AIMS) Machine tool prototype that meets specified requirements. There is a risk that that prototype AIMS will not meet the anticipated production rates. AIMS, SDOR, and 15 MeV X-ray are the primary risks.

CSRA Analysis: New Technology Readiness Levels is a significant threat to both cost and schedule during the project. It is associated with 11.0% of cost uncertainty during *Monte Carlo* simulation, as well as 2.6% of schedule duration uncertainty. It was modeled as a 40% chance of a cost increase of up to $240 million and a schedule delay of up to 24 months.

5. Risk CON-3 Craft Labor Availability for Multiple Shifts (M&O)

Description: Competition for key craft labor by commercial nuclear projects may result in higher than anticipated costs to attract labor. Design and construction of TVA's Watts Barr and Bellefonte plants is anticipated to be concurrent to UPF design and construction. If construction progress is impeded due to the lack of qualified welders and weld inspectors to support construction activities, then the UPF schedule could be in jeopardy. If there is a shortage of construction workers due to competition with other large construction projects in the area then the construction schedule could be adversely impacted and/or premium wages could be required. Increasing the number of shifts increases the impact of this risk.

CSRA Analysis: Craft Labor Availability for Multiple Shifts is a significant threat to cost during the project. It is associated with 4.4% of cost uncertainty during *Monte Carlo* simulation. It was modeled as a 40% chance of a cost increase of up to $135 million and a schedule delay of up to 3 months.

6. Risk TST-4 Testing Schedule Issues (M&O)

Description: If the schedule does not reflect the proper testing scope and allow for adequate test durations (to include time for equipment rework) due to late equipment installations, late calibrations, poor planning, or stakeholder influences, then delays in system level testing and system turnovers to Operations will result. Additionally, if Construction Component and/or Preoperational Testing cannot be completed as planned, then Construction and/or Preoperational Testing delays will occur and the schedule will be impacted.

CSRA Analysis: Testing Schedule Issues is a significant threat to schedule during the project. It is associated with 4.1% of schedule uncertainty during *Monte Carlo* simulation. It was modeled as a 40% chance of a cost increase of up to $60 million and a schedule delay of up to 24 months.

7. Risk DES-32 Design Agency Requirement Issues (M&O)

Description: Design is based on PRD & SRDs. As design progresses toward completion, clarification of requirements occurs. There is risk that Design Agency requirements and specifications may be incomplete, missed, or incorrectly interpreted. This may lead to additional requirements in the preliminary design of UPF. Detailed Design Agency requirements have been researched by system engineers at the plant. Review by the project of remaining systems is required. This risk could cause the addition of equipment to the facility.

CSRA Analysis: Design requirements Issues are a significant threat to cost and schedule during the project. It is associated with 4.1% of cost uncertainty during *Monte Carlo* simulation, as well as 2.0% of schedule duration uncertainty. It was modeled as a 40% chance of a cost increase of up to $120 million.

8. Risk TST-16 Failure of Contractor Operational Readiness Review (M&O)

Description: There is a risk that one or more of the planned contractor Operational Readiness Reviews (ORR) will not be successful. Failure of an ORR can lead to rework in Cold Ops/Dry Run, procedures, and safety basis.

CSRA Analysis: Failure of Contractor Operational Readiness Review is a significant threat to schedule during Phase II. It is associated with 4.03% of schedule uncertainty during *Monte Carlo* simulation. It was modeled as a 40% chance of a cost increase of up to $10 million and a schedule delay of up to 6 months.

9. Risk DES-1 Level of Design Development (M&O)

Description: The overall UPF Project design is approximately 40% complete as of August 2010. Further development of the design may result in additional scope, which has cost and schedule impacts. The impact of this risk is significantly less for Phase I than the overall project due to the level of Phase I design development. Design is based on Program Requirements Document & System Requirement Documents. As design progresses toward completion, clarification of project requirements will occur. There is risk that Design Agency requirements and specifications may be incomplete, missed, or incorrectly interpreted.

CSRA Analysis: Level of Design Development is a significant threat to cost during the project. It is associated with 2.7% of cost uncertainty during *Monte Carlo* simulation. It was modeled as a 40% chance of a cost increase of up to $100 million and a schedule delay of up to 6 months.

10. Risk CA-2 Availability of Domestic Specialty Vendors (M&O)

Description: It is likely that numerous key components required for construction of the UPF Project are not produced domestically. Because export of nuclear and nuclear related equipment, materials and

information (including designs) is highly controlled (Export Control Verification), the UPF Project may not be able to source key components without the receipt of waivers or other form of "work-around". 22 CFR Parts 120-130 (ITAR) is considered a primary constraint on the procurement of key components from foreign vendors. For example, some key instruments (for analytical services) are tested to European quality and safety standards. If Underwriters Laboratories and other US standards are required for equipment procured from Europe, delays in meeting installation schedules might occur while vendors attempt to achieve the requirement or while UPF evaluates the equivalency of the European standards to US standards.

CSRA Analysis: Availability of Domestic Specialty Vendors is a significant threat to schedule during the project. It is associated with 2.9% of schedule uncertainty during *Monte Carlo* simulation. It was modeled as a 40% chance of a cost increase of up to $60 million and a schedule delay of up to 12 months.

Table 22 provides a breakdown of UPF updated USACE cost estimate total contingency in dollars by Federal and Management and Operating (M&O) contractor components at the 85% confidence limits.

Table 22. Updated Total Project Cost Estimate Federal and M&O Contingency at 85% Confidence Level

Confidence Level And Risk Owner	Contingency ($)	% Total Contingency
85% CL		
Federal-Headquarters	$469.6	31.3
Federal-YSO	$215.0	14.3
M&O Contractor	$817.2	54.4

6.0 CONTINGENCY AND ESCALATION

For the process of contingency allocation and escalation, the UPF updated USACE TPC cost estimate for the UPF Project, of $4,144,956,973 (FY2011 dollars) was adjusted for the actual costs to date of $217,218,893 to $3,927,738,080. The USACE ICE schedule was resource loaded to WBS Level 5, with the labor and material/subcontract cost. Spend plans for each WBS Level 2 element were generated. Figures 7 and 8 provide the cumulative UPF Project spend plan for the updated USACE cost estimate.

For allocation of contingency, the CSRA analysis developed a breakdown of updated USACE cost estimate contingency by Level 2 WBS element at 50% CL, 85% CL, and 95% CL (Table 23). Total contingency was allocated to the Level 2 WBS elements based on the dollar-weighted relative risk of each element as quantified by *Monte Carlo* simulation. Standard deviation was used as the WBS element-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of total contingency being allocated to project elements with relatively higher estimated uncertainty. The WBS contingency allocation was also further refined using professional judgment to reflect the greater uncertainty associated with out-year scope as compared to near-term scope. Table 24 provides the contingency allocation calculations for the updated USACE cost estimate at the 85% CL. These allocations

provide the relative percent of a particular WBS base cost, which is represented by the contingency that has been allocated to that respective WBS element.

Table 23. WBS Level 2 Contingency Allocations by WBS

WBS	50% CL Contingency (% of WBS base cost)	85% CL Contingency (% of WBS base cost)	95% CL Contingency (% of WBS base cost)
1.07.02.09.10 Planning & Readiness - OPC	14.3	17.8	20.1
1.07.02.09.20 UPF Design (PED)	28.8	35.8	40.3
1.07.02.09.30 Site Preparation & Long Lead Items	19.9	24.8	27.9
1.07.02.09.40 SLPP Procurement & Construction Title III	27.4	34.2	38.4
1.07.02.09.50 SLPP Planning & Readiness	49.9	62.2	70.0

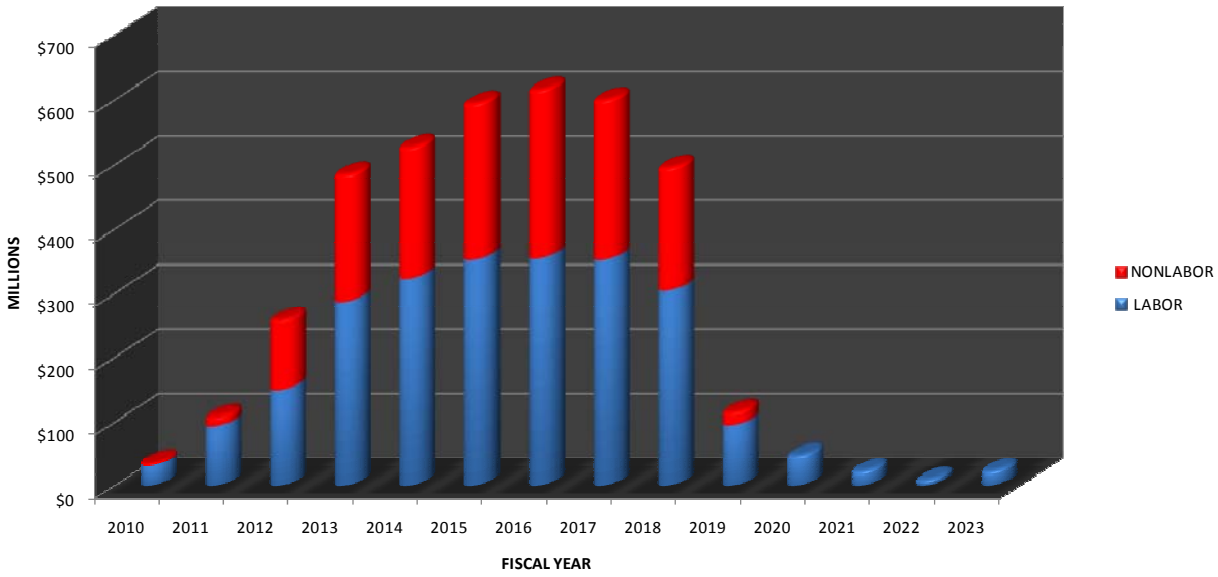

Figure 7. Updated Total Project Cost Estimate Spend Plan by Labor – Non-labor

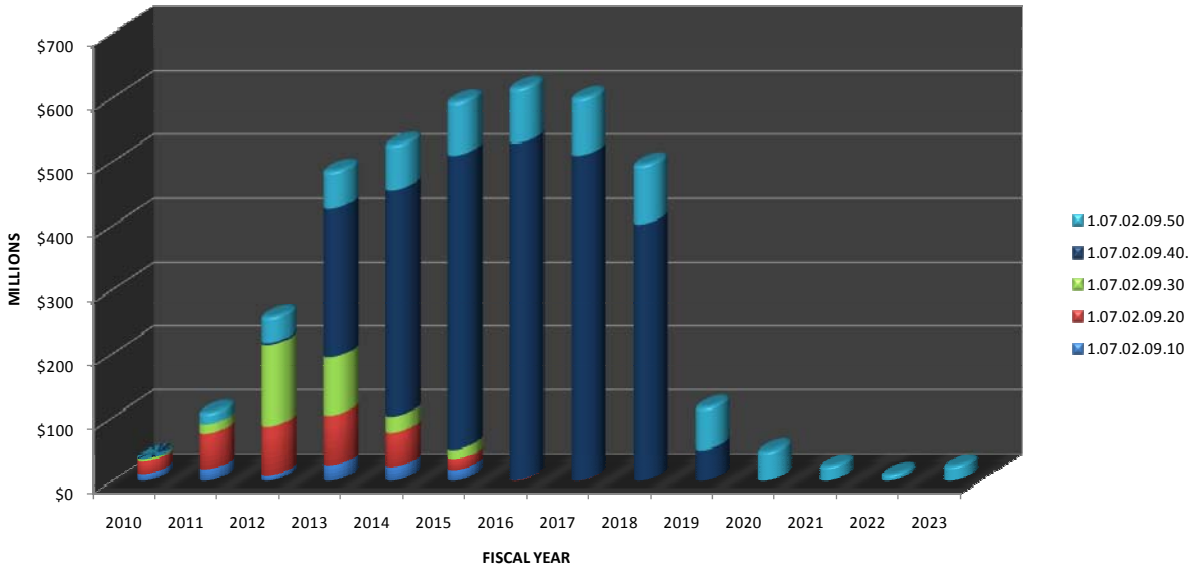

Figure 8. Updated Total Project Cost Estimate Spend Plan by WBS

These costs must be escalated to Year of Expenditure dollars to account for the impacts of inflation and rising prices. These costs have been escalated in two separate calculations that are consistent with the pricing model and practices used by B&W.

For Y-12 labor, which is labor supplied by B&W (including direct hire construction labor), B&W applies *forward pricing* to the wage rates. Forward pricing is similar to escalation in many respects in that it includes the direct effects of inflation on wage rates. Forward pricing, as used by B&W, also includes the impact of anticipated changes to B&W Cost Center rates that result from modifications to divisional overheads, fringe benefit packages, and similar items. For materials and subcontracts (M&S), the B&W pricing model simply applies an Escalation Rate. The applied rates are illustrated in Table 25. The costs for Y-12 Labor and M&S include the contingency calculated at the 85% CL. The overall contingency was apportioned to Labor and M&S by year based on the ratio of the yearly costs to the total base cost. These costs also include B&W Site Overheads.

As illustrated in Table 24, the escalated TPC estimate with allocation of the 85 % CL contingency results in a $6,835.8 million TPC estimate (including cost expenditures through March FY2010). The spending profile illustrating the costs by year and escalation applied to develop a total project cost with contingency is illustrated in Figure 9. Detailed calculations are provided in Appendix G.

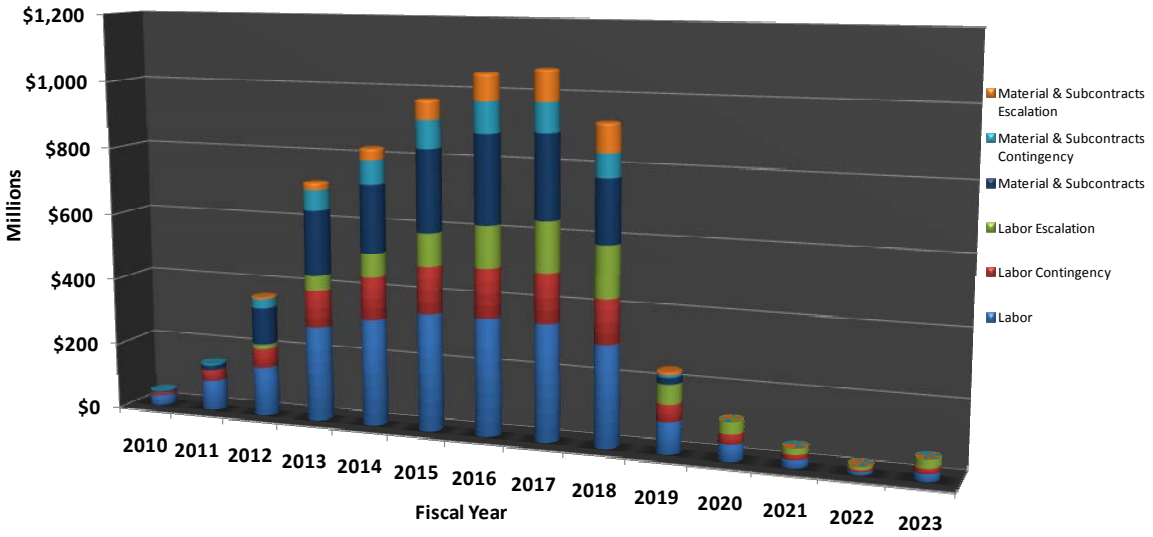

Figure 9. Updated Total Project Cost Estimate Annual Profile – 85% Confidence Level

In response to a YSO request, several alternative scenarios covering various confidence levels (50% CL, 85% CL, 95% CL), cost uncertainty inclusion or exclusion, contingency risk basis (federal-headquarters, federal-YSO, M&O risk contingency), and escalation rates (Y-12 rates, DOE CFO rates) are provided in Appendix H.

Table 24. 85% Confidence Level Contingency Allocation

FISCAL YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	TOTAL
	(Dollars in Millions)														
MII Estimate															
Y-12 Labor Cost (in FY11 dollars)	$31.3	$93.6	$149.6	$287.6	$322.8	$351.5	$353.4	$351.3	$304.8	$95.5	$47.6	$22.4	$9.0	$22.4	$2,442.8
Materials and Subcontracts (in FY11 dollars)	$3.8	$13.5	$107.1	$196.4	$203.9	$242.0	$261.5	$247.6	$189.6	$19.5	-	-	-	-	$1,484.9
Total MII Estimate	$35.1	$107.1	$256.7	$484.0	$526.7	$593.5	$614.9	$598.9	$494.4	$115.0	$47.6	$22.4	$9.0	$22.4	$3,927.7
Contingency 85% Confidence Level															
Contingency Allocated to Y-12 Labor	$9.4	$34.5	$58.2	$108.3	$124.9	$138.9	$143.3	$143.5	$128.4	$50.5	$29.6	$13.9	$5.6	$14.0	$1,003.0
Contingency Allocated to Material. & Subcontracts	$0.9	$3.7	$28.7	$61.9	$69.9	$83.6	$90.8	$86.1	$66.3	$6.9	-	-	-	-	$498.8
Total Contingency	$10.3	$38.2	$86.9	$170.2	$194.8	$222.5	$234.1	$229.6	$194.7	$57.4	$29.6	$13.9	$5.6	$14.0	$1,501.8
MII Estimate + Contingency															
Y-12 Labor Cost w/Contingency (in FY11 dollars)	$40.7	$128.1	$207.8	$395.9	$447.7	$490.4	$496.7	$494.8	$433.2	$146.0	$77.2	$36.3	$14.6	$36.4	$3,445.8
Material and Subcontracts w/Cont. (in FY11 dollars)	$4.7	$17.2	$135.8	$258.3	$273.8	$325.6	$352.3	$333.7	$255.9	$26.4	-	-	-	-	$1,983.7
Total MII Estimate + Contingency	$45.4	$145.3	$343.6	$654.2	$721.5	$816.0	$849.0	$828.5	$689.1	$172.4	$77.2	$36.3	$14.6	$36.4	$5,429.5
Escalation															
Escalation on Y-12 Labor Cost w/Contingency	-	-	$14.6	$44.7	$70.4	$99.9	$125.1	$149.4	$153.3	$59.6	$35.9	$19.0	$8.5	$23.6	$804.0
Escalation on Material and Subcontracts w/Contingency	-	-	$5.4	$21.3	$34.7	$56.7	$78.9	$92.4	$85.3	$10.4	-	-	-	-	$385.1
Total Escalation	-	-	$20.0	$66.0	$105.1	$156.6	$204.0	$241.8	$238.6	$70.0	$35.9	$19.0	$8.5	$23.6	$1,189.1
MII Estimate + Contingency+ Escalation															
Y-12 Labor Cost w/Contingency and Escalation	$40.7	$128.1	$222.4	$440.6	$518.1	$590.3	$621.8	$644.2	$586.5	$205.6	$113.1	$55.3	$23.1	$60.0	$4,249.8
Material and Subcontracts w/Contingency and Escalation	$4.7	$17.2	$141.2	$279.6	$308.5	$382.3	$431.2	$426.1	$341.2	$36.8	-	-	-	-	$2,368.8
Total Estimate To Complete	$45.4	$145.3	$363.6	$720.2	$826.6	$972.6	$1,053.0	$1,070.3	$927.7	$242.4	$113.1	$55.3	$23.1	$60.0	$6,618.6
Actual Cost of Work Performed (through March 21, 2010)															$ 217.2
Total Estimate At Complete															$6,835.8
Note: Totals are not exact due to rounding.															

Table 25. Labor and Materials/Subcontract Escalation Factors

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Labor Annual Forward Pricing Factor		7.01%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
Cumulative Forward Pricing Factor	1.0000	1.0701	1.1129	1.1574	1.2037	1.2519	1.3019	1.3540	1.4082	1.4645	1.5231	1.5840	1.6474
Materials and Subcontracts Annual Escalation Factor		4.00%	4.07%	4.11%	4.19%	4.26%	4.33%	4.40%	4.47%	4.54%	4.61%	4.68%	4.68%
Cumulative Escalation Factor	1.0000	1.0400	1.0823	1.1268	1.1740	1.2240	1.2770	1.3332	1.3928	1.4561	1.5232	1.5945	1.6691
Escalation factors for 2020 and 2021 were estimated by the USACE Team based on the trend of B&W's material escalation factors.													

7.0 UPDATED COST RANGE

7.1 Updated TPC Cost Range Calculation Methodology

The updated USACE cost range was developed in a three-step process (Figure 10).

1. An analysis of the expected accuracy of the MII cost estimate (hereafter referred to as cost accuracy uncertainty) was performed. This analysis provided a range of expected values for the MII cost estimate, referred to as the ETC cost uncertainty range. The ETC cost uncertainty range is expressed in FY2011 dollars.
2. Contingency was applied (as described in Section 6) to the endpoints of the ETC cost uncertainty range. For the lower end of the range, contingency calculations were based on the CSRA results at the 50% CL. For the upper end of the range, contingency calculations were based on the CSRA result at the 95% CL. These values represent lower and upper ends of the ETC cost range, and are expressed in FY2011 dollars.
3. The ETC cost range was then escalated to Year of Execution dollars (as described in Section 6.0) and actual costs to date are added. These escalated values then define the updated USACE cost range for the project.

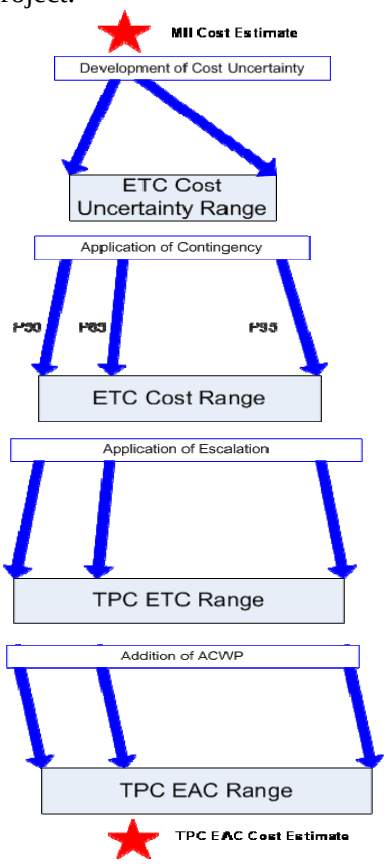

Figure 10. Development of the Updated USACE Cost Range

7.1.1 Cost Accuracy Uncertainty

In order to analyze the expected accuracy of the MII cost estimate and develop the cost uncertainty range, the MII cost estimate was evaluated at Level 3 of the WBS using AACEI Estimate Classes.

AACEI Estimate Classes provide a methodology for classifying cost estimates according to the degree of project definition and the estimating methodology used to develop the estimate. The method of assigning AACEI Estimate Class was based on:

- The level of project design definition. The level of project definition defines maturity and types of project planning, design, and engineering information available to the estimating process. These include project scope definition, requirements documents, specifications, project plans, drawings, calculations, and information from similar projects.
- The estimating methodologies used. Stochastic methods often involve simple or complex modeling based on inferred or statistical relationships between costs and programmatic and/or technical parameters. Deterministic methods tend to be straightforward counts or measures of units of items multiplied by known unit costs or factors.

The expected accuracy range is a secondary characteristic of the estimate class and was used as the basis for developing the cost uncertainty.

To accomplish this, an AACEI Class and Class Index designation was assigned to each Level 3 WBS element. Once the Class and Class Index were assigned to each WBS element, AACEI guidelines on the expected accuracy range for that Class and Class index were used to assign an accuracy range to each Level 3 WBS element.

A *Monte Carlo* analysis of the resulting ranges was performed and the quartile values for the distribution were examined. The initial cost uncertainty range was taken to be from the first quartile, to the third quartile. This includes the central 50% of the expected values and cuts off the lowest 25% and the highest 25% of the values. This establishes the ETC Uncertainty Range.

In order to develop an annual spend plan that corresponds to the endpoints of this range, the spend plans for each Level 3 WBS element were adjusted by the ratio of the endpoint to the overall MII cost estimate. These data sets were then fed into step two of the process, to develop the Contingency Allocation.

7.1.2 Contingency Allocation

Table 22 provides contingency values, as a percentage of the estimated cost, by WBS element and CL. These values were developed based on the CSRA and provide a methodology for allocating contingency to a specific WBS element at a specific CL. For example, a WBS element within WBS 1.07.02.09.40 that is estimated at $1,000,000 would have a contingency of $342,000 (34.2%) assigned to it at the 85% CL.

In developing the ETC cost range, contingency based on the 50% CL was allocated to the lower end of the ETC cost uncertainty range. The 50% CL identifies a risk neutral value and provides an

appropriate lower level for contingency allocation. Contingency based on the 95% CL was allocated to the upper end of the ETC cost uncertainty range. The 95% CL essentially incorporates the realization of all project risks and provides an appropriate upper level for contingency allocation. Use of the 95% CL as the basis for the upper end of the cost range was deemed appropriate, given the relatively flat contingency curve, the sharp increase in contingency between 95% CL and 100% CL, and YSO's request for cost estimate at the 85% CL.

These contingency allocations were then applied to the annual spend plans for each of the Level 3 WBS elements at the endpoints of the ETC cost uncertainty range. This resulted in an annual spend plan for each Level 3 element that includes contingency, but has not been escalated to Year of Execution dollars. These spend plans detail spending for labor and for materials/subcontracts separately, since different escalation rates are applied to costs for labor and materials/subcontracts.

7.1.3 Escalation Application

Table 25 identifies the factors that are used to escalate FY2011 dollars to the Year of Execution dollars. These factors are specific to labor and materials, and are applied on a year-by-year basis to the spend plan for each Level 3 WBS element. The escalated result for the lower endpoint of the cost range defines the lower endpoint of the TPC ETC cost range; the escalated result for the upper endpoint of the cost range defines the upper endpoint of the TPC ETC Range.

The actual costs to date are then added to the TPC ETC Range to generate the TPC Estimate at Completion (EAC) Range.

7.2 Updated Cost Range Calculation

7.2.1 Development of the Cost Uncertainty Range

As identified in Section 7.1.1, assignment of the AACEI Cost Estimate Class (and associated range) was based on project design definition and estimating methodologies. In this case, the facility and the support facilities are "structure-centric". As a result, the level of project definition and estimate maturity level is significantly determined by how well the facility structure is defined. The process areas are "process equipment-centric". As a result, the level of project definition and estimate maturity level is significantly determined by how well the equipment – including the procurement, installation, testing of that equipment, and the follow-on startup activities (pre-operational testing, cold operations, and readiness confirmation testing) are defined. In addition, many of the process areas will advance the "state of technology" through incorporation of new process technologies and the placement of current processes into glovebox operations.

Utilizing the EVMS information provided (percent completes as of March 21, 2010); the ICE team estimated the project design level of definition as shown in Table 26 and Appendix E.

Table 26. Relative Design Percent Complete

M&O WBS	Item	Weighted % Complete
1.07.02.09.20	Uranium Processing Facility	
1.07.02.09.20.05	Facility & Support	
1.07.02.09.20.05.10	Balance Of Plant	
1.07.02.09.20.05.10.10	Site Preparation	51.92
1.07.02.09.20.05.10.20	Support Facilities	15.49
1.07.02.09.20.05.10.40	Power Supply	14.65
1.07.02.09.20.05.10.45	Substation	2.61
1.07.02.09.20.05.20	Processing Facility	
1.07.02.09.20.05.20.10	Building (UPF Main Bldg)	35.44
1.07.02.09.20.05.20.20	Building Services	39.63
1.07.02.09.20.05.20.30	Process Services	1.14
1.07.02.09.20.05.20.40	Facility Support Common Activities	39.57
1.07.02.09.20.05.50	HEUMF Connector	12.50
1.07.02.09.20.05.30	Information Technology	0.00
1.07.02.09.20.05.40	Security Systems	0.00
1.07.02.09.20.10	Process Areas	
1.07.02.09.20.10.10	Assembly, Disassembly, QE	
1.07.02.09.20.10.10.10	Assembly	12.60
1.07.02.09.20.10.10.20	Disassembly	9.12
1.07.02.09.20.10.10.30	Quality Evaluation	12.11
1.07.02.09.20.10.20	EU Metalworking	
1.07.02.09.20.10.20.10	Casting	9.36
1.07.02.09.20.10.20.20	Rolling & Forming	11.99
1.07.02.09.20.10.20.30	Machining	10.49
1.07.02.09.20.10.20.40	Turnings Cleaning & Conversion	9.96
1.07.02.09.20.10.30	Chemical Processing	
1.07.02.09.20.10.30.10	EU Purification & Metal Production	9.81
1.07.02.09.20.10.30.20	Chemical Recovery	11.05
1.07.02.09.20.10.30.30	Special Oxide Production	10.28
1.07.02.09.20.10.40	Process Support	
1.07.02.09.20.10.40.10	Product Certification	11.74
1.07.02.09.20.10.40.50	Analytical Services	10.33
1.07.02.09.20.10.40.70	Process Support Common Activities	45.31

Based on the Relative Design Percent Complete, a cost estimate class and index was assigned to each Level 3 WBS element. These assignments are shown in Table 27. Where an estimate class and index are assigned at Level 2 of the WBS, each of the Level 3 elements was judged to be in that estimate class.

Table 27. Updated Cost Estimate Classes

Description	AACE Class - Index	Accuracy Range	Rationale
1.07.02.09.10 Planning & Readiness - OPC	2-2	-10% - +20%	Estimated from PED; Rationale for PED applies
1.07.02.09.20 UPF Design (PED)	2-2	-10% - +20%	Design in process since CD-1 date (July 2007); significant information available from EVMS on % Complete; although draft or interim, major design documentation exists (see Table 22 for design basis)
1.07.02.09.30 Site Preparation & Long Lead Items	2-2	-10% - +20%	Design & engineering is >50% complete (see Table 23), Interim plot site drawings/plans, concrete specification & pour plan layout drawings, interim single line diagrams for electrical, and detailed site preparation execution plans
1.07.02.09.40.05 Facility & Support	3-4	-20% - +40%	Design is about 35% complete (see Table 23). Estimate could be developed from crews and material pricing from vendors or from 2010 RSM. Crews developed using estimator experience, vendor videos and modified RSM crews. Productivity developed using RSM productivity as a basis, modified to include additional crewmembers for transportation and high work, with site-specific crew makeup depending upon the item (walls, slab etc). Quantities were taken from the M&O's TPC books associated with the main building wall, slabs, steel, roof, platforms and stairs, and the HEUMF TPC data from the M&O. The work scope was determined from the draft WBS developed for the schedule and compared with estimating items from the TPC data. A few exceptions were noted and deleted or added as necessary. Construction sequences and pouring schedules were derived from assumptions in the TPC data. Quantity data in the TPC data was adequate.
1.07.02.09.40.10 Process Areas	3-4	-20% - +40%	Design is preliminary at just greater than 10% for each process area (see Table 23). Estimate prepared based on limited information, used development level sketches, draft plans, equipment lists/specifications, block schematics, indicated layout, process flow diagrams for main process systems, and preliminary engineered process equipment lists. Several "Build-to-Print" items had very limited detail for the estimator to derive an estimable cost for procurement or installation. Several items on the "Common Equipment to Process Areas" list had to be estimated to the most reasonable assumptive item due to the lack of information provided.
1.07.02.09.40.15 Project Integration	3-4	-20% - +40%	
1.07.02.09.40.40 Title III Engineering	3-4	-20% - +40%	
1.07.02.09.40.50 Construction Management & Indirects	3-4	-20% - +40%	
1.07.02.09.40.60 Preoperational Testing	4-5	-25% - +50%	No specific method to determine % complete. Estimate prepared based on limited information, using preliminary, draft Commissioning Strategy. Safety basis is preliminary draft. No specific plans, testing specifications, cold operations plan(s), operational drill Scenarios and emergency drill program. Too early for procedures and work control documents, passive design feature inspections, maintenance procedures, material handling and storage procedures, administrative procedures, or security procedures. Used combination of factoring, SME parametric techniques, and some "force detail' developed for less defined areas of the project.
1.07.02.09.50.05 YSO	4-5	-25% - +50%	
1.07.02.09.50.20 Project Execution Phase	4-5	-25% - +50%	
1.07.02.09.50.30 Mission Support	4-5	-25% - +50%	
1.07.02.09.50.40 Project Integration	4-5	-25% - +50%	Based on1.07.02.50.30 Mission Support rationale.

The MII cost estimate provided an ETC value for each of these Level 3 WBS elements. The indicated accuracy ranges were applied to these elements to develop a triangular distribution for their ETC. A cost uncertainty analysis was performed utilizing *Monte Carlo* techniques to determine the cost uncertainty associated with the MII cost estimate (Tables 28 and 29).

Table 28. Cost Uncertainty Analysis Inputs

WBS Element	Updated USACE Estimate	AACE Class	AACE Accuracy Range	Low Range	High Range
1.07.02.09.10.05 YSO	$16,728,192	2-2	-10% - +20%	$15,055,372.80	$20,073,830.40
1.07.02.09.10.20 Project Execution Phase	$26,026,238	2-2	-10% - +20%	$23,423,614.20	$31,231,485.60
1.07.02.09.10.40 Project Integration	$54,246,219	2-2	-10% - +20%	$48,821,597.10	$65,095,462.80
1.07.02.09.20.05 Facility And Support	$123,670,814	2-2	-10% - +20%	$111,303,732.60	$148,404,976.80
1.07.02.09.20.10 Process Areas	$105,630,699	2-2	-10% - +20%	$95,067,629.10	$126,756,838.80
1.07.02.09.20.15 Project Integration	$81,896,247	2-2	-10% - +20%	$73,706,622.30	$98,275,496.40
1.07.02.09.30 Site Preparation/Long Lead Items	$279,251,114	2-2	-10% - +20%	$251,326,002.60	$335,101,336.80
1.07.02.09.40.05 Facility & Support	$524,333,889	3-4	-20% - +40%	$419,467,111.20	$734,067,444.60
1.07.02.09.40.10 Process Areas	$830,851,126	3-4	-20% - +40%	$664,680,900.80	$1,163,191,576.40
1.07.02.09.40.15 Project Integration	$285,811,601	3-4	-20% - +40%	$228,649,280.80	$400,136,241.40
1.07.02.09.40.40 Title III Engineering	$258,927,300	3-4	-20% - +40%	$207,141,840.00	$362,498,220.00
1.07.02.09.40.50 Const. Management & Indirects	$526,014,358	3-4	-20% - +40%	$420,811,486.40	$736,420,101.20
1.07.02.09.40.60 Preoperational Testing	$112,020,820	4-5	-25% - +50%	$84,015,615.00	$168,031,230.00
1.07.02.09.50.05 YSO	$49,764,585	4-5	-25% - +50%	$37,323,438.75	$74,646,877.50
1.07.02.09.50.20 Project Execution Phase	$73,141,762	4-5	-25% - +50%	$54,856,321.50	$109,712,643.00
1.07.02.09.50.30 Mission Support	$200,474,342	4-5	-25% - +50%	$150,355,756.50	$300,711,513.00
1.07.02.09.50.40 Project Integration	$378,948,774	4-5	-25% - +50%	$284,211,580.50	$568,423,161.00
Total	**$3,927,738,080**				

The results of this Monte Carlo analysis are provided in Table 29 below.

Table 29. Cost Uncertainty Quartiles

Quartile (Confidence Level)	0th (0% CL)	1st (25% CL)	2nd (50% CL)	3rd (75% CL)	4th (100% CL)
ETC Estimate	$3,610,632,448	$4,064,614,181	$4,175,447,735	$4,291,098,005	$4,816,910,385

The initial ETC cost uncertainty range was taken to be from the first, or lower quartile, to the third, or upper quartile. The range is from $4.064 billion to $4.291 billion. This range includes the central 50% of the expected values and cuts off the lowest 25% and the highest 25% of the values.

Note that the MII ETC cost estimate ($3.928 billion) is less than the lower endpoint of this range. This results from the positive skew of the distribution for each of the individual WBS elements. Because of this, the ETC cost uncertainty range uses the MII ETC cost estimate as the lower endpoint of the ETC cost uncertainty range. Thus, the ETC cost uncertainty range used is $3.928 billion to $4.291 billion. These values, and the supporting spend plans by WBS, were passed forward for allocation of contingency.

7.2.2 Development of the Updated Cost Range

In this section, contingency is applied to the ETC cost uncertainty range in order to establish the ETC cost range for the UPF project. The ETC cost range is developed in FY 2011 dollars, which must then be escalated to the Year of Expenditure to establish the TPC ETC cost range for the project.

As a first step in the development of the ETC cost range, individual spends plans were developed at Level 3 of the WBS from the resource-loaded P3 schedule. For each Level 3 element, a spend plan that identifies the annual estimated spending for labor and for materials/subcontracts was developed.

To develop the ETC cost range, contingency values from Table 19 were applied to the endpoints of the ETC cost uncertainty range. For the lower end of the ETC cost range, the contingency percentages for the 50% CL were applied to spend plans for each Level 3 WBS element of the lower end of the ETC cost uncertainty range, using the 50% CL contingency percentage appropriate for that WBS element. For the upper end of the ETC cost range, the contingency percentages for the 95% CL were applied to spend plans for each Level 3 WBS element of the upper end of the ETC cost uncertainty range, using the 95% CL contingency percentage appropriate for that WBS element.

An example of this approach is shown in Table 30. In this example, contingency is applied to the spend plan for WBS element1.07.02.40.10 – Process Areas at the 50% CL. The spend plan from P3 for this WBS is shown in the first section of the table. This WBS element is completed in 2019, and subsequent years with zero costs are not shown in this example. Assuming the appropriate contingency percentage for WBS 1.07.02.09.40 at the 50% CL was 27.4% (Table 22), this percentage is calculated and added to the spend plan to develop the spend plan for the WBS with contingency.

Table 30. Updated USACE Cost Estimate Contingency Allocation Calculation

WBS Element	2011	2012	2013	2014	2015	2016	2017	2018	2019	ETC
Spend Plan for WBS 1.07.02.40.10 – Process Area (taken from the MII Estimate)										
Labor	$0	$0	$16.7	$49.7	$98.4	$111.9	$111.1	$79.4	$3.4	$470.6
Materials/ Subcontracts	$0	$0	$13.4	$33.8	$75.8	$88.2	$87.5	$59.3	$2.3	$360.3
Total	$0	$0	$30.1	$83.5	$174.2	$200.1	$198.6	$138.7	$5.7	$830.9
Contingency for WBS 1.07.02.40.10 – 27.4% of the MII Cost Estimate at 50% CL										
Labor	$0	$0	$4.6	$13.6	$27.0	$30.7	$30.4	$21.8	$0.9	$129.0
Materials/ Subcontracts	$0	$0	$3.7	$9.2	$20.8	$24.2	$24.0	$16.3	$0.6	$98.8
Total	$0	$0	$9.3	$22.8	$47.8	$54.9	$54.4	$38.1	$1.5	$227.8
Spend Plan for WBS 1.07.02.40.10 with Contingency at 50% CL (Unescalated)										
Labor	$0	$0	$21.3	$63.3	$125.4	$142.6	$141.5	$101.2	$4.3	$599.6
Materials/ Subcontracts	$0	$0	$17.1	$43.0	$96.6	$112.4	$1111.5	$75.6	$2.9	$459.1
Total	$0	$0	$38.4	$106.3	$222.0	$255.0	$253.0	$176.8	$7.2	$1058.7

These unescalated spend plans (based on the MII cost estimate) are summed for all Level 3 WBS elements at the 50% CL to determine the lower end of the cost range. Similarly, the unescalated spend plans (based on the $4,291.1 million upper end of the cost uncertainty range) are summed for all Level 3 WBS elements at the 95% CL to determine the upper end of the cost range. The ETC cost range (in unescalated FY11 dollars) is $5,133.3 to $5,980.5 million.

7.2.3 Updated Cost Range Calculation

To develop the updated cost range, the ETC cost range must be escalated on a year-by-year basis using the factors identified in Table 25. Because the escalation rates applied to labor and to materials/subcontracts are different, these must be escalated separately. Table 31 shows this calculation for one Level 3 WBS element.

Table 31. Updated USACE Cost Estimate Escalation Calculations

WBS ELEMENT	2011	2012	2013	2014	2015	2016	2017	2018	2019	ETC
Spend Plan for WBS 1.07.02.40.10 with Contingency at 50% CL (Unescalated)										
Labor	$0	$0	$21.3	$63.3	$125.4	$142.6	$141.5	$101.2	$4.3	$599.6
Materials/ Subcontracts	$0	$0	$17.1	$43.0	$96.6	$112.4	$111.5	$75.6	$2.9	$459.1
Total	$0	$0	$38.4	$106.3	$222.0	$255.0	$253.0	$176.8	$7.2	$1058.7
Escalation for WBS 1.07.02.40.10										
Labor	$0	$0	$2.4	$10.0	$25.5	$35.9	$42.7	$35.8	$1.8	$154.1
Materials/ Subcontracts	$0	$0	$1.4	$5.5	$16.8	$25.2	$30.9	$25.2	$1.1	$106.1
Total	$0	$0	$3.8	$15.5	$42.3	$61.1	$73.6	$61.0	$2.9	$260.2
ETC Spend Plan for WBS 1.07.02.40.10 (with Contingency at 50% CL and Escalated)										
Labor	$0	$0	$23.7	$73.3	$150.9	$178.5	$184.2	$137.0	$6.0	$753.7
Materials/ Subcontracts	$0	$0	$18.5	$48.5	$113.4	$137.6	$142.4	$100.8	$4.0	$565.2
Total	$0	$0	$42.2	$121.8	$264.3	$316.1	$326.6	$237.8	$10.1	$1318.9

These escalated spend plans are summed for all Level 3 WBS elements at the 50% CL to determine the lower end of the TPC ETC Range. Similarly, the escalated spend plans (based on the $4,291.1 million upper end of the cost range) are summed for all Level 3 WBS elements at the 95% CL to determine the upper end of the TPC ETC cost range. The TPC ETC cost range is $6,255.0 to $7,290.7 million. To this range, the UPF Project costs to date must be added. These costs include $217.2 million expended to March 21, 2010. This results in an overall TPC EAC range for the UPF Project of $6,472.2 to $7,507.9 million.

7.3 Updated Cost Range Summary

The updated USACE cost range is summarized in Table 32.

Table 32. UPF Updated USACE Cost Range Summary ($M)

Cost Item	Cost Range		
	Range Lower Boundary (50% Confidence Level)	Updated USACE Cost Estimate (85% Confidence Level)	Range Upper Boundary (95% Confidence Level)
MII Cost Estimate	$3,927.7		
Cost Accuracy Uncertainty	-		$363.4
Cost Accuracy Uncertainty Range	$3,927.7		$4,291.1
Contingency	$1,205.6	$1,501.8	$1,689.4
% of Cost Accuracy Uncertainty Range	30.7%	38.2%	39.4%
Subtotal - Cost Accuracy Uncertainty Range and Contingency	$5,133.3	$5,429.5	$5,980.5
Escalation	$1,121.7	$1,189.1	$1,310.2
% of Cost Accuracy Uncertainty Range and Contingency	21.9%	21.9%	21.9%
Subtotal - Cost Accuracy Uncertainty Range with Contingency and Escalation	$6,255.0	$6,618.6	$7,290.7
Actual Cost of Work Performed (as of March 2010)	$217.2	$217.2	$217.2
Total	$6,472.2	$6,835.8	$7,507.9

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