Office of Enterprise Assessments
Targeted Assessment of the
Y-12 National Security Complex
Uranium Processing Facility
Preliminary Safety Design Basis

April 2017

Office of Nuclear Safety and Environmental Assessments
Office of Environment, Safety and Health Assessments
Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

Acronyms

CFR	Code of Federal Regulations
CNS	Consolidated Nuclear Security, LLC
CRAD	Criteria and Review Approach Document
CSPS	Criticality Safety Process Study
CVS	Confinement Ventilation System
DID	Defense-in-Depth
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
FPS	Fire Protection System
HEUMF	Highly Enriched Uranium Materials Facility
IOI	Item of Interest
LLC	Limited Liability Corporation
LS	Limit State
MPB	Main Process Building
NCS	Nuclear Criticality Safety
NNSA	National Nuclear Security Administration
NPH	Natural Phenomena Hazards
NPO	NNSA Production Office
OFI	Opportunity for Improvement
PDSA	Preliminary Documented Safety Analysis
PFHA	Preliminary Fire Hazards Analysis
PHA	Preliminary Hazard Analysis
PSDR	Preliminary Safety Design Report
PSVR	Preliminary Safety Validation Report
SAB	Salvage and Accountability Building
SBRT	Safety Basis Review Team
SDC	Seismic Design Category
SSC	Structure, System, and Component
UPF	Uranium Processing Facility
UPO	UPF Project Office
Y-12	Y-12 National Security Complex

Office of Enterprise Assessments
Targeted Assessment of Y-12 National Security Complex
Uranium Processing Facility Preliminary Safety Design Basis

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted a targeted assessment of the Preliminary Safety Design Report (PSDR) and Preliminary Safety Validation Report (PSVR) for the Uranium Processing Facility (UPF) at the Y-12 National Security Complex (Y-12). This targeted assessment focused on select aspects of the UPF highest hazard building, the Main Process Building, and sampled a spectrum of hazards and controls for general conformance to the requirements of DOE-STD-1189-2008, *Integration of Safety into the Design Process*. The PSDR reflected the current level of design maturity (i.e., 60 percent) based on preliminary systems-level details. This assessment is part of a series of targeted safety basis assessments of nuclear facility design and construction projects at selected DOE sites.

This assessment addressed whether aspects of the PSDR and PSVR conformed to the requirements of DOE-STD-1189-2008 and DOE Order 420.1C, *Facility Safety*, for the development, review, and approval of the UPF safety design documents. The assessment was not a full compliance assessment of UPF preliminary safety design documents. In reviewing a vertical slice of selected aspects of the PSDR and supporting hazard analysis, EA examined the summary of the hazards analyses in the PSDR, along with key documents that included the Preliminary Fire Hazards Analysis (PFHA), preliminary hazard analysis (PHA) reports, and criticality safety process studies (CSPSs). EA also examined the safety functions, functional classifications, functional requirements, performance criteria, and identification of applicable design requirements for selected structures, systems, and components.

Overall, the PSDR conforms to the requirements of DOE-STD-1189-2008 and DOE Order 420.1C and adequately supports the progression of the UPF safety design. The PSDR adequately summarizes a thorough hazard analysis, which is supported by an appropriate set of PHAs and CSPSs. The consequence analyses used to support the hazard analysis and control selection are suitably conservative, and the hazard category 2 designation based on criticality potential is appropriate. The selected controls adequately protect the public, workers, and the environment for the analyzed events, and their functional classifications are appropriate. The PSDR safety strategy properly incorporates defense-in-depth controls. The PFHA adequately identifies and analyzes the hazards associated with UPF operations. The PSDR adequately addresses the safety functions, functional requirements, and performance criteria for the selected safety systems. Appropriate design criteria for this stage of design are included in the PSDR, including design criteria for defense-in-depth systems such as the Fire Protection System and Confinement Ventilation System.

During the review, EA commented on several discrepancies in the PSDR. Following UPF project team review and response to the comments, follow-on discussions resulted in resolution of all the EA comments. Eleven comments are closed pending verification of actions to resolve the identified issues in the Preliminary Documented Safety Analysis.

The PSVR was completed by a National Nuclear Security Administration Production Office NPO Safety Basis Review Team (SBRT), which included members with appropriate subject matter expertise. Overall, the PSVR addresses the approval bases, includes discussion of the modifications to the design that resolve the SBRT's safety concerns identified during the review, and appropriately concludes that there is no remaining impediment to proceeding to the final design phase.

Office of Enterprise Assessments
Targeted Assessment of the Y-12 National Security Complex
Uranium Processing Facility Preliminary Safety Design Basis

1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted a targeted assessment of the Preliminary Safety Design Report (PSDR) and Preliminary Safety Validation Report (PSVR) for the Uranium Processing Facility (UPF) at the Y-12 National Security Complex (Y-12). The targeted assessment evaluated the current UPF preliminary safety design basis and also evaluated, using a sampling basis, the principal products of the design process such as preliminary design media and calculations. This assessment is part of a series of targeted safety basis assessments of nuclear facility design and construction projects at selected DOE sites.

2.0 SCOPE

This assessment covered the development of the UPF preliminary safety design basis, which consisted of the PSDR and supporting documents that included the Preliminary Fire Hazards Analysis (PFHA). The assessment also included the review and approval of the PSDR by the National Nuclear Security Administration (NNSA) Production Office (NPO), which is documented in the PSVR.

3.0 BACKGROUND

Consolidated Nuclear Security, LLC (CNS), the management and operating contractor for Y-12, is designing and constructing the UPF. A CNS senior vice president, who reports to the CNS Chief Executive Officer, heads the UPF project team as the project director. The NNSA UPF Project Office (UPO) provides management and oversight of the project for NNSA. NPO provides direct support to UPO for independent review and approval of the safety design basis, and the NPO Deputy Manager is the Safety Basis Approval Authority.

The UPF project team is implementing the requirements and processes established in DOE Order 420.1C, *Facility Safety*, and DOE-STD-1189-2008, *Integration of Safety into the Design Process*, for the development, review, and approval of the facility's preliminary safety design basis. The PSDR, PSVR, and supporting analyses collectively comprise the UPF preliminary safety design basis.

The project's approach to UPF incorporates a multi-building strategy to replace a set of Y-12 Building 9212 processing capabilities. The set of Building 9212 processing capabilities planned for installation in the UPF includes highly enriched uranium casting (casting/pickling/vacuum annealing), special oxide production, chemical recovery, and support operations (e.g., maintenance shop, decontamination, and packaging). The multi-building layout of the UPF complex segregates the processes into buildings according to the magnitude of the nuclear safety and security risks, with the Main Process Building (MPB) containing the most hazardous processes. The Salvage and Accountability Building (SAB), next to the MPB, will house medium-risk support processes and services needing only a moderately robust structure. The Personnel and Support Building, connecting the MPB and SAB, will provide a material transfer area, a loading dock, an enclosed dock, and a personnel monitoring station to support transferring material and personnel to and from the complex and between buildings within the complex. A separate, standard industrial building, called the Mechanical/Electrical Equipment Building, will contain most of

the supporting utility equipment. Finally, the Highly Enriched Uranium Materials Facility (HEUMF) Connector will physically connect the MPB to the HEUMF.

The project received Critical Decision-1 (approval of the alternate selection and cost range) reaffirmation of the conceptual design in June 2012 and subsequently commenced preliminary design activities. In May and August 2015 respectively, NPO approved the UPF Conceptual Safety Design Report and Safety Design Strategy (revision 10). The UPF project team submitted the PSDR for NNSA review on June 10, 2016. NPO provided comments to the UPF project team; the resolution of those comments (among other things) resulted in an engineering change proposal that revised the PSDR. NPO issued the approved PSVR on December 22, 2016.

EA conducted a previous assessment of the safety design basis documents for the UPF in fall 2012, but did not identify any findings. Therefore, there were no items for follow-up during this assessment.

4.0 METHODOLOGY

DOE Order 227.1A, *Independent Oversight Program*, describes and governs the DOE independent oversight program. EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use varying terms to document specific assessment results. In this report, EA uses the terms "deficiencies, findings, and opportunities for improvement (OFIs)" as defined in DOE Order 227.1A. In this report, less significant issues that, if left unresolved, can potentially arise to a deficient condition are defined as "discrepancies."

As identified in the approved EA plan (*Plan for the Office of Enterprise Assessments Targeted Assessment of the Y-12 Site Uranium Processing Facility Preliminary Safety Basis, July 2016*), this targeted assessment considered requirements for the UPF preliminary safety design basis documents from Title 10 to the *Code of Federal Regulations* (CFR) Part 830, DOE Order 420.1C, DOE-STD-1189-2008, and DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. For the PSDR and PSVR review, EA used selected objectives and criteria from the EA Criteria and Review Approach Document (CRAD) 31-29, *Review of Nuclear Facility Preliminary Safety Basis Development (Rev. 0)*, to guide the assessment. In particular, the PSDR assessment utilized the lines of inquiry in the General Information, Hazard and Accident Analysis, and Preliminary Design sections of the CRAD's first criteria, which govern the hazards and accident analysis and preliminary design of safety structures, systems, and components (SSCs).

EA independent oversight assessments are not structured to thoroughly review all aspects of the preliminary safety design basis, but rather focus strategically on selected aspects of nuclear safety that are essential to ensuring effective protection of co-located workers and the public. By performing a vertical slice sampling review of selected aspects of the PSDR and supporting hazard analysis, the assessment addressed line management preparation, review, and approval processes that ensure integration of safety into design. EA examined key documents such as the PFHA, preliminary hazard analysis (PHA) reports, and criticality safety process studies (CSPSs). EA also conducted meetings with key UPF project team personnel responsible for developing the preliminary safety design basis documents and toured areas of Y-12 Building 9212 currently housing processes within the assessment sample. Appendix A lists the members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment. Appendix B provides a detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment that are relevant to the findings and conclusions.

EA generally uses a comment and response process to address issues identified during its review of safety basis documents. During the review, EA provided comments on the PSDR to the UPF project team, and received written responses back. Follow-on discussion of the comments in subsequent meetings resulted in closure of a number of the initial comments. The final UPF project team responses satisfactorily resolved the remainder of the comments, through stated actions to address the issues in the Preliminary Documented Safety Analysis (PDSA). Eleven comments, identified as discrepancies in the discussion of the results, are closed pending verification of the stated actions. None of the identified discrepancies are deficiencies or findings. Attachment 1 contains a summary of the discrepancies that are discussed in this report.

5.0 RESULTS

Criteria: The PSDR will demonstrate the adequacy of the hazard analyses and the selection and classification of hazard controls, including consideration of the application of the principles associated with the hierarchy of controls. (DOE-STD-1189-2008, Section 6.3)

The PSDR should demonstrate the adequacy of the hazards analyses and the selection and classification of the hazard controls, based on the maturity of the preliminary design; apply the principles associated with the hierarchy of controls; and include important safety design aspects in the preliminary design. These safety design aspects include:

- Site information of the type that can affect UPF nuclear safety
- Summary of the hazard analyses, including process hazards evaluation, fire hazards analysis, and criticality safety evaluation
- Selected safety SSCs and their safety function, functional classification, and required seismic and other natural phenomena hazards (NPH) design criteria and applicable design code of record
- Functional requirements and performance criteria (including applicable design requirements from the supporting DOE guides) for safety class and safety significant SSCs
- Documentation of implementation of the nuclear safety design criteria of DOE Order 420.1C, Chapter 1.

The first two subsections of the results evaluate these safety design aspects of the PSDR. The last subsection evaluates the Federal review and approval of the PSDR using DOE-STD-1104-2014.

5.1 Hazard Analysis

5.1.1 General Information

EA reviewed the general information and the site characteristics in the PSDR to verify that, at this maturity of preliminary design, the information is sufficient to support the hazard analysis.

The UPF preliminary design is defined as 60 percent complete. The supporting process flow diagrams and process and instrumentation drawings are consistent with the preliminary level of design and sufficient to support the hazard analysis at the system level. The site characteristics in the PSDR provide sufficient information to understand the hazards associated with NPH and external hazards and site environmental considerations affecting the safety design basis. In particular, the UPF project team completed extensive modeling and analysis of the NPH associated with seismic hazards and external flooding at the site. The PSDR also adequately describes nearby Y-12 facilities and their interfaces with UPF.

5.1.2 Hazard Identification

EA reviewed the implementation of procedure Y74-95-801, *UPF Hazardous Material Identification and Screening*, for compliance with the requirements in DOE-STD-1189-2008.

RP-OP-801768-A006, *Hazardous Material Estimates for the Preliminary Safety Design Report*, adequately identifies specific locations, such as cabinets, tanks, and workstations, where concentrations of hazardous material are stored relative to process equipment and hazards. Projections for the maximum anticipated quantities of hazardous materials are suitable based on the preliminary level of design maturity. These projections are based on preliminary process and instrumentation drawings and general arrangement drawings and process flow diagrams (revision 0), and include margin to account for design elements still in development (e.g., adding ten percent of tank volumes to account for materials in piping systems). An additional report, RP-EF-801768-A066, *Preliminary Hazard Identification and Screening for the Uranium Processing Facility*, identifies a subset of the hazardous materials warranting additional analysis (in the process-specific hazard analyses).

The hazard identification and screening implementation is adequate overall; however, AR-SH-801768-A003, *Chemical Compatibility Analysis of the Uranium Processing Facility*, did not fully address the possible hazards associated with unintentional chemical reactions. The scope of the chemical compatibility analysis was limited and did not include large quantities of chemicals (e.g., oxidizers in quantities over 40 pounds) in Table A.2, Materials not Requiring Further Analysis, of RP-EF-801768-A066. In response to this discrepancy, the UPF project team committed to revise the chemical compatibility analysis to include large quantities of materials from Table A.2.

5.1.3 Hazard Evaluation

EA reviewed the hazard analysis to determine whether an appropriate spectrum of facility and process upset events was considered. EA reviewed the analyzed hazard scenarios and potential effects of events related to explosions, loss of confinement, earthquakes, and earthquake-induced fires. The assessment also evaluated the supporting consequence calculations to verify that unmitigated analyses for workers and the public were appropriately conservative.

The UPF project team prepared an appropriate set of PHAs to support the PSDR, including an integrating PHA providing common information to all of the PHAs, building PHAs addressing NPH and external hazards, and process-specific PHAs. The integrating PHA provides an overview of the UPF hazard analysis process, a description of the hazard identification and screening process, a description of the hazard analysis tools and techniques, and a list of potential engineered controls. The MPB PHA contains three sections (MPB, HEUMF Connector, and Utilities and Services) that suitably cover the facility-level hazards including earthquake, flooding, criticality, and fire, for each of the building sections. Finally, PHAs appropriately evaluated each process through a “what-if” analysis or hazard and operability analysis for fires, explosions, loss of confinement, criticality accidents, external hazards, and NPH events. The hazard analysis tables in the PHAs demonstrate a thorough, questioning analysis. The select use of hazard and operability analysis aids in the repeatability and transparency of the process.

An appropriately conservative set of consequence calculations supports the hazard analysis and SSC functional classification. DAC-EF-801768-A024, *Consequence Calculations for the Uranium Processing Facility*, documents the calculations that support the consequence binning of hazard event scenarios (e.g., fires, spills, nuclear criticality accidents) in the hazard analyses. Notably, the potential hazard events in the MPB result in low radiological or toxicological consequences to the public, so the PSDR identifies no safety class SSCs or design basis accidents. The most significant postulated hazards result from fires,

explosions, and criticality events, which result in moderate consequences to the co-located workers and high consequences to the facility workers.

The PSDR provides a sufficiently detailed hazard analysis. Table 3.7-1 summarizes the hazard events, including the event description, summary of causes, frequency/consequences, and both safety significant and defense-in-depth (DID) controls. The safety SSCs identified in the PSDR are consistent with the logic in the hazard analysis and the functional classification requirements. Their designation as safety SSCs focuses appropriately on the prevention of criticality events or process hazard events, such as explosions, that can result in serious consequences (e.g., fatality or serious injury) to the facility worker. Those SSCs elevated to the safety significant functional classification are suitably described and appropriately classified, and their NPH design bases are provided.

5.1.4 Nuclear Criticality Safety

EA reviewed the documentation supporting the identification of criticality controls for conformance to DOE-STD-3007-2007, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*. The review focused on the functional classification of SSCs chosen as criticality controls and the thermal protection of passive design features that prevents potential criticality accidents resulting from loss of geometry controls during facility fires.

CSPSs, completed for each process, analyze the potential for nuclear criticality accidents and identify controls that will prevent potential accidents. Each CSPS identifies the design requirements and presents a set of controls for prevention of a nuclear criticality accident for normal and credible abnormal events. RP-EN-801768-B002, *UPF Criticality Control Review*, evaluates the SSC controls identified in the CSPS against the criteria in Appendix K of Y70-68-001, *Criticality Safety Approval/Requirements Development, Review, and Approval*, for elevation of controls to the functional classification of safety significant and provides an adequate technical basis for the decisions. Overall, the process is well defined and the integration of the nuclear criticality safety (NCS) controls into the PSDR is adequate.

The PFHA (revision 0) Chapter 19, *Fire Prevention/Protection Controls for NCS Items of Interest*, includes analysis of the potential fire exposure to the NCS Items of Interest (IOIs) resulting from fires in the MPB. IOIs are SSCs designed to prevent a nuclear criticality accident due to exposures from a fire. In support of PSDR development, the UPF project team evaluated the impact of fires on the IOIs and issued several reports documenting the controls for protecting IOIs in a fire event.

Selection of controls to protect IOIs is appropriately based on fire exposure evaluations and analysis. COI-EN-801768-A006, *List of NCS Items of Interest (IOIs) for Fire Protection*, documents the assessment of the vulnerability of NCS IOIs to the major fire hazards/sources. This comprehensive technical analysis involves a qualitative analysis and quantitative fire modeling to evaluate the potential for fire induced thermal damage to the IOIs. Identified fire exposure zones (i.e., areas where threshold damage to an IOI may occur during a fire) establish minimum safe distances between selected fire sources and IOIs. In the event an IOI is within a fire exposure zone, the IOI is binned into one of six control packages (i.e., control strategies) designed to further mitigate the risk of exposure to fire. These control packages include passive measures (e.g., separation distances and protective wraps) and administrative controls, and exclude the intervention of sprinklers for the major fire events. Following submittal of the PSDR, the initial control strategies were modified and implemented in the PSDR through ECP-EF-801768-A001, *PSDR NCS IOI Revised Strategy*. The control packages provide multiple layer DID protection to mitigate fires in fissile material areas and protect NCS IOIs from failing to meet their criticality safety function; however, the effectiveness of these control packages under postulated fire conditions is not evaluated in the PFHA.

Overall, the PSDR adequately implements the criticality safety strategy identified in the Safety Design Strategy (revision 10), which focuses on preventing an inadvertent criticality event through implementation of the double contingency principle. The selected NCS engineered design feature requirements and administrative controls for UPF are in accordance with DOE-STD-3007-2007. The NCS controls documented in the CSPSs and PFHA and integrated into the PSDR are generally adequate; however, EA identified two discrepancies. The first discrepancy involved the effectiveness of the sprinklers installed in high ceiling areas, which is indeterminate since the ability of the Fire Protection System (FPS) to meet its safety function and performance criteria, as a layer of protection DID control, has not been adequately evaluated in the PFHA. The second discrepancy related to the PFHA, which does not explicitly discuss the control packages that protect the NCS IOIs and evaluate their effectiveness under postulated fire conditions. The UPF project team committed to address these discrepancies in the PDSA.

5.1.5 Preliminary Fire Hazards Analysis

EA reviewed the UPF PFHA, along with the supporting design documents, to evaluate the fire hazard identification and hazard analysis processes and resulting fire hazard controls. EA reviewed the analyzed fire scenarios and potential effects of events related to explosions, loss of confinement, earthquakes, and earthquake-induced fires.

The PFHA addresses appropriate nuclear safety requirements and objectives and is consistent with the requirements in DOE Order 420.1C. The PFHA identifies potential fire hazards and scenarios that adequately support functional classification of fire protection SSCs. In addition, the PFHA analyzes and evaluates major fire hazards, and proposes fire prevention and exposure control strategies (for instance, design features, combustible loading restrictions, and spill containment). The PSDR adequately integrates the analysis in the PFHA through a comprehensive evaluation of the fire scenarios and potential damage to the process buildings and supporting critical equipment.

The PFHA adequately identifies and analyzes the hazards associated with UPF operations and identifies a broad set of fire hazard controls. Nonetheless, the analyses of two fire hazard events in the PSDR are incomplete. These analyses involve a postulated fire in the HEUMF connector that involves two powered industrial trucks and a fire event at the Personnel and Support Building loading dock that could potentially migrate into the material pass-through area affecting both the MPB and the SAB. The PFHA and PSDR conclude that the fire will not propagate into the interior of the MPB or the SAB; however, contributing fire risks (e.g., fire severity, credible fire loss, and contaminated water runoff) were not fully evaluated. The UPF project team committed to address the discrepancies in the PDSA.

5.2 Preliminary Design

5.2.1 Safety System Functional Classification and Design Criteria

EA reviewed the PSDR to verify that the functional classification of select MPB safety SSCs is appropriate and that adequate design criteria for these systems are identified. EA also reviewed the Safety Detection and Response System to assess whether the safety functions, functional requirements, and performance criteria are technically correct.

PSDR Section 3.2.4.1 describes the methodology and criteria for safety functional classification of hazard controls. This description includes classification of controls that protect against both radiological and chemical hazardous releases. The discussion on functional classification of hazard controls adequately incorporates the criteria and requirements from DOE-STD-1189-2008. The UPF PSDR hazard and consequence analysis has determined low impacts to the public and hence there are no safety class

controls.

The PSDR clearly identifies the safety functions for credited safety systems and provides the criteria to evaluate whether or not the safety systems can perform the safety functions when required. In most cases, the Chapter 4 description includes the safety functions, functional requirements, performance criteria, and any open technical issues, including planned changes to the design. The safety functions of credited controls are consistent with the hazard analysis. The functional design requirements adequately address the nuclear safety-related hazards that they must prevent or mitigate, and the system evaluations adequately assess control performance. The PSDR also provides adequate descriptions of the support systems and interfaces for each control. EA identified a discrepancy related to the need for a Specific Administrative Control (or engineered control) to ensure that an adequate purge volume (i.e., a hazard control to prevent potential explosions) was available. The UPF project team committed to analyze the control and ensure its effectiveness.

The PSDR provides an adequate description of the Safety Detection and Response System (Section 4.3.1.2), which is a facility-level, safety significant SSC. The PSDR section addresses the requirements of DOE-STD-1189-2008 and includes appropriate statements of the safety function to support design, a summary system description, functional requirement statements for the identified safety functions, and performance criteria for each functional requirement. The section also contains a brief evaluation of the ability to meet the functional requirements; for example, conservative design features, safe failure modes, and environmental design, and a short discussion of support systems and interface design.

Nonetheless, the system description and system evaluation do not address the seismic sensors or discuss the location and mounting requirements for the seismic sensors. The PSDR also does not discuss the functional and performance requirements for personnel evacuation and does not fully describe the interfaces between the Safety Detection and Response System and the supported process systems. The UPF project team agreed to address these discrepancies in the PDSA.

The PSDR addresses safety SSC design criteria generally in Section 4.3, with reference to the safety and instrumentation design criteria and lists of some key design requirements. Individual sections in Chapter 4 address design criteria for the specific safety SSCs (e.g., Section 4.3.1.2.4), and Appendix B contains additional details for applicable orders, guides, codes, and standards. The design of UPF and control selection includes proper consideration of seismic design criteria.

In summary, while some identified discrepancies remain to be addressed, the PSDR appropriately classifies safety systems; establishes their safety functions, functional requirements, and performance criteria; and identifies design criteria for this preliminary stage of design maturity.

5.2.2 Defense-in-Depth Systems

EA also assessed whether design criteria for selected DID systems meet the requirements of DOE Order 420.1C and DOE-STD-1189-2008.

The UPF project team uses a multi-layer approach, in accordance with the requirements of DOE Order 420.1C and DOE-STD-1189-2008, to prevent or mitigate the unintended release of hazardous materials to the environment. The PSDR describes a DID approach for confinement of hazardous materials and identifies a number of SSCs as providing a DID function for hazardous events such as fires and explosions, including the MPB structure, the FPS, and the Confinement Ventilation System (CVS). The consequences due to a failure of any or all of these DID controls in a severe event, such as seismically induced facility-wide fire, do not exceed low consequences to the public.

The FPS is an integral part of the overall layer of protection strategy for reducing risk associated with fires and is designed to control fires by providing sufficient water supply, flow, and pressure. The fire protection design and system components, along with mitigation techniques, minimize the risk associated with fire, in accordance with DOE Order 420.1C, and meet the design objectives of DOE-STD-1066-2012, *Fire Protection*. The fire protection SSCs include automatic wet pipe sprinkler systems designed to minimize the size of the fire, two-hour, seismically designed fire barriers for life safety and structural integrity purposes, and a fire water ring main with independent supplies for redundancy.

The CVS, described in PSDR Section 2.5.3.2, consists of primary, secondary, and tertiary confinement systems. The primary confinement system includes the areas that may have airborne contamination during normal operation. The secondary confinement system surrounds the primary confinement system to confine airborne contamination resulting from a breach of a primary confinement barrier. The tertiary confinement system includes the areas where airborne contamination is not normally expected. Each confinement system consists of a set of physical barriers (e.g., gloveboxes, walk-in enclosures, or rooms) serviced by a ventilation system. Chapter 14 of the PFHA provides a detailed description of the CVS and includes the general response of the system to fires and its protection from fires within the MPB.

The CVS is identified as a DID control in three analyzed fire events, in the MPB East and West and the SAB, in PSDR Table 3.7-1, Summary of Analyzed Events. For these events, the CVS design meets its design function by filtering potential releases of radiological material through the exhaust flow paths that include High-Efficiency Particulate Air filters to reduce exposure to co-located workers and the public.

The FPS and CVS design criteria are consistent with the requirements of DOE Order 420.1C, as are the current seismic design categories. Based on the consequence analysis, the PSDR appropriately designates the CVS and the FPS as DID for protection of the workers. The functional classification of the systems as DID meets the requirements of DOE-STD-1189-2008.

Overall, the UPF preliminary safety design basis adequately addresses the requirements of DOE-STD-1189-2008 and DOE Order 420.1C. The PSDR appropriately integrates the supporting hazard analyses with the nuclear safety design and is consistent with the hierarchy of controls in the order. The PSDR also incorporates important nuclear facility design requirements; for example, multiple layers of protection, minimizing material-at-risk, and successive physical barriers for protection against radioactive material releases. The preliminary system safety designs also address the use of multiple means to maintain processes in a safe condition.

5.3 Preliminary Safety Validation Report

Criteria: The reviewer should refer to DOE-STD-1189-2008, Appendix I, for detailed guidelines on the expected contents for a PSDR and the reviewer of the PSDR shall also confirm that it adequately addresses the following safety design basis aspects for the preliminary design phase (items 1 through 6 below). (DOE-STD-1104-2014, Section 8.5)

EA reviewed the PSVR to determine its adequacy as the approval basis for the PSDR, as required by DOE-STD-1104-2014.

The NPO Safety Basis Review Team (SBRT) included members with appropriate subject matter expertise in nuclear safety, criticality safety, fire protection, systems engineering, and operations. The SBRT concluded that the PSDR presents sufficient information for the preliminary design, meets the format and content requirements of DOE-STD-1189-2008, and acceptably resolves SBRT comments. Based on this assessment, the SBRT recommended approval of the UPF PSDR.

Generally, the PSVR addresses the approval bases identified for review in DOE-STD-1104-2014, which include verification that the design requirements of DOE Order 420.1C are met, assessment that the PSDR presents a viable design solution based on the safety functions identified in the hazard analysis, and confirmation that the appropriate design criteria are identified. For each approval basis, the PSVR provides a satisfactory basis for recommending approval of the PSDR, including a summary of the contents of the PSDR. The PSVR appropriately includes a condition of approval to require that select combustible controls be captured as Specific Administrative Controls in the PDSA. The PSVR also identifies that four of six conditions of approval generated during review of the PSDR are closed, noting that closure of the remaining conditions of approval will be accomplished in the PDSA.

The SBRT recorded more than 100 comments on the PSDR, categorized according to their significance and formally transmitted to the UPF project team for resolution. After the transmittal, the SBRT held meetings with UPF project team management and staff to obtain resolution of comments and develop a path forward. Comment resolution discussions led to a revision to the criticality safety strategy to protect NCS IOIs, which is implemented through an engineering change proposal for the PSDR (ECP-EF-801768-A001). The PSVR adequately summarizes the important issues raised in the SBRT comments, whose resolutions are to be implemented in the PDSA, and includes the agreed-on resolutions to specific SBRT comments as an enclosure.

Overall, the PSVR includes discussion of the modifications to the design that resolve the SBRT safety concerns and appropriately concludes that there is no remaining impediment to proceeding to the final design phase.

6.0 FINDINGS

EA identified no findings or deficiencies during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified no OFIs during this assessment.

8.0 ITEMS FOR FOLLOW-UP

During review of the PDSA, EA may follow up to verify closure of actions for the comments provided to the UPF project team.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment:	September 6-15, 2016
Offsite Assessment:	September 19-23, 2016
	November 14-18, 2016

Office of Enterprise Assessments (EA) Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Deputy Director, Office of Environment, Safety and Health Assessments
C.E. (Gene) Carpenter, Jr., Director, Office of Nuclear Safety and Environmental Assessments
Patricia Williams, Director, Office of Worker Safety and Health Assessments
Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

William A. Eckroade
John S. Boulden III
Thomas R. Staker
William E. Miller
C.E. (Gene) Carpenter, Jr.
Michael A. Kilpatrick

EA Site Lead for Y-12

Jimmy S. Dyke

EA Assessors

James O. Low - Lead
Kevin E. Bartling
Roy R. Hedtke
David J. Odland
Joseph J. Panchison
Joseph E. Probst
Jeffrey L. Robinson

Appendix B
Key Documents Reviewed, Meetings/Interviews, and Observations

Documents Reviewed

- AR-SH-801768-A003, Chemical Compatibility Analysis of the Uranium Processing Facility, Rev. 1, 1/2016
- COI-EN-801768-A006, NCS Items of Interest and Fire Protection Control Option Review, 3/2015
- CSPS-EN-801768-BMU-B001, Nuclear Criticality Safety Process Study of Batch Makeup, Rev. A, 2/2016
- CSPS-EN-801768-CAL-B001, Nuclear Criticality Safety Process Study of Calcination, Rev. A, 1/2016
- CSPS-EN-801768-CAST-B002, Redacted Control Set from the Criticality Safety Process Study of the Normal Casting Process, Rev. A, 12/2015
- CSPS-EN-801768-UTIL-B001, Nuclear Criticality Safety Process Study of Utilities, Rev. A, 1/2016
- DAC-EF-801768-A024, Consequence Calculations for the Uranium Processing Facility, Rev. 5, 12/2015
- DAC-F000Y12-F-0004, Technical Basis for Y-12 Site Specific Dispersion Parameters, Rev. 0, 5/2012
- DE-PE-801768-A012, UPF Natural Phenomena Design Criteria, Rev. 7, 10/2015
- DE-PE-801768-A029, UPF Instrumentation Design Criteria, Chapter 3, Section 800 of the UPF Design Criteria, Rev. 6, 1/2015
- DG-EF-801768-A004, UPF Structure, System, and Component (SSC) Analysis, Rev. 1, 5/2016
- ECP-EF-801768-A001, PSDR NCS IOI Revised Strategy, 10/2016
- FH-EF-801768-A002, Preliminary Fire Hazards Analysis of the Uranium Processing Facility, Rev. 0, 9/2016
- FH-EF-801768-A002, Preliminary Fire Hazards Analysis of the Uranium Processing Facility, Rev. A, 10/2015
- HZ-FS-801768-A005, UPF Hazardous Material Identification (UPFHMI), Rev. B0, 9/2015
- PSVR-9226-1, Preliminary Safety Validation Report for the Uranium Processing Facility Preliminary Safety Design Report, RP-EF-801768-A076, Revision 0, June 2016 and Engineering Change Proposal, ECN-EF-801768-A001, Dated October 4, 2016, December 22, 2016
- RP-EF-801768-A023, Integrating Preliminary Hazard Analysis for UPF, Rev. C, 5/2016
- RP-EF-801768-A048, Preliminary Hazard Analysis for SOX (SMP), Rev. C, 5/2016
- RP-EF-801768-A049, Preliminary Hazard Analysis for SOX (OMP), Rev. C, 5/2016
- RP-EF-801768-A051, Preliminary Hazard Analysis for Casting, Rev. B, 5/2016
- RP-EF-801768-A053, Preliminary Hazard Analysis for General Building – MPB, Rev. B, 5/2016
- RP-EF-801768-A066, Preliminary Hazard Identification and Screening for the Uranium Processing Facility, Rev. B, 9/2015
- RP-EF-801768-A068, Preliminary Hazard Analysis for General Building – SAB, Rev. B, 5/2016
- RP-EF-801768-A076, Preliminary Safety Design Report for the Uranium Processing Facility, Rev. 0, 6/2016
- RP-EF-801768-A078, Hazard Categorization for the Preliminary Design of the UPF, Rev. A, 10/2015
- RP-EF-801768-A079, Preliminary Analysis of Accidents at the Uranium Processing Facility, Rev. A, 5/2016
- RP-EF-801768-A080, Preliminary Evaluation of Radiological and Toxicological Exposure for the Uranium Processing Facility, Rev. A, 1/2016
- RP-EF-801768-A085, Analysis of Fires in the Uranium Processing Facility, Rev. A, 5/2016
- RP-EF-801768-A189, Evaluation of Fire Exposure to NCS IOIs in MPB West, Rev. A, 6/2016

- RP-EN-801768-B002, UPF Criticality Control Review, Rev. A, 6/2016
- RP-FS-801768-A003, UPF Safety Design Strategy, Rev. 10, 7/2015
- RP-OP-801768-A006, Hazardous Material Estimates for the Preliminary Safety Design Report, Rev. B, 9/2015
- WP-EN-801768-A005, Building Structure Study for Nuclear Criticality Safety, Rev. 1, 3/2015
- Y70-68-001, Criticality Safety Approval/Requirements Development, Review, and Approval, Rev. 03/24/2016
- Y74-95-801, UPF Hazardous Material Identification and Screening, Rev. 0, 5/2014

Meetings/Interviews

CNS

UPF Project

- Safety Analysis Engineers
- Facility Safety Engineers
- Manager of Engineering
- Deputy Manager of Engineering
- Project Engineering Manager, Nuclear Safety Engineering
- Deputy Nuclear Safety Manager
- Fire Protection Engineers
- Mechanical Engineers – Fire Protection
- Criticality Safety Chief
- Criticality Safety Engineers
- Instrumentation & Control Supervisor
- Senior Director, Nuclear Safety

Y-12 Building 9212

- Criticality Engineer
- Operator
- Facility Safety Lead
- Process Manager
- Casting Manager

NPO/UPO

- NPO Safety Basis Review Team Lead

Observations

- Building 9212 Tour

Attachment 1
Summary Discrepancies

1. The PSDR and the supporting chemical compatibility analysis, whose scope did not include oxidizers in quantities over 40 pounds, did not fully address the possible hazards associated with unintentional chemical reactions (as required by DOE-STD-1189-2008, Appendix C).

2. The effectiveness of the sprinklers installed in high ceiling areas to perform their function within a layer of protection for fires (in accordance with DOE-STD-1066, Paragraph B.4.4) has not been adequately evaluated in the PFHA.

3. The set of criticality safety controls packages that result from the strategy employed in the Criticality Control Review and carried forward into the PSDR have not been evaluated for effective performance under the postulated fire conditions documented in the PFHA.

4. The technical analysis and supporting documentation (expected by DOE-STD-1189-2008, Section 7.3) for two fire related scenarios does not consider contributing fire risk factors for evaluating consequence as a result of fire, such as fire severity and credible fire loss and contaminated water runoff.

5. There is no Specific Administrative Control provided to ensure adequate purge volume is available in exhaust systems (Primary Confinement System/Process Offgas) to support controls that prevent potential explosions.

6. The system description and evaluation for the Safety Detection and Response System are incomplete; for example, the seismic sensors and interfaces with supported process systems are not addressed.