NNSA National Nuclear Security Administration

Department of Energy
National Nuclear Security Administration
Washington, DC 20585

JUN 27 2012

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Mr. Chairman:

I am following up on our May 2, 2012, response to your April 2, 2012, letter to National Nuclear Security Administration (NNSA) Administrator Thomas P. D'Agostino concerning the Uranium Processing Facility (UPF) preliminary design and integration of safety into the design. In your letter you requested a report and briefing that describes NNSA's approach for demonstration of the adequate integration of safety in the preliminary design and addresses: (1) the resolution of issues identified by the Defense Nuclear Facilities Safety Board (Board) and NNSA with respect to the safety documentation for UPF; (2) resubmitting and approving the Preliminary Safety Design Report; and (3) completing a technical independent project review of the integration of safety into the design for UPF as required under DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*.

On May 2, 2012, we responded with an initial report that addressed the Board's specific concerns where agreement had been achieved on the approach and indicated that we would provide a comprehensive report within 60 days to address and close outstanding issues. This was followed by a briefing on May 7, 2012. The enclosed report provides this comprehensive response to your outstanding concerns.

The project remains committed to ensuring protection of the public, workers and environment through integration of safety into design. We look forward to continuing our dialogue with you and to resolving issues and providing the technical bases to support them. If you have any questions, please contact the UPF Federal Project Director, Mr. John Eschenberg, at (865) 574-5620.

Sincerely,

for Donald L. Cook
Deputy Administrator
for Defense Programs

Enclosure

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60-Day Comprehensive Report to the Defense Nuclear Facilities Safety Board in Response to Defense Nuclear Facilities Safety Board Letter Concerning the Safety Control Set and Preliminary Safety Design Report for the Uranium Processing Facility at the Y-12 National Security Complex (Y-12)

1. Introduction

On April 2, 2012, the Defense Nuclear Facilities Safety Board (DNFSB) sent a letter to the National Nuclear Security Administration (NNSA) concerning the Uranium Processing Facility (UPF) preliminary design and integration of safety into the design. That letter requested a report and briefing that describes NNSA's approach for demonstration of adequate integration of safety in the preliminary design. On May 2, 2012, the NNSA responded that the project remains committed to the principles in DOE-STD-1189 and transmitted (along with a briefing to the Board on May 7, 2012) an initial report addressing several of the specific concerns with a commitment to follow up the report with a comprehensive report within 60 days that addresses all outstanding issues. This report provides the approach and resolution to the following areas:

- Integration of Safety in Design
- Hazards Analysis
- Representative and Bounding Design Basis Accidents
- Bounding unmitigated/conservative consequence methodology
- Safety Controls
- Other Technical Areas
- Federal Oversight

2. Integration of Safety in Design

The NNSA is committed to follow the requirements of DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, and the principles of DOE-STD-1189, *Integration of Safety in Design*. These requirements include the completion of a Preliminary Safety Design Report and a Technical Independent Project Review (TIPR) prior to Critical Decision (CD)-2 and a Preliminary Documented Safety Analysis (PDSA) prior to CD-3.

The scope of the UPF will be executed in several subprojects and the scope of each subproject is being developed to meet the objectives of the recent CD-1 reaffirmation. Each subproject will have a separate CD-2 and CD-3. With the exception of general site and utility readiness subprojects, there will be a completed PDSA that supports each CD-3 prior to approval of each subproject. Construction for the initial general site and utility readiness and Y-12 site preparation subprojects do not impact the safety basis of the UPF and, hence, do not require completion of the PDSA. The PDSA will contain safety functions, functional requirements, and performance criteria for the CD-3 approval of applicable subprojects and will contain PSDR-level information for the remaining process SSCs and facility-level safety systems (e.g., fire sprinkler systems and criticality accident alarm system.

3. Hazards Analysis

The UPF Project is committed to a robust safety analysis that supports the design. Reviews of some of the UPF Hazard Evaluation Studies (HES) have identified the following potential systemic issues:

- Initial conditions or key assumptions may have precluded identification of potential controls.
- Unclear or disconnected traceability of developing controls through HES, Accident Analysis (AA), and the Preliminary Safety Design Report (PSDR).
- Incomplete development of Safety Functions and Functional Requirements to be included in AA design analyses and calculations (DACs).
- Incomplete consideration of all potential events that could require the identification of controls for protection of the worker or public.

The HES documents are being reviewed and revised as necessary to address these issues. The review and revision process is being performed in the following two stages:

- **HES documents that support the PSDR** – All HES documents that support the PSDR are being reviewed for the identified issues and the results of the review are being documented. If the review identifies new controls are necessary or that a change in functional classification is required, then the HES will be amended and the required changes will be addressed in the revised PSDR. The current schedule for the completion of this activity is the end of July 2012, with the submittal of the PSDR to the NNSA Production Office (NPO) Y12 (formerly the NNSA Y12 Site Office) shortly thereafter, pending review of the TIPR recommendations.
- **HES documents that support the PDSA** –HES documents that support ongoing design changes and the PDSA are in progress. All HES documents in revision for the PDSA will include corrections to the identified issues. The HES documents to support the PDSA for the first applicable CD-3 will be completed during the time period from the fourth quarter of fiscal year (FY) 2012 through the end of FY 2013.

In addition, the PSDR is being revised to incorporate the NPO comments that are grouped into the following functional areas:

- Post-Seismic Fire Analysis
- Small Fires that do not actuate the Fire Suppression System/ Self-Protective actions
- Crediting Fire Barriers/Bounding Fire Event (Full facility fire vs. Process Area fires)
- Safety Functions/Functional Requirements/Performance Criteria/SDC Rating
- Bounding Criticality Accident Parameters (Single Pulse vs. Multiple Pulse; Total Fissions, Collocated Worker exposure, etc.)
- Chemical Reactions
- Criticality Safety
- Miscellaneous Control Issues

4. Representative and Bounding Design Basis Accidents

The UPF safety analysis is ensuring that representative and bounding design basis accidents are being evaluated to conform to DOE-STD-1189 and DOE-STD-3009. Specific design basis accidents that are being evaluated include:

- Natural Phenomena Hazards (NPH) Events (Earthquake, High Winds/tornado, Excessive precipitation, Flooding, Lightning)
- Fires (including single and multiple process areas as well as a full facility fire)
- Nuclear Criticality Accidents
- Energetic events (e.g., Hydrogen explosion, Dust explosion, Steam overpressure, Chemical energetic events)
- Hazardous material releases (such as spills)
- Aircraft Crash
- External fire/explosion

Specific attention is being placed to ensure that a “bounding” accident analysis does not mask the need for evaluating more representative accidents or mask control sets necessary to address less-limiting accident scenarios. The Board letter identified the generic concern about ensuring accident analyses properly treat the design basis accident scenarios and actions are underway to ensure a robust safety basis is developed and integrated into the design. As part of the stated concern, four examples were presented to illustrate the point. While clearly understanding and appropriately addressing the Board's broader concern, the following addresses the specifics noted in the Board letter.

- **Fire Scenarios**. The least developed design basis accidents in the existing PSDR are those associated with fire scenarios, which also happen to be scenarios with the greatest potential for hazardous material releases. All fire scenarios, both large and small are being re-evaluated. These evaluations will be documented in a new HES document(s) along with revised consequence calculations and incorporated into the PSDR. In the interim, the UPF project identified a base set of fire scenario controls to address toxic material releases and included this set in a revision to the Safety Design Strategy. The revised Safety Design Strategy was approved by NPO Y12 on June 18, 2012.
- **Post-Seismic Fire Analysis**. The purpose of the post-seismic fire analysis is to provide additional data to support the design capacity of the fire water supply. There is also a need to identify the post-seismic fire scenario for the purposes of establishing an unmitigated accident analysis for the event. The seismic fire analysis is being reworked to account for fires with unique or easily ignitable hazards (e.g., pyrophoric material) and to account for random fires. For more probable fire ignitions, a deterministic approach will examine all such fire hazards to determine the potential demand on water supply. The occurrence of random fires will be predicted based on industry data interpreted by fire protection engineers for applicability to the UPF. The potential water demand determined by this analysis will be compared to NFPA-13 requirements to ensure that sufficient water supply is available to the fire suppression system. The scenarios identified by the deterministic evaluation will also be used to determine a representative, unmitigated seismic fire accident analysis. The results of this analysis will be incorporated into the PSDR.

- **Nuclear Criticality Accident Consequences**. The board letter identified that the criticality accident scenario was not reasonably conservative with regard to the dose consequences. The PSDR did not adequately reflect the fission yields actually used in the analysis or the dose consequences. The actual total fission yields used were 3.3 x 10^{18} fissions for the collocated worker (2-hr exposure, multi-excursion event) and 1.0 x 10^{19} fissions for the public boundary (8-hr exposure multi-excursion event) based on DOE-HDBK-3010-94. The doses calculated from these fission yields conservatively assumed a dose quality factor of 10 for both neutron and gamma radiation. The analysis is being revised to provide doses based on more applicable dose conversion factors and the text in the PSDR will be corrected. The dose consequences from the first analysis show doses to the collocated worker approaching the 100 rem criterion. Although results from more recent analysis show lower dose consequences, the UPF Project is conservatively classifying the exterior walls as safety significant for radiation shielding from a criticality accident to protect the collocated worker. This has been documented in the Safety Design Strategy, RP-FS-801768-A003, Rev. 6, which has been approved by NPO Y12. The shielding provided by the exterior wall design reduces the dose to the extent that residual uncertainties in postulated fission yields are bounded.
- **Beyond Design Basis Accidents** – The UPF project will identify and evaluate beyond design basis accidents per the requirements of DOE-STD-1189-2008 as part of the PSDR revision process.

5. Bounding Unmitigated Analysis/Conservative Consequence Methodology

The calculations performed to determine the site specific deposition velocity are consistent with DOE Safety Bulletin 2011-02 and the input parameters used in the calculations satisfy the "reasonably conservative" requirement of the safety bulletin. During a PSDR review in October 2011, the DNFSB staff recommended performing sensitivity analyses on dose calculations to ensure that the methodology is reasonably conservative. During the past nine months, the UPF project has provided various sensitivity calculations, has had many technical interactions with the DNFSB staff, and has responded to several series of questions regarding the sensitivity calculations. The UPF project has performed a parametric evaluation to determine the 95th percentile χ/Q values for combinations of the following:

- dispersion coefficients (e.g., rural, open country, and urban) covering a range of surface roughness values from 3 cm to 100 cm;
- deposition velocities (DV) ranging from 1 cm/s to no deposition (i.e., 0 cm/s);
- minimum wind speeds of 0.5 m/s and 1 m/s; and
- stability class determinations.

This approach examines both of the options presented in Office of Health, Security, and Safety Safety Bulletin 2011-02, *Accident Analysis Parameter Update*, by evaluating the impact of a default DV of 0.1 cm/s and by developing a site-specific deposition velocity. The results are used to establish a conservative dispersion coefficient to be used in dose consequence calculations.

The UPF Project has requested and received a Central Technical Authority (CTA) position regarding the development and use of the dispersion coefficient to resolve this issue. (Reference memorandum from T. P. D'Agostino to D. K. Hoag subject: Central Technical Authority concurrence with the Y-12 site specific determination of Deposition Velocity and Dispersion Coefficient for the Uranium Processing Facility, dated June 14, 2012). Given the results of the parametric evaluation and the CTA position, the project will use a dispersion coefficient (χ/Q) of 1.4E-4 sec/m^3 for the PSDR, which is a reasonably conservative value for the Y-12 site.

The UPF project is also reviewing the technical justification for the damage ratios of material at risk used in the dose calculations as well as the material at risk inventories to ensure that the overall source term for the dose calculations is reasonably conservative.

6. Safety Controls

The key to effective integration of safety into design is to perform proper safety analyses and to integrate the requirements that flow out of the safety analyses into the design. Early in design, the requirements are written in a general, top level summary so that the design team has flexibility to identify the most effective and efficient means of implementing the requirements. As design progresses, the functional requirements and the performance criteria need to be specific so that final design and procurement of structures, systems, and components (SSC)s will perform the safety function as intended by the safety analysis. The current revision of the PSDR has general, top level functional requirements specified, which is not appropriate for CD-2. The UPF project is revising the functional requirements and where applicable, the performance criteria so that specific compliance can be demonstrated in the design. This is part of the PSDR revision effort.

Accordingly, safety design strategies become more specific as the hazards are analyzed. The UPF Safety Design Strategy, RP-FS-801768-A003, Rev. 6, was revised significantly and conditionally approved by NPO Y12 on April 5, 2012. A subsequent change was submitted to NPO Y12 on May 1, 2012 to address the NPO Y-12 condition of approval. This revision of the Safety Design Strategy enhanced the position of several key areas. A summary of the changes are as follows:

- UPF Confinement Strategy

  The UPF confinement strategy involves a series of defense-in-depth physical barriers to prevent or mitigate the unintended release of radioactive materials to the environment. These barriers include:

  - Process systems including tanks of aqueous uranium systems designed to Seismic Design Criteria (SDC)-2, Limit State (LS)-D
  - Storage racks containing fissile material designed to SDC-3, LS-D
  - All building structural walls designed to SDC-3, LS-D
  - Zone 1B of the confinement ventilation system with HEPA filtration designed to SDC-2, LS-D (new upgrade per the SDS)

The UPF Project is committed to a robust, DOE Order 420.1B compliant confinement ventilation system for UPF that minimizes the potential release of radioactive materials during normal operation and during and following accidents. To accomplish this objective, the UPF Project is designing a portion of the Confinement Ventilation System (Zone 1B) to SDC-2. The Zone 1B confinement ventilation system provides a defense-in-depth function of confinement during and following a design basis seismic event. The seismic design requirements applied to this system (including interfaces with other systems such as confinement dampers, piping isolation valves, and required support systems including power) are SDC-2, Limit State D. The Zone 1B confinement ventilation system, in combination with the facility structure, is designed to provide active exhaust ventilation, which generates sufficient in leakage of air across any openings (e.g., doorways, penetration seals) that are not seismically qualified during post-seismic conditions. The UPF main facility structure below the utility floor and within exterior walls serves as the physical confinement boundary, and the Zone 1B confinement ventilation system will direct potential releases of radiological material through HEPA-filtered exhaust flow paths.

- Nuclear Criticality Safety Strategy

The UPF Project is committed to ensure fissile material operations remain subcritical during and following a seismic event. Where SSCs whose natural phenomena hazards initiated failure can by themselves, lead to a criticality accident, those SSCs will be designed to SDC-3 as stated in the project's safety design strategy. For example, fissile storage racks maintain spacing between fissile units and should the storage rack collapse during a seismic event, the resultant configuration may not remain subcritical. These racks will be designed to SDC-3. On the other hand, some solution systems contain low equity, low fissile concentration solutions (i.e., below the subcritical concentration limits) and under seismic conditions the resulting configuration would remain subcritical regardless of seismic design. These systems would remain at SDC-2.

The UPF Project is also committed to protecting workers from criticality events. To that end, three significant approaches are being taken. These are:

(1) **Shielding protection for the workers outside the facility**. The external building walls are being credited for shielding in the PSDR to demonstrate that doses to the collocated worker are below 5 rem.
(2) **Shielding protection for workers inside the facility during evacuation**. Dose calculations have been performed for typical evacuation routes. The facility design is being reviewed to include shielding as a defense in depth measure to mitigate doses that may be received during evacuation.
(3) **Post Seismic Evacuation**. The UPF Project has an evacuation strategy designed to meet the purpose of ANSI/ANS-8.23 in lieu of seismically qualifying the Criticality Accident Alarm System (CAAS) detection components. The concern associated with qualifying the CAAS is the ability to show survivability and operability of detection components in a post-seismic environment. The ability to seismically qualify CAAS detection components will be explored with CAAS vendors. Currently, the strategy is implemented through the Seismic Detection and Response System and the facility fire

alarm system. As design proceeds, more effective implementation options may be identified, such as using the criticality accident alarm system annunciation components in lieu of the fire alarm system for evacuation purposes. NNSA will review the evacuation strategy as part of the Technical Independent Project Review.

- Fire Protection Strategy

  The fire protection strategy is based on an approach that involves preventing fires and preventing release of hazardous materials where fire hazards exist. There is much emphasis on the prevention of fires in the design that includes systems such as defense-in-depth inerting systems and isolation devices for hazardous materials. The mitigating features of the facility are robust and include safety significant internal fire barriers designed to SDC-3, Limit State D criteria, and safety significant automatic fire suppression systems designed to SDC-3, Limit State D criteria.

  An under-developed fire scenario involves the release of toxic materials. The UPF project is currently evaluating fire scenarios involving toxic materials and will document the results in the upcoming revision to the PSDR. While the analysis is ongoing, a preliminary evaluation identified SSC controls that could be incorporated into the design so that design risks are minimized. These SSC controls are specified in the Safety Design Strategy and include:

  - Ensuring the hazardous material of concern is only stored in areas where coverage is provided by a fire suppression system equipped with fast response sprinkler heads to ensure activation by the fire of concern;

  - storing the hazardous materials of concern in containers that are designed to withstand a standard transportation basis fire; and

  - minimizing the amount of hazardous material stored in a process area by limiting physical storage positions.

  A comprehensive revision to the Project Fire Hazards Analysis (PFHA) is being performed. The analysis is scheduled to be completed in October 2012, which is after the PSDR completion. However, key elements of the PFHA are being documented separately for incorporation into the PSDR.

Enhancements of the Safety Design Strategy revise the functional classifications and seismic qualifications of some systems. It is important to note that these revisions have not significantly impacted the design of the UPF because of the robust baseline design. Protection of the environment, the workers, and the public continues to be the goal of the project. The current status of key safety SSCs is identified in Table 1.

Table 1. Functional Classification of Key SSCs for UPF.

Key Structure, System, or Component	Current Safety Design Strategy
Facility Structure	SS/SDC-3
Fire Barriers	SS/SDC-3
Fire Suppression System, Water supply, Fire Alarms	SS/SDC-3
Process Confinement	SDC-2
Confinement Ventilation System	SDC-2*
Emergency Power (Uninterrupted Power Supplies)	SS / SDC-2 or 3 depending on application
Backup Power	SDC-2*
Criticality Prevention	SS based on analysis /SDC-2 or SDC-3**
Explosion Prevention	SS/SDC-2
Process Shutdown	SS/SDC-2
Seismic Detection and Response System	SS/SDC-3
Criticality Accident Alarm System	SS/SDC-1

*Portion of confinement ventilation system and associated support systems designed to SDC-2 limit state D to provide an active, post seismic defense in depth function of minimizing potential release of radioactive material.
**SSCs whose NPH-initiated failure can by themselves lead to a criticality accident shall be designed to SDC-3

7. Other Technical Areas

The enclosure to the DNFSB Board letter identified a couple of open issues with regard to some of the elements of the preliminary design. The status of these open issues is:

- **Structural Summary/System for Analysis of Soil Structure Interactions (SASSI) issue**. Modeling and design assumptions have been made in the structural analyses and design of the UPF structures, as is always the case when such analyses and designs are performed. Some of these assumptions clearly require separate studies to validate the decisions, and some of the decisions are based on industry practices and/or engineering judgment. Most of the assumptions based on industry practice and/or engineering judgment have been validated by previous engineering studies, whose results have been incorporated into industry standards and codes. The interpretation and implementation of these types of modeling and design assumptions are one of the primary reasons that industry standards require independent design verification and peer review of the analyses and designs, which is being performed for the UPF project. In addition, the B&W Y-12 technical staff is reviewing the analyses and design of the UPF structures.

The NPO Y-12 Structural Peer Review Team (PRT) and the B&W Y-12 review have identified several modeling and design assumptions that have required separate studies to ensure the decisions are adequate. Some of these studies are related to finite element mesh sizes, modeling and design of composite beams, modeling of openings in walls, design of beams, etc. These studies have been or are being reviewed to ensure the NPO Y-12 PRT and B&W Y-12 agree that the assumptions have been validated. The reviews and resolution of any concerns will be resolved before the final design is completed.

Based on evaluation and agreement with the concerns identified in the DNFSB letter, a separate dedicated review of DAC will be performed by B&W Y-12 and the structural design subcontractor to identify specifically these modeling and design assumptions. A plan for performing the review and documenting the assumptions has been developed and provided for DNFSB staff review. These assumptions for each DAC will also be provided to the DNFSB staff for their review. The project will evaluate any additional concerns that the DNFSB staff may have and ensure an appropriate technical disposition.

The Board letter identified some issues with SASSI, which are being addressed by a DOE integrated program that is being coordinated with the DNFSB staff. The implementation of the program began in December 2011, and the schedule for completion of the DOE program is in alignment with the CD-3 schedule for the UPF project. Based on the SSI analyses performed for the UPF project, it is not anticipated that the results from the DOE program will impact the UPF design. Therefore, it is appropriate for the resolution of the SASSI issues to occur in parallel with the ongoing design of the UPF project.

- **Instrumentation and Control (I&C) Single Failure Implementation in Design**. The enclosure identified that the approach to I&C design for safety significant controls was consistent with the requirements of DOE Order 420.1. However, it was stated in the enclosure that the approach had not been fully detailed in the Control System Philosophy for the Y-12 (UPF) and thus has not been implemented for the design of safety significant instrumented systems. The requirements to use IEEE-379, *IEEE Standard Application of the Single Failure Criteria to Nuclear Power Generating Stations*, and IEEE-384, *IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits* for safety significant instrumentation and controls were specified in revisions to the UPF Design Criteria in May of 2011 (DE-PE-801768-A029, Rev. 4, *General Design Requirements*, and DE-PE-801768-A039, Rev. 4, *System Design Requirements*) and are being implemented in the design.

8. Federal Oversight

The UPF Federal project team is currently staffed full time with 9 federal employees and 5 contracted support personnel. In addition, the UPF Federal project team receives limited matrix support from the NPO Y-12 and NNSA Headquarters of about 4 FTEs. The near term staffing plan is to fill 7 key positions. These key positions will focus on priority management functional areas and not specific subject matter expertise. The first addition to the existing staff is a contracting officer and the plan is to fill this need with a federal employee. The remaining 6 key positions will be filled with contracted support. The 6 key positions are: Nuclear Safety Management (focus on nuclear safety processes/procedures and schedule implementation); Engineering Management (focus on design processes/procedures and design/nuclear safety integration); Technology Management (focus on technology design, development, maturity and integration); Risk Management (focus on risk processes/procedures and integration with project cost and schedule); Schedule Management (focus on schedule development, maintenance, integration, completeness); and Project Management (focus on project systems and practices). The plan is to staff these 7 key positions by the end of calendar year 2012.

NNSA performed a review of project staffing for the UPF project, *Project Staffing Review of MOX Fuel Fabrication Facility, Waste Solidification Building, Pit Disassembly and Conversion Facility, Uranium Processing Facility, and Chemistry and Metallurgy Research Building Replacement*, dated April 14, 2010. The NNSA Staffing Review Committee evaluated the 2010 UPF staffing analysis against the Office of Engineering and Construction Management model and also developed a revised staffing model to account for “economies of scale” on major construction projects. With the addition of the 7 key positions, the UPF staffing will align with the Review Committee model.

UPF Federal project team staffing plan for 2013-2014 is to staff specific subject matter expertise positions such as fire protection engineer, confinement ventilation engineer, nuclear criticality safety engineer, nuclear quality assurance, construction oversight, etc. The current plan is to use contracted support to staff these positions. The projected staffing numbers for 2013-2014 based on the NNSA Review Committee model is in the range of 30-40. The current projects fall within this range. A detailed staffing plan is being prepared.