Department of Energy
National Nuclear Security Administration
Washington DC 20585

November 21, 2013

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

Dear Chairman Winokur:

This is in response to your letter of August 26, 2013, regarding integration of safety into design on the Uranium Processing Facility (UPF) project. The National Nuclear Security Administration (NNSA) has prepared the enclosed report addressing the "Open Issues with the UPF Safety Basis" identified by your staff during their review of the UPF Preliminary Safety Design Report (PSDR). The enclosed report provides a status for each open technical issue from your letter, identifies any actions still needed to resolve each technical issue, identifies any potential design changes, and provides an initial schedule for when the resolution actions will be completed. As you mentioned in your letter, I am also encouraged by the progress that the UPF project has made to improve integration of safety into UPF's design. I am confident that the UPF project will continue to improve execution of an effective safety basis program that will ensure safety controls are identified and incorporated into design.

The second element in your letter relates to NNSA's safety basis review and approval process; specifically, oversight of control selection and evaluation. NNSA is committed to ensuring a robust safety basis review and approval process is in place. The NNSA Production Office (NPO) has requested independent individuals from the Environmental Management Office of Safety Management, the NNSA Office of Safety and Health, and the Office of Science to perform an independent assist review of the NPO safety basis review and approval process. These individuals will bring both independent and specific experience in the implementation of DOE-STD-1189, *Integration of Safety into the Design Process*. The scope of the review includes personnel (background and depth of the safety basis review team), procedures, and products (safety basis review plan, preliminary safety validation report). The review will focus on control selection and evaluation with special attention to worker safety controls and criteria.

NNSA will schedule a briefing on the enclosed report as soon as it is mutually convenient. If you have any questions or need additional information, please contact Teresa T. Robbins, Acting Senior Scientific and Technical Advisor, NPO, at (865) 576-0841.

Sincerely,

Edward Bruce Held
Acting Administrator

Enclosure

Responses to DNFSB Letter Dated August 26, 2013, Rev. 2

Summary

The Defense Nuclear Facilities Safety Board (DNFSB) letter of August 26, 2013, to the Administrator of the National Nuclear Security Administration (NNSA) identified 13 issues that the DNFSB is following with regards to Uranium Processing Facility (UPF) design. These issues are associated with RP-EF-801768-A004, Rev. 1, *Preliminary Safety Design Report for the Uranium Processing Facility (U)*, and are being tracked by the UPF project to ensure that issue resolution occurs in a timely manner to preclude significant impacts to design.

Two of the issues are associated with controls for scenarios that could exceed either the co-located worker or the public toxicological exposure thresholds. Two other issues are associated with dose consequence methodology. The remaining nine issues are associated with hazards to facility workers. In all cases, resolution of the issues will be achieved in time to be incorporated into the design, as applicable.

The following sections summarize the status of each issue identified in the subject DNFSB letter. An abbreviated summary of the issue is presented, along with the current status of addressing that issue. Actions that are planned or in progress to resolve each issue are identified, as well as potential design changes that may occur to resolve the issue. In addition, the schedule for achieving final resolution is presented. The schedule is reported to the NNSA UPF Project Office (UPO), and any changes to the schedule on these issues will be coordinated through that office.

Issue #1 - Fires Involving Canned Subassemblies (CSAs)

Summary of Issue: The Safety-Significant fire protection system is credited to control fires to prevent energetic events or significant releases of toxicological material. For some scenarios, it has not yet been demonstrated that the fire protection system's documented functional requirements and performance criteria are sufficient to ensure that the system will perform its credited safety function.

Status: The effectiveness of the fire suppression system is dependent upon: (1) the heat flux necessary to cause energetic events or cause releases of toxicological materials that exceed co-located worker or public thresholds for safety; (2) the proximity of in-situ combustibles (i.e., fixed combustibles and normal operating quantities of consumable combustibles) to structures, systems, and components (SSCs) of interest; and (3) whether the sprinkler system will actuate prior to reaching damaging heat fluxes if sufficient combustibles are present to generate such a heat flux. In August, 2013, equipment layout drawings (ELDs) were issued for use, and a task team was established to identify the physical location of SSCs requiring protection as well as the types and quantities of combustibles. Along with design analyses and calculations (DACs), the team's data will be used to further refine the performance criteria of the sprinkler system and the effectiveness demonstrated by analysis.

Actions:

1. Identify the location of SSCs of interest within the facility as well as locations of in-situ combustibles using the new ELDs.
2. Prepare DACs to determine the heat flux necessary to cause an energetic release or toxicological material release that exceeds safe thresholds for the co-located worker or the public.
3. Document the analysis in the Preliminary Fire Hazards Analysis or applicable design basis fire report.
4. Incorporate design features as appropriate (e.g., mezzanine floors) resulting from the analysis into the design.

Potential Design Issues: The following types of design changes may be necessary to ensure the effectiveness of the fire suppression system:

- Design intermediate mezzanine floors to capture heat early and activate the fire suppression system sooner
- Apply fire resistant coatings to protect SSCs that need to maintain structural integrity
- Use fire-rated or resistive enclosures for storage or containment of combustible materials (e.g., double walled tanks for combustible liquids)

Schedule: A critical path in the schedule is to determine where mezzanine floors are required so that the building structural analysis may proceed. The use of localized fire protection measures such as fire-resistant coatings or fire enclosures is not a critical path schedule item. The current baseline schedule requires that the determination of mezzanine floor locations be established in the first quarter of Fiscal Year (FY) 2014. Relevant actions listed above to meet this determination will be completed to support this schedule. The effectiveness of the suppression system will be documented in either the Preliminary Fire Hazards Analysis (PFHA) or a separate design basis fire report and the DACs establishing heat flux performance criteria. All documents are projected to be complete in the third quarter of FY 2014.

<u>Issue #2 - Glovebox Fires</u>

Summary of Issue: Gloveboxes can house pyrophoric materials and components that contain hazardous, thermally reactive materials. Under normal operating conditions, these gloveboxes are provided with a defense-in-depth, inert gas atmosphere that does not allow combustion. Under certain scenarios (e.g., a seismic event), the inerting system may be postulated as being rendered inoperable in multiple gloveboxes, and if simultaneous fires are caused, the postulated fires could cause toxicological releases.

Status: The amount of combustibles (including pyrophoric materials) present in a glovebox that also contains hazardous, thermally reactive materials is limited by the process. The strategy for demonstrating safety is to document that the ignition sources and the types of combustibles inside a glovebox are insufficient to generate enough heat to result in a release of toxicological materials. Furthermore, the scenario requires simultaneous fires in multiple gloveboxes over the same significant duration in time before co-located and public thresholds are reached. The safety analysis will demonstrate that the scenario will not exceed the safety thresholds given the low combustible loading and the limited amount of toxicological materials present.

Actions:

1. Prepare DACs to determine the heat flux necessary to cause an energetic release or toxicological material release that exceeds safe thresholds for the co-located worker or the public.
2. Develop a DAC justifying that the heat fluxes released from combustibles inside a glovebox are insufficient to damage hazardous, thermally reactive materials.
3. Document the combined analysis in the PFHA or process accident analysis.

Potential Design Issues: None. Existing fire protection controls are effective for all but a seismic event that affects more than one glovebox. If the analysis shows that the release is possible, the limited amount of toxicological materials can be controlled through the use of Specific Administrative Controls (SACs), if necessary.

Schedule: Process areas that are affected by this scenario are part of the deferred scope. If significant alternate design changes (e.g., seismically qualifying the gloveboxes) would be required, the changes would not challenge placement of the deferred processes into the facility. Therefore, there is no design driver to complete this earlier than the current baseline for the development of safety basis documentation. The current baseline schedule shows that the PFHA or process accident analysis would be completed in the third quarter of FY 2014.

<u>Issue # 3 - Aircraft Crashes</u>

Summary of Issue: The Preliminary Safety Design Report (PSDR), Rev. 1, analyzes the aircraft crash as a design basis accident for the UPF Main Building but does not analyze aircraft crash scenarios for ancillary UPF structures such as the Highly Enriched Uranium Materials Facility (HEUMF) Connector, the Loading Dock/Truck Bay, or the Enclosed Dock/Dock Vestibule.

Status: Shortly after the Preliminary Safety Validation Report (PSVR) was approved, DAC-EF-801768-A080, *Aircraft Crash Analysis for the Uranium Processing Facility (U)*, was issued in March 2013 to update the frequency analysis of the airplane crash and to identify those structures that exceed the frequency and exposure screening guidelines. The results of that analysis show that the ancillary UPF structures exceed the frequency analysis guidelines, and the report provides options to meet compliance with DOE-STD-3014, *Accident Analysis for Aircraft Crash into Hazardous Facilities*. The current status for each structure is as follows:

- UPF Main Building, X-Ray Vaults—Designed to withstand airplane crash
- Administration Connector, Loading Dock/Truck Bay, and the Enclosed Doc/Dock Vestibule—Not designed to withstand airplane crash

- HEUMF Connector—Still under evaluation. The structure exceeds the frequency threshold, but the quantities and types of materials present in any given time in the connector are still being determined. The options available for the structure are:
  - design the entire structure to withstand the airplane crash
  - design the walls of the structure to withstand the airplane crash with some administrative controls on material-at-risk in the connector
  - establish SACs on material-at-risk in the connector

Ancillary structures that are not to be designed to withstand the airplane crash will limit the material-at-risk through an SAC in those structures. This is acceptable because these areas do not routinely contain the hazardous materials.

Actions:

1. Document the bases for the design criteria for the ancillary structures in an appropriate DAC or report to account for limited materials in the ancillary structures.
2. Revise DE-PE-801768-A007, *UPF Facility Safety Design Criteria (U).*

Potential Design Issues: None. The determination for the design criteria will be completed in time to support structural analyses of the ancillary structures.

Schedule: The current baseline schedule has the start of the structural and seismic analysis of the facility in the first quarter of FY2014. The actions listed above will support the start of the design of the ancillary structures.

<u>Issue # 4 - Non-Seismic Natural Phenomena Hazards and Man-Made External Events</u>

Summary of Issue: The PSDR credits the UPF structures to provide protection against a broad range of natural phenomena hazards and man-made external events. However, the PSDR does not clearly link the identified functional requirements and performance criteria for UPF structures to the specific accident stresses that they are credited to protect against for all design basis accidents. Important structural attributes may not be effectively captured and incorporated into the design if functional requirements and performance criteria for UPF structures are not clearly linked to the accident-driven environmental conditions these structures are credited to withstand.

Status: DE-PE-801768-A007, *UPF Facility Safety Design Criteria (U)*, was updated in June 2013 to link the functional requirements for UPF structures to the specific design basis accidents. Additional detailed performance criteria resulting from the accident analysis are being identified and will be included in a revision to DE-PE-801768-A007.

Actions:

1. Revise DE-PE-801768-A007 to include specific performance criteria for the UPF structures.

Potential Design Issues: None. The structural design and analyses for the UPF structures has not been initiated. Any additional performance criteria will be documented in DE-PE-801768-A007 in time to support the structural design and analyses.

Schedule: The current baseline schedule has the start of the structural and seismic analysis of the facility in the first quarter of FY2014. DE-PE-801768-A007 will be revised to support the start of the design of the UPF structures.

<u>Issue # 5 - Concurrent Releases of Multiple Hazardous Materials</u>

Summary of Issue: Some UPF fire scenarios can concurrently release multiple hazardous chemicals. The PSDR and its supporting analyses do not evaluate the potential for concurrently released chemicals to have compounding toxicological effects. As a result, the PSDR determines the need to credit controls to prevent or mitigate toxicological hazards based solely on the potential for any single chemical to exceed public or co-located worker exposure thresholds. This could result in the need to credit additional controls when the cumulative consequence effects of concurrently released chemicals are evaluated.

Status: The data and supporting analyses for hazardous toxic chemicals have been reviewed for additive effects and whether the public or co-located worker exposure thresholds have been exceeded. Some hazardous toxic chemicals exist in quantities that may exceed public or co-located worker exposure thresholds if released in an accident scenario. These chemicals already have controls identified to keep the public and co-located workers safe. The remaining chemical material inventories in each process area were reviewed to see if the public and co-located worker thresholds were exceeded assuming the entire inventory has additive effects. This review showed that there is one process area in the facility where the inventory of two standard industrial acids could exceed co-located worker thresholds but not public thresholds. The bulk of the standard industrial acids inventory is required to be stored in a fire-rated enclosure that provides adequate protection from a fire-initiated release. The hazardous material inventory is currently being updated to reflect the new building design and equipment layout. When the hazardous material update is available, the associated analyses will be updated to include an analysis of the additive effects of chemical releases.

Actions:

1. Document the review of additive chemical releases using existing inventories in a report.
2. Revise the hazardous material inventory for the new building design and equipment layout.

3. Create a DAC documenting the results of using the Mixture Methodology "Hazard Index" approach recommended by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) Chemical Mixtures Working Group (Craig, et. al., 1999).

Potential Design Issues: None. With the exception of one process area, the additional hazardous chemicals are not expected to exceed public or co-located worker thresholds based on current analysis data. The one process area with a significant inventory of standard industrial acids currently has adequate controls to ensure the protection of the co-located worker and the public.

Schedule: The report documenting the review of the existing chemical inventory is scheduled to be complete in November 2013. The final analysis based on the updated hazardous material inventory is scheduled to be complete in the second quarter of FY 2014.

<u>Issue # 6 - Dust Explosions</u>

Summary of Issue: Processing activities in gloveboxes can generate suspended pyrophoric or reactive dusts that could seriously injure facility workers. Under normal operating conditions, affected gloveboxes are provided with an inert gas atmosphere that prevents the rapid combustion reaction necessary to produce a dust explosion. However, the features that provide this inert atmosphere are not credited safety controls, and the inert environment can be lost under credible upset or accident conditions. The effectiveness of currently identified Safety-Significant controls has not yet been demonstrated.

Status: Hazard evaluation studies for the PSDR postulated worst-case unmitigated consequences without detailed consideration of the process design. For the situation involving the Saltless Direct Oxide Reduction (SDOR) process, the strategy being implemented is to demonstrate that the combination of the initiating scenario and the characteristics of the uranium material does not support the conditions for a dust explosion or a deflagration resulting in an overpressure with high consequences to the facility worker. The most limiting reaction expected is a flash fire, which is considered a weak deflagration with a pressure of less than 2 bar that will not seriously injure the facility worker. The project is developing an analysis to document the basis for this conclusion.

A similar approach is being taken for lathe cutting operations. Normal operations do not involve machining materials that may become pyrophoric. The tooling used to make lathe cuts does not create particles of sufficient size to support a dust explosion. Observations of current operations have confirmed these conditions. Therefore, if the glovebox is breached and ignition sources are present, the material created is incapable of forming a dust cloud, thus preventing an explosion. The basis will also be documented in an analysis.

Actions:

1. Create a DAC to determine whether the SDOR dust explosion scenario will injure a worker.
2. Create a DAC to determine whether lathe cutting operations result in a dust explosion.

Potential Design Issues: For SDOR, it may be necessary to conduct further testing offsite to provide additional supporting data or incorporate a rupture disk into the glovebox design should the analysis not reach the anticipated conclusion. The rupture disk design would provide a means to control a dust explosion in such a manner that the facility worker is not seriously injured by the over-pressurization event.

There are no new controls affecting design expected for lathe cutting operations. Existing engineered features, however, may be credited.

Schedule: For SDOR, the potential design change would require a rupture disk in the glovebox. This glovebox design modification would be needed during the fabrication procurement, which is several years from now. The process areas that are affected by the lathe cutting scenario are part of the deferred scope. If design changes were needed to be made to the Disassembly/ Quality Evaluation gloveboxes, this would not challenge placement of the process into the facility. Therefore, there is no design driver to complete this earlier than the current baseline for development of the safety basis documentation. The current schedule shows that the applicable accident analysis documents would be completed in the third quarter of FY 2014.

Issue # 7 -Violent Chemical Reactions:

Summary of Issue: Chemical dissolution activities associated with basket dissolver and beaker leaching unit operations in the Special Oxide Production process area can result in violent chemical reactions that forcefully expel heated chemical agents from process vessels. The PSDR does not identify any credited controls to protect facility workers from chemical burns resulting from these violent chemical reactions. The current UPF safety basis has not demonstrated how this approach complies with Appendix C of DOE-STD-1189-2008, *Integration of Safety into the Design Process*.

Status: The most recent information from Y-12 Development described the basket dissolver reaction as "aggressive" with metal plate floating on gas bubbles. The amount of material present is limited by the process. Fines will be dissolved in the beaker leaching process, not in the basket dissolver. The rate of reaction is limited by surface area and by reactant addition rate. A metering pump is used to slowly add reagents to the basket dissolver. In the beaker leaching process, oxide powder is added manually. Slowly adding reactants prevents a vigorous reaction. Reactions in the basket dissolver are expected to produce bubbling and foaming. Reactions in the beaker leaching process are expected to generate gas. Worst-case reactions in both processes are expected to only result in a boilover.

Actions:

1. Prepare a report to characterize the reaction in the basket dissolver and beaker leaching process.
2. Document inadvertent chemical reactions in the hazard analysis.

Potential Design Issues: None. If reactions are proven to have a worst-case reaction of a boilover, then existing glovebox panels could be credited as shielding to protect the operator from splashes.

Schedule: Y-12 Development is scheduled to complete a report to characterize reactions in the third quarter of FY 2014.

Issue # 8 - Organic Material Combustion in the Calciner

Summary of Issue: Chemical recovery processes upstream of the high temperature calciner contain organic material used for solvent extraction. If combustible organics are introduced into the calciner when heated to its normal operating temperature (roughly 1400°C), rapid combustion of the organic material could release enough energy to rupture the calciner unit and injure facility workers. Currently, the calciner lacks a credited control to prevent the introduction of organics that could rapidly combust, over-pressurize the system, and seriously injure facility workers.

Status: The latest version of the design criteria does contain a credited pressure relief device and relief path control for organics that could get into the calciner and cause a pressure excursion.

The low equity calciner converts concentrated uranyl nitrate (UNH) solution to uranium oxide (U_3O_8) powder. The calciner is a rotating cylinder with three electrically heated zones that are kept at a high operating temperature. The solid U_3O_8 product exits the discharge end of the calciner and free-falls (via gravity) into a receiver located directly below the calciner. Concentrated UNH from the recovery evaporator is fed to the calciner at a low rate by feed pumps.

The credited control for red oil in the recovery evaporator has been changed from a phase separator to a high temperature shutoff. The phase separator will now be defense-in-depth for preventing red oil reaction in this evaporator.

Based on the low feed rate to the calciner and its high operating temperature, which is well above the auto-ignition temperatures for organics, feeding an organic solution to the calciner would most likely result in combustion. With a low injection rate, an explosion of a size to affect workers is not deemed credible during normal operation because the calciner process would convert the organics into NO_x and CO_2 products. If organic material is injected into the calciner before it reaches operating temperature, the material would flow through the rotating cylinder and fall into the unheated product receiver. The calciner is incapable of accumulating the amount of material necessary to result in an event that would affect the local worker.

Actions:

1. Complete the accident analysis for the calciner.

Potential Design Issues: None expected if the analysis and data show there are no explosion issues in the calciner. If the results of the studies performed by Y-12 Development and Fire Protection Engineering show potential overpressure/explosion issues, several options for design changes or refinements could be considered:

- Metering pumps limit the feed flow to the calciner to flow rate. If studies show that limiting the feed flow to the calciner is important in preventing consequences to the facility worker, then the pumps and flow rate may become credited controls.
- If studies show that feeding organics to the calciner at temperatures above its flash point but below its auto-ignition temperature results in an explosion hazard, an interlock preventing feeding of the calciner below the operating temperature may need to be added.
- If an explosion is possible in the calciner, administrative controls or a door interlock to prevent entry of personnel into the walk-in enclosure while the calciner is operating may be required.

Schedule: The accident analysis is scheduled to be completed in the third quarter of FY 2014. It is possible that additional data are required from testing that would be performed by Y-12 Development. This additional data may extend the resolution date.

Issue # 9 - Steam Overpressure in Casting Furnaces

Summary of Issue: Water intrusion into a casting furnace vessel during high-temperature operations can cause a violent steam overpressure event that could seriously injure facility workers. The PSDR credits the primary system integrity of the casting furnace vessel and its supporting equipment to prevent water ingress. However, the PSDR also identifies mechanisms for water to enter the heated furnace from sources inside the system's water-tight boundary due to credible upsets in ventilation or utility gas systems that are plumbed directly into the furnace vessel. The PSDR needs to demonstrate how the Safety-Significant primary system integrity control can effectively prevent steam overpressure events caused by water ingress from these internal sources.

Status: The primary integrity of the microwave casting furnace is credited to prevent the introduction of liquid (e.g., water) into the furnace. This engineered control is expected to provide protection from external water sources (e.g., fire protection sprinklers) and internal sources (e.g., cooling water for the microwave generators or upsets in the primary confinement system). The Facility Safety design criteria were revised and issued in June 2013 to clarify these requirements. This revision included the addition of a performance criterion to provide protection from the introduction of liquid through internal pathways. The design of the casting furnaces is still in the conceptual stage. The piping and instrumentation diagrams for the microwave casting furnaces show that microwave waveguides and all utility connections are designed to prevent the introduction of water inside the furnaces. Drawings for the associated ventilation/vacuum lines for the furnaces also show that they must be designed to prevent the introduction of water into the furnaces. Analyses of specific liquid ingress pathways are delayed until the conceptual design of the microwave casting furnaces is completed. As noted in the PSDR, a failure mode analysis will be required to determine credible water ingress scenarios. Necessary features (e.g., overloops in the primary confinement system) to prevent the ingress of water through internal pathways will then be formally identified.

Actions:

1. Complete conceptual design of the casting furnaces.
2. Review and analyze the conceptual design to ensure internal pathways for liquid ingress are protected.

Potential Design Issues: None. Casting furnace design is in its initial phase, so design features do not require back-fitting controls.

Schedule: The current schedule shows the conceptual design of the casting furnaces to be issued in the first quarter of FY 2015. Subsequent analysis of water ingress will be performed after conceptual design is complete.

<u>Issue # 10 - Hydrogen Explosion in Hydrogen Reduction (HR) Fluidized Bed Reactor</u>

Summary of Issue: A hydrogen explosion could occur in the Enriched Uranium Purification and Metal Production process if oxygen is present when pure hydrogen gas is introduced into the fluidized bed reactor vessel to begin a hydrogen reduction evolution. The current UPF safety strategy relies on operator action to purge oxygen from the reactor vessel using inert gas prior to starting reduction operations to prevent a hydrogen explosion. However, the PSDR does not credit this operator action as an SAC, even though it is relied upon to prevent an event that could result in serious facility worker injuries. This situation does not comply with Sect. 1.2 of DOE-STD-1186, *Specific Administrative Controls*.

Status: The initiation and effectiveness of the nitrogen purge is relied upon to prevent a hydrogen explosion in the fluidized bed reactor. Facility Safety is currently evaluating the need to (1) elevate the nitrogen purge on the fluidized bed reactor to an SAC or (2) credit a permissive that would interlock the flow of hydrogen to the reactor with the nitrogen purge. Completion of the SDOR accident analysis is necessary to determine what control should be credited to prevent the hydrogen explosion event.

Actions:

1. Complete the SDOR accident analysis to determine the most effective control set that should be credited to prevent the hydrogen explosion event.

Potential Design Issues: In the event it is necessary to credit the existing permissive, a process-level control must be elevated to Safety-Significant status.

Schedule: This issue will be closed with the issuance of the SDOR accident analysis, which is currently scheduled for the third quarter of FY 2014.

Issue # 11 - Hydrogen Explosion in the Assembly Environmental Room

Summary of Issue: Hydrogen would be released if water reacted with lithium compounds used in UPF. A significant quantity of these water-reactive materials will be present in a process area that is equipped with a wet pipe fire suppression system. The PSDR needs to evaluate the potential for a hydrogen explosion in the Assembly Environmental Room if credible upset conditions allow water to interact with lithium compounds, causing hydrogen to accumulate inside the enclosure.

Status: Preliminary calculations indicate hydrogen generations based on currently known material quantities and assumed exposures will remain below the Lower Explosive Limit.

Actions:

1. Receive and review revised Hazardous Material Identification Document (HMID) to confirm assumptions of material quantities and exposures in preliminary calculations.
2. Prepare calculation for maximum hydrogen generation based on exposed material.

Potential Design Issues: None. If the revised quantities of material-at-risk increase significantly such that generation of hydrogen from water reactive materials is unacceptable, containers could be credited to prevent water intrusion.

Schedule: The DAC for hydrogen generation is scheduled for completion in the third quarter of FY 2014.

Issue # 12 - Damage Ratio of 0.1

Summary of Issue: The PSDR assumes that only 10% of enriched uranium metal material-at-risk located in storage racks would be impacted and made available for release by seismically induced fires. The PSDR implements this assumption by assigning the damage ratio value of 0.1 for uranium metal in storage racks. This damage ratio value is derived from the empirical results from a series of experiments conducted at Los Alamos National Laboratory (LANL) where uranium metal specimens were heated for 2 hours under controlled laboratory conditions. The Board's staff believes that these experimental conditions are not a reasonably conservative representation of the unmitigated seismically induced UPF fire environment for several reasons.

First, the postulated seismically induced fire scenario analyzed in PSDR Rev. 1 assumes material-at-risk is exposed to fire temperatures for 3 hours, whereas the referenced LANL experiments only subjected uranium to elevated temperatures for 2 hours. Increasing the amount of time uranium metal is exposed to high temperatures tends to result in greater oxidation and higher damage ratios. Second, the cited LANL experiments subjected uranium specimens to controlled temperatures and thus did not account for the significantly increased uranium oxidation that can result from temperature fluctuations that thermally cycle the exposed material. The unmitigated seismically induced UPF fire environment could exhibit significant temperature fluctuations as burning combustibles are consumed and new combustibles ignite. Therefore, the Board's staff believes that the UPF project has inadequate data to support the use of a damage ratio of 0.1 as a reasonably conservative input parameter consistent with Sect. A.3 of DOE-STD-3009-94, Chg. 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*.

Status: The choice of damage ratio for uranium metal in storage racks does not, by itself, impact postulated accident consequences enough to require the functional classification of UPF controls to be upgraded to Safety Class. Additional justification will be added to dose consequence calculations to support this conclusion. In addition, experimental tests performed by Y-12 involving these materials have been conducted for the last several years. The testing was benchmarked against data fromDOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities: Volume I – Analysis of Experimental Data,* for the unique alloy referenced. The airborne release fraction of uranium metal compounds used at Y-12 shows a two-order magnitude reduction from values used in the current consequence analysis. Therefore, the combination of the low impact of the damage ratio on the consequence analysis results and the reduction of the airborne release fraction provides significant safety margin in the consequence analysis. As part of PDSA development, data to support the choice of damage ratio and airborne release fraction will be incorporated.

Actions:

1. Issue report documenting additional burn tests of uranium in a peer-reviewed journal article.

Potential Design Issues: None.

Schedule: Testing data will be published internally and submitted to a peer-reviewed journal in FY 2014 with intent to publish said data before submittal of the PDSA.

Issue # 13 - Atmospheric Dispersion Modeling

Summary of Issue: The results of UPF accident consequence calculations depend heavily on the degree of dispersion and dilution that a plume of released material is assumed to experience in the atmosphere as it travels from the facility in an accident. Atmospheric dispersion effects are represented by the relative concentration factor (x/Q). Changes to x/Q affect accident consequence calculations used to determine the functional classification of UPF safety controls. In an April 2, 2012, letter to the NNSA Administrator, the Board communicated concerns with the conservatism used by the analysis to derive a Y-12 site-specific dry deposition velocity value of 1.0 cm/s. Dry deposition velocity is a key input parameter for calculating x/Q. In response to the Board's concerns, UPF project personnel requested that the NNSA Administrator, as NNSA' s Central Technical Authority (CTA), review and concur on the project's derivation and selection of dry deposition velocity and x/Q values. In June 2012, the NNSA Administrator issued a memorandum providing formal concurrence with the UPF project team's selection of atmospheric dispersion parameter values. The Board's staff has reviewed the CTA concurrence memo and its supporting documentation and believes that for UPF, a dry deposition velocity value of 1.0 cm/s is not reasonably conservative or consistent with recent DOE guidance on deposition velocity calculations. As a consequence, the Board's staff believes the resulting x/Q value is not technically justified. Despite continued concerns that UPF values for dry deposition velocity and x/Q are not reasonably conservative according to Sect. A.3 of DOE-STD-3009, the Board's staff performed an independent analysis of current UPF project data and concluded that correcting these non-conservatisms would not increase postulated accident consequences enough to require the functional classification of UPF safety controls to be upgraded to Safety Class.

Status: The primary purpose of modeling atmospheric dispersion of postulated released hazardous material is to establish the functional classification (i.e., Safety Significant or Safety Class) of safety systems. The DNFSB letter acknowledges that the "non-conservatisms" in atmospheric dispersion modeling would not increase postulated accident consequences enough to require the functional classification of UPF controls to be upgraded to Safety Class. Furthermore, the UPF project is designing key process area fire barriers to Safety Class requirements to ensure that uncertainties in the methodology will not adversely impact the design in the future.

Presently, the issue of atmospheric dispersion modeling resides with DOE and NNSA.

Actions: No additional actions by the UPF project are required at this time.

Potential Design Issues: None.

Schedule: Not applicable.