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**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



December 23, 2020

The Honorable Dan Brouillette
Secretary of Energy
US Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Brouillette:

The Defense Nuclear Facilities Safety Board issued Recommendation 2012-1, *Savannah River Site Building 235-F Safety*, on May 12, 2012. Recommendation 2012-1 identified the need for actions to reduce the hazards associated with the material-at-risk (MAR) that remained as residual contamination within Building 235-F. The Department of Energy (DOE) issued its original implementation plan in response to Recommendation 2012-1 on December 5, 2012, which it subsequently updated on November 28, 2014. In May 2020, DOE submitted a revised implementation plan under this recommendation, outlining significant changes to the overall strategy that it would use to address the hazards. On June 22, 2020, DOE sent a letter to the Board, stating that DOE “has completed all actions identified in the Department’s May 2020, revised Implementation Plan in response to the DNFSB Recommendation 2012-1.”

The Board has reviewed the revised implementation plan per the Board’s Policy Statement 1, *Criteria for Judging the Adequacy of DOE Responses and Implementation Plans for Board Recommendations*, and acknowledges that DOE has taken positive steps to reduce the risks posed by the hazards in Building 235-F. However, the Board is concerned that the revised implementation plan does not ensure that DOE will maintain Building 235-F in a safe condition as the facility awaits its final end state. Specifically, under the revised approach, DOE downgraded an existing safety control and ceased MAR removal activities due to the anticipated limited effectiveness of additional removal efforts.

The revised implementation plan focuses on reducing the risk posed by facility hazards by preventing fires, whereas the original remediation strategy reduced risk by removing the MAR from Building 235-F. Upon review, the Board believes that halting MAR removal is acceptable as long as the revised implementation plan is updated to ensure that Building 235-F’s E5 ventilation system and sand filter are maintained as safety significant equipment, including retention of the technical safety requirements for sand filter efficiency, during the facility’s deactivation period. Upon completion of deactivation, the Board believes that it would be prudent to continue to operate the sand filter in some capacity until all process enclosures are placed in their final end state condition, to minimize any accidental release or migration of radioactive materials.

The Board has also identified potential issues that might warrant further consideration as DOE moves forward to revise the implementation plan and complete the deactivation of Building 235-F. These issues are included in the enclosure to this letter.

Pursuant to 42 United States Code § 2286b(d), the Board requests to be notified, within 60 days of the receipt of this letter, of DOE's intent to address the previously mentioned ventilation system items at Building 235-F. The Board also requests that within one year of receipt of this letter, and annually thereafter, DOE provide the Board with an update on deactivation progress in Building 235-F, the results of radiological surveys and inspections to verify that contamination in the facility is not spreading, status updates on establishing a final end state determination with regulatory authorities, and the updated schedules for activities required to achieve such a final end state.

Yours Truly,

Thomas A. Summers

Thomas A. Summers
Acting Chairman

Enclosure

c: Mr. Joe Olencz
Mr. Michael D. Budney

Enclosure

Additional Information Regarding Safety-Related Activities at Savannah River Site's (SRS) Building 235-F

The Defense Nuclear Facilities Safety Board's (Board) staff team reviewed the Department of Energy's (DOE) execution of activities associated with the implementation plans for the Board's Recommendation 2012-1, *Savannah River Site Building 235-F Safety*. This enclosure presents observations by the staff team members. The Board's staff team has previously discussed these observations with SRS personnel, and is providing them for consideration as DOE revises the implementation plan and completes the deactivation of Building 235-F.

Source Term, Hazards Analysis, and Controls: Safety Basis Deficiencies.

DOE has neither revised the Building 235-F basis for interim operations¹ (BIO), nor fully updated several supporting calculations to reflect the current work scope and material-at-risk (MAR). This introduced a number of safety basis quality issues with the DOE-approved BIO. DOE updated its inputs and assumptions² document to reflect the latest non-destructive assay results that quantified the remaining MAR in Building 235-F. Further, DOE added a new appendix to the *Building 235-F D&D* [Decontamination & Decommissioning] *Deactivation Accident Analysis*³ for the seismic event with a propagating fire. However, DOE did not update radiological dose consequences for the other seven scenarios to reflect current facility conditions.

Table 3-20 in the revised BIO provides a summary of accident analysis results. A footnote to the table states, "These events were not recalculated for revision 4. Use of the higher MAR provides a conservative value." This approach is problematic because the mitigated analysis inappropriately credits a safety control that was downgraded in the revised BIO. Specifically, the calculation of mitigated consequences shown for a breach of an enclosure (DEACT-3-008) takes credit for the sand filter removing greater than or equal to 99.51 percent of the radioactive material. However, the technical safety requirements⁴ (TSR) no longer credit the sand filter to remove material. While the BIO notes the absence of this control, it is misleading to present the results of the mitigated consequences that reflect mitigation by a control that is no longer credited to perform a safety function.

Instead of recalculating the radiological dose consequences in DEACT-3-008 to reflect the current MAR and control set, the BIO qualitatively assessed the consequences to be below 100 rem Total Effective Dose to the co-located worker and stated that no controls were required. When the Board's staff team questioned this conclusion based on its own analysis, SRNS

¹ Savannah River Nuclear Solutions, Aiken, SC, *Basis for Interim Operation for Building 235-F Deactivation*, U-BIO-F-00003, Rev. 4, February 2020.

² Savannah River Nuclear Solutions, Aiken, SC, *Inputs and Assumptions*, U-CLC-F-00061, Rev. 1, January 2020.

³ Savannah River Nuclear Solutions, Aiken, SC, *235-F D&D Deactivation Accident Analysis*, S-CLC-F-00646, Rev. 6, February 2020.

⁴ Savannah River Nuclear Solutions, Aiken, SC, *Technical Safety Requirements for Building 235-F Deactivation*, U-TSR-F-00005, Rev. 4, February 2020.

performed a calculation that determined the mitigated dose to the co-located worker using the new MAR value would be 101 rem. This is above the on-site evaluation threshold criterion (100 rem) and would require a safety significant control. DOE stated that it is not realistic to assume that all of the MAR would be released and the dose would likely be less than 100 rem. In a more recent discussion, DOE indicated that the BIO will be updated to reflect a lower MAR value for certain scenarios. DOE claims that this update would lower the calculated dose consequences to the co-located worker to below the 100 rem threshold for safety-related controls.

In parallel, the Board's staff team has been reviewing the input parameters for the dose consequence calculation and has identified potential non-conservatisms that could cause the dose consequences to exceed 100 rem to the collocated worker even when accounting for the lower MAR value. The most significant concerns include:

- During a seismic event, the holdup material is subjected to the following release mechanisms: 1) shock/vibration, 2) falling object stresses, and 3) aerodynamic entrainment after the seismic event. Each of these mechanisms would be subject to a separate effective release fraction. All holdup material would be subject to shock/vibration and entrainment, while only a subset of holdup material would be impacted by a falling object. In a previous analysis⁵, the entire MAR was subjected to shock/vibration and falling object stresses, which is conservative. In the revised analysis, a seismic impact ratio (or damage ratio) is calculated to determine the amount of MAR impacted by falling objects. The revised analysis removed the shock/vibration release mechanism that impacts the entire MAR without technical justification.
- The dose consequence calculation assumes Pu-238 lung absorption class S. Case history and experimental data suggests that class M may be more appropriate at times, even for Pu-238 oxides stabilized at elevated temperatures.^{6, 7, 8, 9} Class M would result in a higher dose consequence. There is no current characterization data for the Pu-238 still in 235-F.

Independent of a DOE update to the BIO, the Board's staff team concluded that maintaining the safety significant classification of the ventilation system and sand filter would provide continued assurance of worker safety across the range of accident scenarios.

⁵ Savannah River Nuclear Solutions, Aiken, SC, *Scoping Assessment for Fire Event Involving Pu-238 Holdup Material for Building 235-F DSA (U)*, S-CLC-F-00517, Rev. 0, April 2004.

⁶ International Commission on Radiological Protection, *Age-dependent Doses to Members of the Public from Intake of Radionuclides - Part 4 Inhalation Dose Coefficients*, ICRP Publication 71, Ottawa, Ontario, Canada, September 1995.

⁷ Mewhinney, J.A., and J.H. Diel, *Retention of Inhaled ²³⁸PuO₂ in Beagles: A Mechanistic Approach to Description*, *Health Physics*, Volume 45, Issue 1, pp. 39-60, July 1983.

⁸ Park, J.F., G.A. Apley, R.L. Buschbom, G.E. Dagle, D.R. Fisher, K.M. Gideon, E.S. Gilbert, J.D. Kashmitter, G.J. Powers, H.A. Ragan, R.E. Weller, and E.L. Wierman, *Inhaled Plutonium Oxide in Dogs*, *Pacific Northwest Laboratory Annual Report for 1985 to the DOE Office of Energy Research*, PNL-5750, Part 1 Biomedical Sciences, pp. 3-17, Richland, Washington, February 1983. Available from National Technical Information Service, Springfield, Virginia.

⁹ Bair W.J., J.E. Ballou, J.F. Park, and C.L. Sanders, *Plutonium in Soft Tissues with Emphasis on the Respiratory Tract*, 1973. In: Hodge H.C., J.B. Hursh, J.N. Stannard (eds), *Uranium · Plutonium Transplutonic Elements*, Springer-Verlag, Berlin, Heidelberg, 1973.

Inadequate Confinement Strategy.

The revised BIO credits the E5 exhaust ventilation system to provide confinement and to provide a flow path from the enclosures to the E5 exhaust fans (e.g., the dampers, exhaust tunnel, and sand filter building). The revised TSRs 1) do not require an operable sand filter, 2) do not require the glovebox exhaust ventilation system high efficiency particulate air (HEPA) filter banks to be on line if the sand filter is inoperable, and 3) do not require verification every 18 months that sand filter efficiency is ≥ 99.51 percent. The revised BIO also does not credit the exhaust stack to prevent a ground level release or to mitigate the dose consequences of a release.

The BIO analyzes the impact of a radiological release to a facility worker inside a process room and credits the ventilation system to remove the release from the worker's vicinity, but it does not look at the downstream impacts of that same release on the co-located worker outside. The only difference in the dose consequences is due to dilution, since the filter and stack can no longer be assumed to reduce the consequences. As mentioned previously, this resulted in a dose consequence of 101 rem to the co-located worker, which would drive the need for a safety significant control.

Until the facility is in a cold and dark state, the Board's staff team believes that Building 235-F should have a sand filter that is operable, for which the filter efficiency has been verified to protect workers in the area. The Board's staff team also observed that the procedures provided by DOE to illustrate how the sand filter would be maintained as general service equipment did not have the same rigor as those for a safety significant system.

Fires Impacting Enclosure MAR.

The *Fire Scenarios For 235-F*¹⁰ report rules out any fire events that would impact MAR inside of process enclosures. The report describes the potential hazard of cabling and powered instrument panels in certain locations. The independent 235-F fire hazard evaluations^{11,12} commissioned by DOE and referenced in the fire scenario report, are silent on the presence of the powered instrument panels. The active panels in the Plutonium Fuel Finishing Facility (PuFF) shift operating base might be both an ignition point and a source of sufficient combustible material to constitute at least a moderate fire, particularly if they involve the cable trays above. While DOE acknowledges that powered instrument panels might be an ignition source, DOE maintains that such a fire would not impact MAR in the enclosures. No technical basis for this position is documented. If a fire were to impact MAR, the dose consequences could significantly exceed 100 rem to the co-located worker.

¹⁰ Savannah River Nuclear Solutions, Aiken, SC, *Fire Scenarios For 235-F*, F-TRT-F-00004, Rev. 4, January 2020.

¹¹ Campbell, B., *Building 235-F Evaluation of the Current Status of the Facility*, SRNS-RP-2019-00698, Rev. 0, Jensen Hughes, September 2019.

¹² Mowrer, F., *Report on the Peer Review of the SRS 235-F Fire Hazard and Risk Technical Evaluation*, SRNS-TR-2019-00378, Rev. 0, CP Fire, LLC, December 2019.

Unprotected Assumptions in Independent Fire Evaluations and Fire Hazards Analysis.

In general, the Board's staff team agrees with the conclusions in the independent evaluations of the fire hazards conducted for DOE. The conclusions of these evaluations reflected the conditions at the time they were performed. The key to ensuring that the conclusions of those evaluations remain valid is ensuring that the hazards in the facility do not significantly change. When the Board's staff team inquired about how the site was ensuring that the assumptions and conditions noted in the independent evaluations were being maintained, it learned that nothing was in place at the time. The contractor, Savannah River Nuclear Solutions (SRNS), subsequently developed a matrix. SRNS has not yet specified how this matrix will be used to ensure that the assumed conditions are maintained.

The Board's staff team has validated that information from the independent evaluations of the fire hazards has been incorporated into the Fire Scenario Document, which is an input to BIO and the fire hazards analysis (FHA). The team notes that while the Fire Scenario Document is an input to the BIO, it is neither classified as a safety basis document nor formally identified as a support document necessary to perform Unreviewed Safety Question Evaluations.

The Board's staff team also reviewed the latest revisions of documents associated with control of transient combustibles in 235-F. These documents contain positive changes specific to 235-F, but do not reference the matrix. The current procedures may not protect all specific assumptions identified in the matrix, as they are not all identified in the documentation (e.g., maintaining locations where cable trays penetrate walls in enclosure areas free from transient combustibles, and maintaining the water-filled doors to the PuFF cells in the closed position).

Heavy Reliance on Safety Management Programs.

DOE has stated that it intends to achieve the objective of Recommendation 2012-1 by protecting the public and co-located workers with a strategy to eliminate fire risks associated with postulated seismic events. Fire events in the revised BIO include pool and combustible material fires that impact transuranic waste and radiologically contaminated HEPA filters. The main control for preventing large fire events in the BIO, and thus obviating the need for engineered fire protection controls, is the Fire Protection Program, a safety management program.

The assumptions and analysis in the *Fire Scenarios For 235-F*¹³ report rule out any fire events that would impact MAR inside the process enclosures. The BIO does not formally identify any fire protection controls as credited initial conditions. That being said, the BIO states that the "The Fire Protection Program reduces the frequency of fires by limiting ignition sources, the quantity of transient combustible material, and the quantity of flammable or combustible fluids and flammable gas that are allowed to be in the vicinity of MAR, enclosure rooms or area that abuts enclosure rooms."

The BIO credits the Fire Protection Program to protect several assumptions in the hazards analysis (e.g., limited amounts of flammable liquids and flammable gas cylinders). This

¹³ Savannah River Nuclear Solutions, Aiken, SC, *Fire Scenarios For 235-F*, F-TRT-F-00004, Rev. 4, January 2020.

approach is inconsistent with DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, which states that safety management programs are not to be assumed available for unmitigated analysis of plausible accident scenarios. The standard provides an example, stating that “combustible controls may not be used as an initial condition to show that a full facility fire is not plausible.” The example is similar to the approach taken in the *Fire Scenarios For 235-F* report, which assumes a lack of combustibles as an initial condition.

DOE Standard 3009-2014 states, “The criteria for designating an AC [administrative control] as a SAC [specific administrative control] include two conditions that need to be met: (1) ACs are identified in the safety analysis as a control needed to prevent or mitigate an accident scenario and (2) ACs have a safety function that would be SS [safety significant] or SC [safety class] if the function were provided by an SSC [structure, system, or component].”

The BIO states that the Fire Protection Program is a programmatic administrative control that serves a safety significant function. Where DOE is crediting the use of an administrative control (i.e., the Fire Protection Program) to prevent the accident scenario and to serve a safety significant function, the standard would require the use of a SAC to increase the rigor and reliability of this critical control.

During the Board’s staff team’s interactions with site personnel, SRNS stated there were several conservatisms in the dose consequence calculations and that reliance on just an administrative control was consistent with a DOE-Savannah River Operations Office publication, *Position on Use of Administrative Controls to Support DSA Accident Analysis*, dated March 14, 2017. However, the Board’s staff team disagrees and notes that DOE has implemented SACs at other facilities to limit or prohibit the amount of combustible and flammable materials present.

The Board’s staff team also notes that for 235-F, the Emergency Response Program is a safety management program that serves a safety significant function and is credited to reduce the radiological risk to the collocated worker. The team has concerns with this safety management program similar to those noted for the Fire Protection Program, although Emergency Response Programs are less suitable to implement as a SAC. That being said, the Emergency Response Program is the key control for reducing co-located worker doses below 100 rem from a seismic event, so program implementation needs to be rigorous. While DOE has been regularly conducting emergency response drills and exercises for 235-F since the issuance of Recommendation 2012-1, the scenarios have primarily focused on events external to the facility (e.g., vehicle and gas cylinder accidents) rather than seismic event scenarios.

Unclear Deactivation End Points for Building 235-F

The deactivation project plan¹⁴ that SRNS submitted to DOE states that at the end of deactivation:

¹⁴ Savannah River Nuclear Solutions, Aiken, SC, *Deactivation Project Plan Preparation for Decommissioning Building 235-F, Metallurgical Building*, V-PMP-F-00247, Rev. 1, September 4, 2020.

- Contamination outside process enclosures will be removed to the extent practical.
- Process enclosures and ventilation will be sealed to prevent migration of MAR from these components during Safe Storage.

In theory, these two conditions would address many of the Board's concerns regarding loss of confinement of MAR while Building 235-F is awaiting decommissioning, but this is dependent on implementation and the interpretation of "to the extent practical." The plan includes a number of associated end points addressing residual contamination. The end points discuss decontaminating the West Maintenance Area, Airlock 158, Hot Press Vacuum Pump containment, and Cold Press Glovebox. The end points also discuss seals around the manipulator penetration to Cell 1 and East Line cells, and the north door. The end points do not discuss other locations inside PuFF or the Plutonium Experimental Facility, Old Metallography Laboratory, or Actinide Billet Line (ABL). The Board's staff team believes that it is important to include these specific areas as end points in the deactivation project plan as well.

While DOE sealed some previously identified leaks in PuFF and ABL earlier this year, it is likely that additional leaks will arise as seals continue to degrade due to radiation exposure and age. Facility personnel have also previously identified locations in the facility where migration of contamination has been detected that are not explicitly addressed by the current end points.