DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

December 6, 2022

The Honorable Jennifer M Granholm
Secretary of Energy
US Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Granholm:

The National Nuclear Security Administration (NNSA) intends to increase the plutonium inventory limits for the PF-400 facility, currently the Radiological Laboratory Utility Office Building, to support its national security missions at Los Alamos National Laboratory (LANL). PF-400 will be a Hazard Category 3 facility, and as such, subject to the requirements of Title 10 Code of Federal Regulations (CFR) 830, *Nuclear Safety Management*, and its associated orders and standards. Department of Energy (DOE) Order 420.1C, *Facility Safety*, and Standard 1066-2016, *Fire Protection*, are two examples containing operational safety requirements applicable to this facility.

The LANL contractor encountered issues with the PF-400 confinement ventilation system, specifically related to the plenum deluge spray system protecting the high efficiency particulate air (HEPA) filters. To avoid maintenance and testing issues, the contractor prepared an analysis meant to show that the filters would remain intact and function during facility fire accidents—even without the deluge system being activated—and requested permission from the NNSA Los Alamos Field Office for an equivalency (which was approved in August 2021) to disconnect the deluge system.

The Defense Nuclear Facilities Safety Board (Board) reviewed the equivalency request and its supporting analysis and concluded that this documentation includes errors and non-conservatisms that may lead to incorrect conclusions regarding the HEPA filters' performance and survivability, and therefore their ability to perform their confinement function following a fire. The enclosure to this letter describes the Board's findings in more detail.

The Board understands that the LANL contractor is considering a similar equivalency request to disconnect the HEPA deluge system at the PF-4 Plutonium Facility which is a Hazard Category 2 facility with significantly higher risk of operational events to the public. The Board urges NNSA to ensure that any decisions regarding these systems are based on sound technical analysis, meet applicable DOE requirements, and will not degrade the confinement capabilities provided by the ventilation system and its associated HEPA filters.

The Board has noted a pattern of increased reliance on inadequate safety analyses at LANL and is concerned that the safety posture of LANL's plutonium facilities will be degraded if this pattern continues. Relying on installed engineered controls that are required by DOE directives is the appropriate safety strategy in the unlikely event of an accident leading to a radiological release at the plutonium facilities.

Therefore, pursuant to 42 United States Code §2286b(d), the Board requests, within 90 days of the date of this letter:

a) A report that documents a technically valid safety analysis of the accidents identified in the Fire Hazard Analysis and Documented Safety Analysis of PF-400 to demonstrate that the HEPA filters' temperature would not exceed the limit established by DOE Standard 1066-2016, taking into account the concerns detailed in the enclosure, or

b) A briefing on NNSA's plans and schedule for restoring operability to the HEPA filter plenum deluge system and ensuring that ventilation system at PF-400 meets all applicable safety requirements contained in DOE orders and standards, and

c) A briefing and report on NNSA's plans for the operability of the HEPA filter plenum deluge system at the PF-4 Plutonium Facility.

Sincerely,

Joyce L. Connery
Chair

Enclosure

c: The Honorable Jill Hruby
Mr. Ted Wyka
Mr. Joe Olencz

Enclosure

Equivalency Request to Disconnect HEPA Filter Deluge System at PF-400

Department of Energy (DOE) Requirements. DOE Standard 1066-2016, *Fire Protection*, contains the following requirements:

> *Fire protection in or around nuclear confinement ventilation systems **shall** be designed to accomplish the following objectives: (a) prevent fires from affecting the operation of the ventilation system; (b) protect the filtration function…. In fire events filters should be protected from overheating and potential ignition. Filter cooling should be accomplished by dilution air, or a water-based automatic suppression system, or both. If the cooling of the hot gases is to be accomplished with dilution air, engineering calculations should demonstrate that the inlet temperature to the HEPA* [high efficiency particulate air] *assembly is no greater than 250 F… **[t]he technical adequacy** of the alternate protective strategy **shall** be demonstrated by an analysis that establishes the quantitative **fire demand that could potentially be created in the rooms** and compartments served by the ventilation system* [emphasis added].

DOE Order 420.1C, *Facility Safety*, further requires:

> *The nuclear facility design must include multiple layers of protection (as part of the design defense-in-depth) to prevent or mitigate the unintended release of radioactive materials into the environment.*
>
> *Hazard category 1, 2, and 3 nuclear facilities with uncontained radioactive materials… must have the means to confine the uncontained radioactive materials to minimize their potential release in facility effluents during normal operations **and during and following accidents**, up to and including design basis accidents (DBAs)* [emphasis added].

Background. The Los Alamos National Laboratory (LANL) contractor encountered issues with the PF-400 confinement ventilation system, specifically issues related to maintenance and testing of the deluge spray system protecting the HEPA filters. To alleviate these issues, the contractor prepared an analysis meant to show that the HEPA filters would remain intact and function during facility fire accidents—even without the deluge system being activated—and requested permission from the National Nuclear Security Administration's (NNSA) Los Alamos Field Office for an equivalency to disconnect the deluge system[1].

LANL employed a subcontractor to perform a computational fluid dynamics (CFD) analysis to calculate the air temperature at the HEPA filters during room fires.[2] The CFD model analyzed six individual fire scenarios as the primary events to demonstrate that the temperature of the HEPA

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[1] Los Alamos National Laboratory, Request for Permanent Equivalency Approval to DOE-STD-1066, for the High-Efficiency Particulate Air (HEPA) Filter Plenum Deluge Spray Systems at the Existing Building TA-55-0400 At Los Alamos National Laboratory (LANL-DOE-ORDER-420.1C-EQ-2021-002), August 5, 2021.

[2] Performance Based Fire Protection Engineering, Los Alamos National Laboratory Radiological Lab/Utility/Office Building Support Ventilation System Fire Modeling Rational Analysis, SR-55-0400-110-R0, June 5, 2020.

filters would not exceed the threshold value of 250 °F, established by DOE Standard 1066-2016. The most limiting of the six scenarios is a fire caused by combustibles in the fan room that, according to the model, results in a HEPA maximum temperature of 223.5 °F.

The Defense Nuclear Facilities Safety Board (Board) reviewed the calculations and concluded that they contain errors and non-conservatisms that may lead to incorrect conclusions regarding the performance and survivability of the HEPA filters.

Discussion. The PF-400 hazard analysis identifies multiple scenarios that result in a fire initiated by either operational or seismic events that spread to the entire facility. The PF-400 documented safety analysis (DSA)[3] notes that due to the combination of low combustible loading and "the use of combustible materials that cannot burn or ignite easily" the unmitigated likelihood of a facility fire is assumed to be "Unlikely." However, as noted below, given the ongoing issues with deficiencies in the construction quality of PF-400's fire barriers, it is plausible to have a facility fire that is more severe than the six individual fires analyzed by the CFD modeling.

The DSA identifies the ventilation system and HEPA exhaust filters as part of the defense-in-depth strategy for these scenarios. The CFD analysis, however, evaluated the HEPA filter temperature for individual fires that were not as severe as a full facility fire. While the six individual fires may be conservative using maximum heat release rates of the combustible materials, the CFD analysis does not evaluate the consequences of several such simultaneous fires introducing hot gases into the ventilation ducts at the same time.

LANL contractor personnel stated that extending the duration of the individual fires to 20 minutes is conservative. The CFD analysis, however, shows that the fire duration becomes irrelevant after the first few minutes when the ventilation system energy balance reaches a steady state condition. Multiple simultaneous fires caused by a design basis seismic event, or a facility fire, would lead to higher temperatures at the HEPA filters than those fires evaluated by the CFD analysis and used as the justification for disconnecting the filter deluge system.

While the CFD analysis shows that the maximum HEPA filter temperature for the six postulated individual fires is below the DOE threshold value of 250 °F, the analyzed fire events do not account for more severe fires as described in the approved DSA. By not accounting for these more severe, but credible, accidents, the analysis does not align with requirements in DOE Standard 1066-2016, which states that "the technical adequacy of the alternate protective strategy shall be demonstrated by an analysis that establishes the quantitative fire demand that could potentially be created in the rooms and compartments served by the ventilation system."

DOE Order 420.1C also requires confinement capabilities "during and following accidents." This requirement is not limited to design basis accidents and applies to all events identified in the facility hazard analysis. Further, DOE Order 420.1C states that nuclear facility design "must include multiple layers of protection (as part of the design defense-in-depth) to prevent or mitigate the unintended release of radioactive materials into the environment." Since PF-400's ventilation system is part of the credited defense-in-depth strategy for confining potential releases from a

[3] Los Alamos National Laboratory, TA-55 Plutonium Facility 400 (PF-400), Documented Safety Analysis, DSA-PF400-001-R2, September 1, 2020.

number of accidents, including fires, assumptions regarding the system's performance must be based on solid technical information to ensure the requirements in the order are met.

It is also worth noting that the fire hazard analysis[4] (FHA) for PF-400 identifies numerous deficiencies and code compliance issues with fire barriers that affect the fire safety posture of this facility. Many of these deficiencies remain open, and require NNSA concurrence and funding for their closure. These deficiencies include improperly sealed penetrations, openings, and joints; lack of remote capability to actuate the HEPA deluge system; deficient or suspect penetrations in floors and fire barrier walls, including the first floor poured concrete membrane and laboratory fire barrier walls. As a result, the FHA concludes that: "Due to the deficiencies in fire doors, fire-resistant-joints, and penetration firestops throughout [PF-400], it cannot be expected that a worst-case fire scenario will remain within the defined fire areas." Although this statement is made to estimate the maximum possible fire loss, it also indicates that, consistent with the DSA, small individual fires can propagate throughout the facility and create a more severe fire scenario than postulated in the CFD analysis.

The CFD analysis contains several other safety concerns that were discussed in the Board's staff meetings with the contractor's representatives:

- *Lack of Conservatism in Heat Transfer Properties and Flow Rates*—The analysis assumes that ducting does not transfer heat (adiabatic conditions), which is conservative in most cases. However, one scenario examines the impact of a fire adjacent to the HEPA filter plenums. In this case, the adiabatic assumption is non-conservative because it excludes direct heat transfer from the fire to the filter plenum, which would be significant. The analysis also assumes maximum ventilation flow rates, whereas lower flow rates may produce higher temperatures at the HEPA filter.

- *Inaccurate Room Layout*—In one scenario, the modeled location of the lab exhaust vent is significantly more remote than found in the facility. As a result, the analysis inaccurately analyzes this scenario because it omits an exhaust vent next to a flammable liquid storage cabinet where a pool fire is assumed to occur.

Consequently, the CFD analysis used as the basis for disconnecting the HEPA filter deluge system is technically incorrect and inadequate to demonstrate that the maximum filter temperature is not exceeded during the fire events postulated in the facility DSA. The analysis needs to provide an adequate technical basis that higher HEPA filter temperatures resulting from fire events postulated in the DSA (i.e., multiple simultaneous fires or a facility fire) do not exceed the limiting temperature allowed by DOE Standard 1066-2016. Alternatively, the contractor may reinstate the operability of the HEPA filter deluge system to ensure that a fire in the facility would not disable its confinement capability required by the DOE directives and that the ventilation system meets requirements in applicable DOE orders and standards.

[4] Los Alamos National Laboratory, Technical Area 55, Fire Hazards Analysis, Buildings 400/440 Radiological Laboratory Utility Office Building (RLUOB), ERD-FIRE-06-204, Revision 3, July 2019.