DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

October 17, 2025

The Honorable Chris Wright
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Wright:

The Defense Nuclear Facilities Safety Board (Board) needs additional information from the National Nuclear Security Administration (NNSA) to evaluate the nuclear safety implications of NNSA's recent decision to eliminate the planned installation of a fire extinguishing system in the Principal Underground Laboratory for Subcritical Experimentation (PULSE). NNSA is currently executing multiple line-item construction projects at PULSE, an underground defense nuclear facility at the Nevada National Security Site. These projects introduce new diagnostics and execution locations for subcritical experiments (a package that consists of special nuclear material mated with high explosives). Subcritical experiments provide NNSA with important information on the health of the nation's nuclear deterrent. The operational tempo at PULSE is slated to increase, and larger subcritical experiments (i.e., higher amounts of high explosives and nuclear materials than what has been used for past experiments) will be executed soon.

PULSE operations in the underground involve liquid fueled vehicles and significant amounts of cabling and other combustible materials that represent a fire hazard. PULSE personnel do not have firefighting capabilities beyond portable extinguishers. As such, NNSA has planned since 2012 to install a fire extinguishing system in the new and existing experiment execution locations. The approved safety design basis for PULSE relies on the fire extinguishing system to protect workers from radioactive materials that could be aerosolized if a fire initiates high explosives in a subcritical experimental package. On April 7, 2025, NNSA directed the project to stop design work on this system and on September 29, 2025, NNSA conditionally approved an exemption to satisfy Department of Energy (DOE) requirements related to life safety, automatic fire suppression systems, and subterranean facilities.

This represents a significant change—NNSA completed an alternatives analysis in 2023 that concluded an exemption was not justifiable and identified a hybrid mist fire extinguishing system as the preferred solution. The approved exemption means that NNSA has no means to extinguish a fire in a test bed with an uncontained subcritical experiment that grows past the incipient stage. Such an approach involves accepting greater safety risk to workers, as well as the potential loss of a DOE defense nuclear facility with exquisite mission critical capabilities that support the nuclear stockpile.

The Board reviewed the exemption and notes it identifies some newly planned modifications, including improvements for worker egress and refuge in the underground. However, the Board is concerned that NNSA has ruled-out a common sense engineered control that could prevent a fire-initiated explosion that aerosolizes nuclear material before understanding the risks to nuclear safety. The Board is also concerned that this approval establishes a worrisome precedent for future NNSA projects contemplating subterranean defense nuclear facilities.

The enclosure to this letter provides additional details on the situation and the Board's concerns. The Board has been unsuccessful engaging with NNSA on this matter at the staff level. The Board further understands that NNSA is developing additional fire modeling and analyses that are currently scheduled to be delivered by April 2027.

The Board is committed to providing you timely safety advice regarding design and construction projects as required by Congress. As such, the Board advises that DOE:

- Independently confirm that NNSA's decision to depart from its long-term fire protection strategy at PULSE, reaffirmed as recently as 2023, is technically justified.

- Maintain frequent consultation and engagement with the Board and its staff as NNSA conducts additional analyses to finalize a nuclear safety control strategy for fire-initiated explosions that adequately protects workers from the aerosolization and dispersal of radiological material at PULSE.

- Finalize a nuclear safety control strategy as soon as possible that embodies DOE's preferred hierarchy of safety controls to minimize project risk and maintain joint DOE-Board commitments to Congress to integrate safety early into the design process. This is particularly important given the national security implications of the planned capabilities at PULSE.

Sincerely,

Thomas A. Summers

Thomas A. Summers
Acting Chairman

Enclosure

c: The Honorable Brandon Williams, Under Secretary for Nuclear Security; Administrator, National Nuclear Security Administration
Mr. Joe Olencz, Director, Office of the Departmental Representative to the Board

Enclosure

Fire Protection Strategy for the Principal Underground Laboratory for Subcritical Experimentation

Background. The Principal Underground Laboratory for Subcritical Experimentation (PULSE) is a hazard category 2 defense nuclear facility at the Nevada National Security Site consisting of a series of mined vertical shafts, horizontal drifts, and alcoves. The underground facility is located approximately 1,000 feet below the surface. The National Nuclear Security Administration (NNSA) performs subcritical experiments at PULSE in support of the Stockpile Stewardship Program. A subcritical experiment package consists of special nuclear material (SNM) mated with high explosives that is designed so there is no reasonable likelihood of a self-sustaining nuclear fission chain reaction. The experiments are executed inside of a confinement vessel in an underground area referred to as a test bed. There is no limit on how long the experimental packages can reside without the protection of the vessel.

In 2014, NNSA approved the mission need for the Enhanced Capabilities for Subcritical Experiments (ECSE) projects at PULSE [1]. This approval includes procuring a high energy x-ray diagnostic capability to measure the late stages of implosion and a neutron diagnostic capability to infer neutron multiplication during an implosion. The ECSE projects include the U1a Complex Enhancements Project (UCEP) and Z-Pinch Experimental Underground System (ZEUS) Test Bed Facility Infrastructure (ZTBFI) project. These are major modifications[1] to PULSE and will create two new test beds to conduct subcritical experiments. Once complete, the operational tempo at PULSE will increase and larger subcritical experiments (i.e., higher amounts of high explosives and SNM than what has been used for past experiments) will be executed. The site contractor responsible for these projects, Mission Support and Test Services, LLC (MSTS), has developed the safety design basis documents for these two projects [2, 3].

Based on these safety design basis documents, accident scenarios with the highest radiological dose consequences to the public and co-located worker[2] are those that result in high explosive initiation within the subcritical experiment package leading to the aerosolization and dispersal of SNM. Falling objects (either from equipment failure or a seismic event), fires, or application of electrical energy can initiate such an explosion. Explosion scenarios can occur either above or below ground. In the absence of safety controls (i.e., unmitigated), both scenarios result in potential dose consequences to the public that challenge the Evaluation Guideline (i.e., 25 rem total effective dose) established in the Department of Energy (DOE) Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* [4]. Additionally, the unmitigated dose to the co-located worker exceeds 100 rem total effective dose. When potential dose consequences to these receptors are estimated to be this high, DOE

[1] DOE Standard 1189-2016, *Integration of Safety into the Design Process* [5], defines a major modification as a modification that substantially changes the existing safety basis for the facility.
[2] DOE Standard 3009-2014 defines the co-located worker as a hypothetical individual assumed to be 100 meters from the facility where the accident occurs.

Standard 3009-2014 requires safety controls to reduce the risk associated with the accident (i.e., by preventing or mitigating the consequences of the accident).[3]

For the analyzed fire-initiated explosion scenarios in the test beds,[4] MSTS credits a fire extinguishing system (FES) as a safety significant control (11 scenarios for UCEP and 9 scenarios for ZTBFI) to reduce the likelihood of fires that result in a high explosive violent reaction and/or dispersal of radioactive material in the test beds, including during and after a seismic event. MSTS always credits the FES in conjunction with the fire detection system and fire barrier system. However, these systems are considered supporting controls and do not provide any nuclear safety risk reduction. As noted in the timeline below, installing a fire extinguishing system at PULSE has been a part of NNSA's long-term strategy for improving the facility's fire protection posture since 2012 [6]. NNSA considered its installation to be necessary given the absence of manual firefighting response capabilities (beyond incipient fires) at PULSE. Based on an alternative analysis that evaluated different fire protection systems, NNSA determined that a hybrid mist system[5] was the preferred option for PULSE [7].

However, on April 7, 2025, the acting NNSA Administrator (NA-1) issued a memorandum directing the UCEP and ZTBFI federal project directors to immediately stop design of the hybrid mist FES [8]. The memorandum states, "MSTS identified a strategy that includes an established secondary means of egress from each of the test beds under construction as well as including additional fire barriers and refuge capabilities. This modified strategy is anticipated to have the necessary safety outcomes needed to protect workers." To pursue this alternate fire protection strategy, MSTS needed to develop and submit an exemption request from the DOE Order 420.1C, *Facility Safety* [9], requirement for an automatic fire suppression system. On September 29, 2025, the NNSA Cognizant Secretarial Officer for Safety and the NNSA Central Technical Authority conditionally approved this exemption request [10]. The condition requires MSTS to complete and submit for NNSA approval additional fire modeling and sensitivity analyses by April 2, 2027.

Assessment. The approved exemption identifies several concerns with the design, installation, and maintenance of a hybrid mist FES. For example, the exemption highlights safety concerns related to asphyxiation from nitrogen. However, the NNSA alternatives analysis team that evaluated different fire protection systems for PULSE in 2023 determined that this concern is addressed and minimized by using very sensitive smoke detection systems to evacuate

[3] Safety class controls are required if the unmitigated dose consequences to the offsite public exceed the Evaluation Guideline. Safety significant controls are required if the unmitigated dose consequences to the co-located worker exceed 100 rem total effective dose.

[4] It is also possible for a fire-initiated explosion to occur when the subcritical experiment package is being transported to the designated test bed. MSTS is not considering the installation of an FES along the path the experimental package will travel in the underground drifts. In lieu of an FES in these drifts and as noted in past Board correspondence (see letters dated December 19, 2018 [12], December 1, 2021 [13], and July 25, 2024 [14]), MSTS should credit the shipping container to protect the experimental package from mechanical, electrical, and thermal insults while it is being moved to the test bed.

[5] A hybrid mist system works by using compressed nitrogen to expel small amounts of water through orifice emitters. Both the water and nitrogen (i.e., an inert gas) are relied upon to extinguish a fire.

personnel, using predischarge alarms and time delays associated with the activation sequence (i.e., evacuation is initiated prior to hybrid mist activation), providing alternative respiratory protection that provides oxygen, and utilizing oxygen monitors with audible and visual alarms throughout the facility. The alternative analysis also addressed the concern by considering mechanical failure of nitrogen cylinders, which are rated to American Society of Mechanical Engineers (ASME) standards. The results of that analysis indicated oxygen concentrations decreasing, but not below levels "allowing safe evacuation per NFPA 770." The analysis noted that the design of the systems, which incorporate an independent valve on each ASME rated cylinder, would prevent an inadvertent catastrophic cascade release of all nitrogen cylinders.

The approved exemption also highlights challenges with ensuring the emitters could be maintained as required by National Fire Protection Association (NFPA) 770, *Standard on Hybrid (Water and Inert Gas) Fire Extinguishing Systems* [11]. However, NFPA 770 only requires weekly and semi-annual visual inspections of emitters and suppression agent cylinders. An annual functional test of certain components of the system would be needed but would not require discharging the hybrid suppression agent in the protected space. On a five-year basis, any hoses that are part of the delivery system for the hybrid systems could either be replaced or be subjected to a one-minute hydrostatic test. Thus, the maintenance requirements do not appear to be onerous, and it is unclear why such requirements would pose a significant challenge after acceptance of the hybrid systems.

Lastly, NNSA's conclusions from the alternatives analysis is not consistent with the new fire protection strategy in the approved exemption. The NNSA analysis team evaluated an option of pursuing an exemption from the requirement to have an FES. The team developed criteria to justify an exemption, which included:

- No compatible FES for the underground;
- No fire hazard present; or
- An urgent national need that would require a compressed timeline to execute the mission without an FES.

The NNSA team determined that none of these criteria were met and that a hybrid mist FES was the preferred option.

In general, MSTS' proposed fire protection strategy in the approved exemption focuses on improving the worker's ability to evacuate PULSE, reducing the likelihood of certain fires, and slowing the growth/propagation of fires. Many of the proposed modifications to PULSE will improve life safety in the underground. For example, mining additional means of egress from the new test bed locations will eliminate some areas where a worker could potentially be trapped during a fire event and addresses a concern on which the Board communicated in a letter dated July 25, 2024. However, none of the controls listed in the exemption request eliminate or extinguish a potential fire in the test beds in which a subcritical experiment can be present outside of containment. Therefore, if a fire were to start in a test bed with an uncontained

subcritical experiment and grow past the incipient stage, the proposed control strategy would allow that fire to continue burning until all fuel is consumed.

MSTS has not finalized the new nuclear safety control strategy for these projects. However, MSTS has now eliminated an engineered control that NNSA previously determined to be viable for preventing a fire-initiated explosion that aerosolizes and disperses radioactive material. The Board is concerned that MSTS will instead credit administrative controls to reduce the nuclear safety risk associated with these fire scenarios. While administrative controls can be effective safety controls, they are often less reliable than engineered controls because they depend on human action. Additionally, relying on administrative controls is not consistent with the hierarchy of controls as defined in DOE Standard 1189-2016 (i.e., engineered controls are preferred over administrative controls). Lastly, Appendix D in DOE Standard 1066-2023, *Fire Protection* [15], establishes fire protection requirements for subterranean facilities (e.g., developed spaces are required to have automatic fire suppression systems). The Board is also concerned that this approved exemption could impact implementation of these requirements for future NNSA projects that involve constructing or modifying an existing subterranean facility.

Conclusion. The Board is concerned with NNSA's decision to forego installation of an FES in the test beds at PULSE. While the proposed fire protection strategy will improve the worker's ability to escape the underground during a fire scenario, it eliminates a viable engineered control that can prevent a fire-initiated explosion that aerosolizes and disperses radiological material. MSTS has estimated the radiological dose consequences for these scenarios to be high. The Board expects NNSA to identify a safety control strategy that will adequately protect the public and workers from these scenarios, and that the control strategy is consistent with the hierarchy of controls. This is especially important given that the operational tempo at PULSE will increase and larger subcritical experiments (i.e., higher amounts of high explosives and SNM than what has been used for past experiments) will be executed once these ECSE projects are complete. Additionally, the Board is concerned that approval of the exemption request for PULSE has established a precedent that is detrimental to life safety and fire protection at future NNSA projects that involve constructing or modifying an existing subterranean facility.

Timeline of events related to the Fire Extinguishing System at PULSE

November 2012 [6]	• NNSA approved an exemption from the requirement in DOE Order 420.1B regarding a fire suppression system [6]. • One condition in NNSA's approval states that once new or revised DOE directives that explicitly address life safety and fire protection requirements for subterranean structures are published, applicable requirements must be fully implemented.
December 2016	• DOE approved a revision of DOE Standard 1066, *Fire Protection*, which included Appendix D on fire protection for subterranean facilities. • Section D.2.1 of the standard states, "Developed spaces shall be provided with automatic fire suppression systems."
February 2022 [16]	• MSTS determined a hybrid mist system was most appropriate FES for the UCEP test bed.
March 2022 [17]	• The NNSA Cognizant Secretarial Officer for Safety approved an exemption request for UCEP related to maximum possible fire loss limits. • One condition imposed by NNSA states that the design of the proposed hybrid mist FES for the UCEP test bed shall be in accordance with NFPA 770.
February 2023 [18]	• The NNSA Nevada Field Office (NFO) provided guidance to MSTS that the installation of the NFPA 770-compliant FES would be used in both the UCEP and ZTBFI test beds, as well as when performing a design upgrade analysis for the existing test bed at PULSE. • In the guidance, NNSA stated that an exemption for an automatic fire suppression system was not viable. • Installing a FES in the existing test bed has been part of the long-term strategy for improving the fire protection posture at PULSE (dating back to the November 2012 exemption approval).
March 2023	• Individual from the NNSA Nevada Field Office submits a differing professional opinion (DPO) on the hybrid mist FES.
October 2023 [7]	• In response to the DPO, an NNSA team completed an alternative analysis that evaluated different fire protection systems for PULSE. • The NNSA team concluded that a hybrid mist system was the preferred option.
April 2025 [8]	• NA-1 issued a memorandum directing the UCEP and ZTBFI federal project directors to immediately stop design of the hybrid mist FES.
July 2025 [19]	• MSTS developed an exemption request from the DOE Order 420.1C requirement for an automatic fire suppression system.
September 2025 [10]	• NNSA conditionally approved the exemption request contingent on completion of additional fire modeling and sensitivity analyses that show the selected final control set effectively mitigates design basis fires.

References

[1] National Nuclear Security Administration letter to the Nuclear Weapons Laboratories and National Security Technologies, LLC, *Approval of Mission Need for Enhanced Capabilities for Subcritical Experiments at the Nevada National Security Site, U1a Complex*, September 2014.

[2] Mission Support and Test Services, LLC, *U1a Enhanced Capabilities for Subcritical Experiments Preliminary Documented Safety Analysis*, U1a-ECSE-PDSA-001, Revision 1, September 2021.

[3] Mission Support and Test Services, LLC, *U1a Complex Z-Pinch Experimental Underground System (ZEUS) Testbed Draft Preliminary Documented Safety Analysis*, U1a-ZTB-PDSA-001, Revision 1, March 2023.

[4] Department of Energy, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, DOE Standard 3009-2014, November 2014.

[5] Department of Energy, *Integration of Safety into the Design Process*, DOE Standard 1189-2016, December 2016.

[6] National Nuclear Security Administration letter to National Security Technologies, LLC, *Approval of the Request for Permanent Exemption from the Fire Protection Requirements Designated in DOE O 420.1B and DOE-STD-1066-99 for the U1a Complex in Area 1 of the Nevada National Security Site (NNSS)*, November 2012.

[7] National Nuclear Security Administration, *Final Report U1a Fire Protection Systems Alternative Analysis*, October 2023.

[8] Acting National Nuclear Security Administration Administrator letter to Federal Project Directors for the Enhanced Capabilities for Subcritical Experiments Projects, *Changes to the Fire Protection Strategy at the Principal Underground Laboratory for Subcritical Experimentation (PULSE) to be Implemented on the U1A Complex Enhancement Project (UCEP) and Z-Pinch Experimental Underground System Test Bed Facilities Improvement (ZTBFI) Project*, April 2025.

[9] Department of Energy, *Facility Safety*, DOE Order 420.1C, Change 3, December 2012.

[10] National Nuclear Security Administration, *Conditional Approval of the National Nuclear Security Administration's Nevada Field Office's (NA-NV) Request for Permanent Exemption from Department of Energy (DOE) Order (O) 420.1C Chg. 3, Facility Safety*, September 2025.

[11] National Fire Protection Association, *Standard on Hybrid (Water and Inert Gas) Fire Extinguishing Systems*, NFPA 770, 2021.

[12] Defense Nuclear Facilities Safety Board, *Letter to the Secretary of Energy James Richard Perry regarding U1a Complex Safety Basis Review*, December 19, 2018.

[13] Defense Nuclear Facilities Safety Board, *Letter to the Secretary of Energy Jennifer M. Granholm regarding Alternate Location for the Co-Located Worker at the U1a Complex*, December 1, 2021.

[14] Defense Nuclear Facilities Safety Board, *Letter to the Secretary of Energy Jennifer M. Granholm regarding Safety Posture of the Principal Underground Laboratory for Subcritical Experimentation and Associated Major Modification Projects*, July 25, 2024.

[15] Department of Energy, *Fire Protection*, DOE Standard 1066-2023, June 2023.

[16] Mission Support and Test Services, LLC, *U1a Complex Enhancement Project (UCEP) Subproject 020 Fire Detection and Fire Suppression/Extinguishing System Applicability Analysis*, 01889-RPT-FP01, Revision 0, February 2022.

[17] National Nuclear Security Administration Cognizant Secretarial Officer letter to the Nevada Field Office Manager, *Approval of Permanent Exemption Request from Maximum Possible Fire Loss (MPFL Limits for the U1a.100 Test Bed at the U1a Complex*, March 2022.

[18] National Nuclear Security Administration Memorandum from the Nevada Field Office Manager, *U1a Complex Fire Protection Strategy*, February 2023.

[19] Mission Support and Test Services, LLC, *Exemption Request: Automatic Fire Suppression System Requirements and Maximum Possible Fire Loss (MPFL) Limits at the PULSE Complex Underground from Department of Energy (DOE) Order DOE 0 420.1C*, 01-PULSE-EXM-003, Revision 0, July 2025.