DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

December 4, 2019

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 has reviewed the electrical systems supporting nuclear operations at a number of facilities across the defense nuclear complex during the past two years. Those reviews have identified a recurring concern related to the design and qualification of emergency lighting in key nuclear facilities.

As noted in the enclosure to this letter, the majority of the emergency lighting fixtures installed in the complex have not been designed to survive a design basis earthquake. Given the window-less construction of most defense nuclear facilities, this could lead to a scenario where the facility structure is intact, but there is no light to support evacuation or other emergency response activities. The Board is concerned that the presence of this situation at multiple defense nuclear facilities indicates a weakness in the published guidance regarding the design and qualification of these critical systems.

This enclosure is provided for your information and use.

Yours truly,

Bruce Hamilton
Chairman

Enclosure

c: Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Enclosure
Design and Qualification of Emergency Lighting Systems

Background. During the past two years, the Defense Nuclear Facilities Safety Board (Board) has performed a number of reviews across the complex that included an assessment of facility emergency lighting systems. The purpose of this enclosure is to document a recurring concern that the Board has identified regarding the design and qualification of systems supporting operations at numerous Department of Energy (DOE) defense nuclear facilities.

Discussion. Generally, defense nuclear facilities across the complex provide some form of emergency lighting (e.g., battery-pack lights, lights connected to dedicated emergency circuits, emergency exit signs) to support facility egress and emergency response activities upon the loss of normal electrical power, in accordance with requirements in National Fire Protection Association (NFPA) 101, *Life Safety Code*. However, through discussions with personnel from multiple sites, the Board has noted that emergency lighting generally is not designed to meet the seismic performance requirements associated with the performance category (or seismic design category) of the supported facility. Therefore, there is the potential that neither normal nor emergency lighting will be available during or after a design basis earthquake.

This vulnerability is inconsistent with both modern building codes and emergency management standards. The International Building Code and American Society of Civil Engineers Standard 7 (ASCE 7), *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, establishes seismic performance expectations for all equipment commensurate with its life safety function. In addition, DOE Order 151.1D, *Comprehensive Emergency Management System*, states that "Equipment must be maintained and tested, as applicable, to ensure equipment functions as designed for emergency response and implementation of protective actions[1] based upon the all hazards planning basis." Therefore, if DOE is to rely on equipment to support facility egress, it should design and test that equipment to function in the same environment as that required of the facility where it is installed.

Regardless of whether ASCE 7 or DOE Order 151.1D are contractually required, these standards provide good engineering practices. The emergency lighting system primarily is needed for events that both disrupt normal electrical power and require personnel to perform some manner of protective action. Given the window-less construction of most defense nuclear facilities, designing the emergency lighting system to survive credible accident scenarios is necessary to ensure that the system can perform its intended function. Where not practical, compensatory measures to ensure an alternative means of appropriately lighted egress should be provided.

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[1] DOE Order 151.1D defines these as actions "taken to minimize the consequences of emergencies and to protect the health and safety of workers and the public." Facility evacuation is given as a specific example in the body of the order.

The following sections are provided to capture the Board's current state of knowledge regarding emergency lighting systems at six sites across the complex. This is not intended to be an exhaustive list nor a detailed analysis. It is being provided to help illustrate the breadth of the Board's concern and to capture how certain facilities have already tried to address the qualification of their systems.

Hanford Site—In general, the operational facilities across the site do not have seismically designed or qualified emergency lighting. However, the contractor for the Waste Treatment and Immobilization Plant (WTP) project has specified that emergency lighting be designed to the same performance criteria as the buildings in which they are installed. This approach is consistent with the modern building code requirements captured in ASCE 7.

Lawrence Livermore National Laboratory—Emergency lighting fixtures at the plutonium facility are not seismically designed or qualified. However, the site is planning to replace key fixtures with seismically qualified units to ensure at least some lighting remains functional after a design basis earthquake.

Los Alamos National Laboratory—Emergency lighting fixtures at the plutonium facility are not seismically designed or qualified. The site recently completed additional seismic testing to demonstrate the functionality of the installed systems; however, multiple emergency lighting fixtures failed during testing.

Oak Ridge National Laboratory—A recent review of the Building 2026 preliminary documented safety analysis noted that the emergency lighting system is not seismically qualified. However, multiple scenarios in the facility hazard analysis assume that the facility workers will have the ability to perform self-protective actions to reduce their risk during an accident. This assumption is reflected in the resulting "low" consequence assigned for specific accident analyses. Without functional lighting, the effectiveness of self-protective actions would be significantly reduced and the assumption that workers perform self-protective actions is not protected.

Sandia National Laboratories—Emergency lighting fixtures across the site are not seismically designed or qualified. The site has performed additional seismic testing in the past, but a significant portion of the tested fixtures failed.

Y-12 National Security Complex—The Uranium Processing Facility (UPF) is currently under construction on the site. Engineering personnel have confirmed that the emergency lighting systems are designed to the same seismic performance requirements of the supported structures. Like WTP, this approach is consistent with the modern building code requirements captured in ASCE 7.

Conclusion. There are a handful of facilities across the complex that either have or will have seismically designed and qualified emergency lighting systems. However, the majority of the defense nuclear facilities that the Board reviewed do not have lighting systems that can be expected to function after a design basis earthquake. Given the broad distribution of the facilities reviewed, this recurring concern points to a potential gap in DOE's current guidance for the design of these key life safety systems.