DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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July 1, 2003

The Honorable Linton Brooks
Administrator
National Nuclear Security Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0701

Dear Ambassador Brooks:

Enclosed for your consideration and action, as appropriate, are the observations developed by the members of the staff of the Defense Nuclear Facilities Safety Board (Board) concerning the electrical and the lightning protection and detection systems for the U1a Complex, Device Assembly Facility (DAF), G-Tunnel, and Joint Actinide Shock Physics Experimental Research (JASPER) at the Nevada Test Site (NTS).

Several facilities at NTS, including the U1a Complex, the DAF, and JASPER, perform operations in which special nuclear material (SNM) is collocated with significant quantities of high-explosives (HE). Some operations involving SNM and HE could commence at various NTS facilities with little or no forewarning. However, the Board's staff observed that not all of the facilities that could potentially house these operations are currently equipped with adequate lightning detection capabilities or well-documented lightning protection controls. It would be prudent to establish compensatory measures to mitigate potential lightning hazards until robust lightning detection and protection programs have been adequately implemented.

In addition, the Board's staff observed that the components of the ventilation system at G-Tunnel, such as electric motors, motor controllers, and power cables (which are located outdoors), are old and show severe age-related degradation. It is not clear that these components can be relied upon to perform their intended life-safety functions. Given concerns regarding worker life-safety, it would be prudent to evaluate the adequacy of the complete ventilation system and implement corrective actions developed as a result of this evaluation.

The Board asks to be kept abreast of the National Nuclear Security Administration's actions regarding these and other issues discussed in the enclosed report.

Sincerely,

John T. Conway
Chairman

c: Ms. Kathleen A. Carlson
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

May 22, 2003

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: A. K. Gwal

SUBJECT: Review of Electrical and Lightning Protection and Detection Systems for Facilities at Nevada Test Site

This report documents a review by members of the staff of the Defense Nuclear Facilities Safety Board (Board) of the electrical and the lightning protection and detection systems for the U1a Complex (U1a), Device Assembly Facility (DAF), G-Tunnel, and Joint Actinide Shock Physics Experimental Research (JASPER) Facility at the Nevada Test Site (NTS). Staff members A. Gwal, B. Broderick, and J. Deplitch conducted a site review on March 11–13, 2003, and performed subsequent conference calls and document reviews through May 16, 2003.

U1a Complex. U1a is an underground testbed for experiments with high-explosive (HE) and special nuclear material (SNM). Although U1a is not categorized as a nuclear facility, it hosts subcritical experiments, which are Hazard Category-2 and -3 nuclear activities. U1a is a 962-foot-deep underground tunnel complex consisting of vertical shafts and about a half-mile of horizontal drifts. The shafts contain elevators to transport personnel and equipment underground. U1a has been the site of significant electrical- and lightning-related occurrences during the past few years. On October 17, 2000, a cable failure caused a power outage that rendered the U1a hoist unable to remove personnel from the underground complex. On October 1, 2002, two workers were struck and injured by lightning at U1a. The Board's staff reviewed the corrective actions taken to address the cable failure and lightning strike occurrences, as well as the facility's electrical and lightning protection and detection systems. Detailed below are the staff's observations related to U1a.

Lightning Detection Capabilities—U1a is not capable of detecting locally forming storm cells, such as the one that caused the October 1, 2002, occurrence. Given this deficiency in the facility's lightning detection and warning capability, it is not clear that certain special activities conducted at U1a are adequately safe from lightning threats. U1a personnel are investigating the implementation of field mills to detect locally forming storms that could produce lightning events. Until these devices are installed and can be effectively utilized, however, it appears that compensatory measures are required to ensure nuclear and explosive safety during U1a operations.

Legacy Cable Combustible Loading—The Board's staff observed large bundles of legacy coaxial and diagnostic cables that represent an excessive amount of combustible loading (insulation and jacket material of the cables) in the tunnel. During a fire, these cables would

burn readily, allowing fire to propagate through the tunnel complex. In addition, the combustion of these materials would generate large volumes of toxic gases that could pose serious life-safety hazards to down-hole facility workers.

Hoist Drive Power Sources—A substation has been installed near the U1a shaft that has the capability to feed the hoist system and other loads within 3 hours. A second independent shaft and hoisting system, called U1h, has also been installed, primarily for the replacement and removal of major equipment from the underground complex. This new shaft could also be used as a means of egress in an emergency. Sufficient redundancy for the hoist system and egress now exists.

Device Assembly Facility. The DAF is a vital resource for maintaining the nation's nuclear stockpile. It was originally constructed for nuclear explosive operations, with the primary purpose of supporting underground nuclear testing at NTS. With the cessation of nuclear testing at NTS in 1992, the mission of the DAF evolved to supporting subcritical experiments, disassembly of damaged nuclear weapons, and other tests. Recently the DAF was chosen as the relocation site for activities (such as criticality experiments) currently performed at Technical Area-18 at Los Alamos National Laboratory. The Board's staff reviewed the electrical and the lightning protection and detection systems in the context of the DAF's evolving mission. Detailed below are the staff's observations regarding the DAF.

Lightning Standoff Distance—The staff observed that the lightning standoff, including detailed information on the proper use of qualified, process-related isolation devices, is not adequately captured in the existing Safety Analysis Report (SAR). The establishment of sufficient clear-air standoff distance is an essential component of the lightning protection philosophy currently employed at this facility. Although a variety of documents and reports (including the Nuclear Explosive Safety Master Study and Single Integrated Input Document) provide detailed information in this area, required standoff distances are not expressly delineated in the existing SAR. In addition, electrical isolation devices are not credited and functionally classified relative to this important safety function.

It is unclear how standoff requirements and other important components of the lightning protection philosophy will be codified in the upcoming DAF Documented Safety Analysis (DSA) being developed to comply with the mandates of Part 830 to Title 10 of the Code of Federal Regulations, *Nuclear Safety Management*. To ensure nuclear and explosive safety at the DAF, the results of existing reports and analyses should be used to clearly capture and appropriately credit all elements of the lightning protection system in the new DSA.

Unprotected Uninterruptible Power Supply (UPS)—Three large UPS units are relied upon to provide emergency power to important systems throughout the facility (e.g., emergency lighting, radiation air monitors, and blast door interlocks). These UPS units are located in the electrical room and are constructed with partially open top panels that provide heat dissipation. The orientation of these units is such that they sit directly beneath sprinkler heads of the fire suppression system. Given the partially open upper panels, water spray from the sprinkler

system during a fire or a spurious activation would penetrate the UPS equipment and could initiate water-induced short-circuiting, a common-cause failure that would leave emergency loads without uninterruptible emergency power.

Calibration of Protective Devices—To ensure reliable operation, Institute of Electrical and Electronic Engineers (IEEE) Standard 242-2001, *IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems*, recommends that electrical protective devices be maintained and calibrated in accordance with manufacturer's instructions. During a walkdown of the electrical room, the Board's staff observed that the calibration date had expired by several years for many of the protective devices. DAF personnel stated they would verify that required calibrations had been performed or perform the calibration tests on the expired relays to ensure that they will operate within allowable limits.

Pressure Alarm—Compressed air is required for closing and opening of critical cell and bay doors. Compressed air accumulators have pressure gauges, but no alarms annunciate in the control/operator's room upon loss of air or low pressure. Compressors for the air accumulators are located outside the main DAF building. If pressure were lost during operations, however, manually opening the doors during an emergency would be difficult. Procedural administrative controls exist at the DAF to check for air pressure prior to any operation. An alarm to annunciate low air pressure would provide a more reliable system for determining the operability of these critical cell and bay doors.

Oil-Insulated Transformer—Two oil-insulated transformers located inside the DAF structure are parts of the facility power distribution system. The transformer oil provides cooling for the transformer. Because the oil is flammable, it poses a fire hazard should the transformer leak or fail catastrophically. American National Standards Institute (ANSI) C2, *National Electrical Safety Code,* and National Fire Protection Association (NFPA) 70, *National Electric Code*, require that indoor oil-insulated transformers be located in a separate transformer vault. The code requirements for the transformer vault include fire walls and doors, ventilation, and oil containment. The DAF transformer is collocated with other electrical equipment, and the fire wall is breached by several cables in metal trays that are routed through the room. In addition, the cables could be damaged during a fire, and the loss of any function they provide needs to be evaluated.

G-Tunnel. G-Tunnel, or U12g, provides a safe location for staging and assessing a nuclear device, such as a damaged nuclear weapon or recovered threat nuclear device, involved in an emergency situation. No "normal operations" are anticipated at this time, and G-Tunnel will remain in "emergency phase" while an assessment is conducted in the tunnel. The Board's staff intended to review the adequacy of the electrical, lighting, lightning protection, and ventilation systems that maintain an environment safe for activities in the Disposition Alcove and access drift. Because G-Tunnel was closed for safety reasons, the in-tunnel facility walkdown was canceled. The Board's staff was able to observe the basic outdoor components of the ventilation system, such as electric motors, controllers, cables, and the offsite electrical system. The staff's observations related to these components at G-Tunnel are detailed below.

Ventilation System—Electric motors, motor controllers, and power cables (which are located outdoors) at G-Tunnel are old and degraded. The Board's staff observed severely damaged power cables, some with badly cracked jacket material, installed and routed through open vertical conduits. Water may have entered through these open conduits and deteriorated the electrical characteristics of the cable. The ventilation fan motor controllers were observed to be quite antiquated and exhibited a good deal of age-related wear. As a result, it was not clear that these components could be relied upon to perform their intended life-safety functions. Given concerns regarding worker life-safety, it would be prudent to evaluate the complete ventilation system, including electric motors, controllers, cables, and the installed ventilation ducts inside and outside the tunnel.

Site-wide Lightning Detection and Protection. The Board's staff made the following general observations regarding lightning detection, warning, and protection capabilities of the nuclear facilities at NTS.

Several facilities at NTS, including the DAF, JASPER, and U1a, perform operations in which SNM is collocated with significant quantities of HE. To protect these operations from lightning-related insults, both the DAF and U1a employ a 10-mile lightning proximity threshold. A strike inside this boundary triggers a halt-work order and the initiation of measures aimed at placing potentially vulnerable assemblies in a lightning-safe configuration and location. Unlike the Pantex Plant, however, DAF and U1a do not appear to have a defensible technical basis for ensuring that a 10-mile threshold can provide adequate forewarning to make potentially sensitive assets lightning-safe. Pantex uses a 35-mile lightning proximity threshold to declare cessation of nuclear explosive work. This threshold was derived from thorough evaluations predicting worst-case shutdown times for all approved nuclear explosive operations. It appears that this type of evaluation, or some other technically rigorous analysis, is warranted and necessary to ensure nuclear and explosive safety at the NTS facilities.

Lightning scenarios could initiate high-consequence accidents at NTS facilities where operations (normal or otherwise) involve SNM collocated with HE. Some operations involving SNM and HE could commence at various NTS facilities with little or no forewarning. However, not all of the facilities that could potentially house these operations are currently equipped with adequate lightning detection capabilities or well-documented lightning protection controls. It would be prudent to devise and ready for operation compensatory measures designed to mitigate potential lightning hazards until robust lightning detection and protection programs have been adequately documented and implemented at affected onsite facilities.