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# DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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October 23, 2000

The Honorable Madelyn R. Creedon  
Deputy Administrator  
for Defense Programs  
Department of Energy  
1000 Independence Avenue, SW  
Washington, DC 20585-0104

Dear Ms. Creedon:

The Defense Nuclear Facilities Safety Board (Board) and its staff have followed closely the development of lightning protection controls for nuclear explosive operations at the Pantex Plant. Since the Board's reporting requirement on this subject was issued in 1997, there has been significant improvement in the engineered and administrative controls in place at Pantex to address lightning hazards.

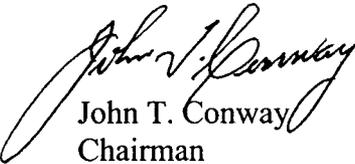
The enclosed staff report regarding a recent Readiness Assessment and Nuclear Explosive Safety Master Study for the Pantex *Lightning Basis for Interim Operation* (LBIO) is forwarded for your information and use, as appropriate. As discussed in this report, significant work remains. In particular, the Board has concerns regarding two recently written minority opinions.

In a minority opinion to the report of the Nuclear Explosive Safety Master Study, one study group member stated that the controls in place for certain facilities are inadequate to support continued nuclear explosive operations. Although the Board agrees with DOE's categorization of the related finding as post-start, based on the conservative nature of the controls already in place, this issue needs to be resolved.

The minority report to the LBIO Safety Evaluation Report concluded that the safety function for the lightning warning system should be not only to detect lightning, but also to warn affected facilities. The Board supports this minority opinion because for affected operations to be halted before lightning reaches the plant, not only must the lightning warning equipment detect lightning, but the plant communication systems must function to allow the warning to reach production operations. In addition, following a recent lightning warning at Pantex, more than 2 hours elapsed before adequate stand off distance was established. The lightning warning criteria in the LBIO and in the site-wide Technical Safety Requirements may not be adequate if more than 1 hour is required to shut down at-risk operations.

The Board requests a response from DOE within 30 days of receipt of this letter outlining the path forward and schedule for addressing these issues.

Sincerely,



John T. Conway  
Chairman

c: Mr. Richard E. Glass  
Mr. Daniel E. Glenn  
Mr. Mark B. Whitaker, Jr.

Enclosure

## DEFENSE NUCLEAR FACILITIES SAFETY BOARD

### Staff Issue Report

September 25, 2000

**MEMORANDUM FOR:** J. K. Fortenberry, Technical Director

**COPIES:** Board Members

**FROM:** W. White

**SUBJECT:** Implementation of the *Lightning Basis for Interim Operation*

This report documents multiple reviews by the staff of the Defense Nuclear Facilities Safety Board (Board). These reviews covered the Readiness Assessment and Nuclear Explosive Safety (NES) Master Study for the *Lightning Basis for Interim Operation* (LBIO). The Readiness Assessment was observed at the Pantex Plant by staff member W. White and outside expert R. West during July 25–August 4, 2000. The NES Master Study was observed by staff member A. Matteucci during July 31–August 4, 2000, at Pantex and on August 31, 2000, at the Department of Energy's Albuquerque Field Office (DOE-AL).

**Background.** On September 12, 1997, the Board wrote to DOE requesting a report on the hazard posed by lightning to nuclear explosive operations at Pantex, the controls needed to address that hazard, and the path forward for implementing and maintaining those controls. Nearly 3 years later (and after several interim control schemes and multiple letters from the Board), Mason and Hanger Corporation (MHC) and DOE have reached a quasi-stable state with respect to a final set of controls for lightning protection. These controls, outlined in the LBIO and in the *Technical Safety Requirements for Pantex Facilities* (TSRs), were reviewed by a NES Master Study Group for adequacy and by a DOE Readiness Assessment team for status of implementation. Until the LBIO and TSRs are fully implemented, nuclear explosive operations at Pantex continue to be conducted under controls defined in the *Lightning Justification for Continued Operation*.

**Nuclear Explosive Safety Master Study.** The lightning protection NES Master Study addressed the adequacy of programs and methodology for lightning protection of nuclear explosive operations at the Pantex Plant. The scope of the NES Master Study included inadvertent nuclear detonation and high explosive violent reaction resulting from a lightning environment. The NES Master Study Group identified several issues. These issues were discussed during deliberations and resulted in six post-start findings and a minority opinion, as documented in the draft report.

Two of the post-start findings addressed by the group involved the lack of NES input documentation concerning the hazards of fire and spalling resulting from a lightning strike.

These hazards will be reviewed in a future NES Study. Other post-start findings addressed the lack of a formal methodology for evaluating the Faraday cage characteristics of transportation equipment and facilities, issues related to calculating stand-off distances in the facilities, and a lack of peer review for the existing lightning protection analyses.

The most controversial post-start finding involved the higher maximum facility voltage levels during a lightning strike that could result from the inductance of the wires used to bond electrical penetrations to the facility reinforcement structure. This finding generated a minority opinion from a NES Master Study Group member, who believed the issue should have been a pre-start finding (i.e., no nuclear explosive operations allowed in affected facilities until the issue is resolved). In calculating stand-off distances in the facilities, Sandia National Laboratories (SNL) and MHC did not address the potential for higher maximum voltages resulting from the inductance of bonds used to connect electrical penetrations to the facility's Faraday cage.

According to the SNL subject matter expert, the conservatism incorporated into the analyses and assumptions used in calculating stand-off distances compensates for any unknown voltages that might result from bond inductance, at least as an interim measure. Because the conservative assumptions could not be clearly quantified or controlled, they were considered but not formally credited as mitigating features. These assumptions included the geometry of the bond conductor (the physical layout of the bond wires is likely to reduce their effective inductance), alternate current division paths (the entire lightning strike is not likely to travel the single, worst-case path through an individual facility), and the effective dielectric strength of air (the climate-controlled atmosphere in the bays and cells may have a higher breakdown voltage per unit distance than is credited in the analysis). In addition, stand-off distances in nuclear explosive facilities incorporate a 2:1 safety factor. Furthermore, defense-in-depth controls exist, including the lightning warning and detection system (certain high risk operations are not allowed during lightning warnings), the facility catenary and air terminal systems, and intrinsic bonding of electrical penetrations to the facility reinforcement.

The author of the minority opinion, however, believed that the conservative nature of the assumptions and the defense-in-depth discussed above did not provide sufficient controls to assure the safety of nuclear explosive operations at Pantex. In particular, the minority opinion held that the stand-off distances controlled (especially those that were only 1–3 inches) by MHC did not always assure the safety of operations in facilities in which the voltage across penetration bonds could reach 120 kilovolts (kV). Using the SNL procedure (including safety factors and conservative assumptions on the dielectric strength of air), these facilities might need a stand-off distance of 11 inches (a factor of 11 higher than actually exists). In most cases, however, the SNL subject matter expert contended that weapons operations rarely come within 11 inches of any facility penetration, and most of the operations (such as hoisting or electrical testing) that would violate that stand-off distance are suspended during lightning warnings.

After deliberating on the topic, the NES Master Study Group (with the exception of the member who wrote the minority opinion) concluded that the bonded stand-off distances (in

conjunction with the conservative analysis assumptions and defense-in-depth controls) were sufficiently conservative. The NES Master Study Group concluded that the conservative nature of the assumptions used to determine the stand-off distances, coupled with the defense-in-depth controls, was sufficient to support continued safety of nuclear explosive operations until the issue could be resolved as a post-start finding.

**Readiness Assessment.** The DOE Readiness Assessment was conducted during July 26–August 4, 2000, by a team consisting of a leader and five members, all from DOE’s Amarillo Area Office. The team was qualified with respect to experience and knowledge in the areas being reviewed, but demonstrated a lack of experience with the Readiness Assessment process. The Readiness Assessment identified 6 pre-start findings, 14 post-start findings, and 9 observations (including 1 positive observation). The team recommended that, upon resolution of all pre-start findings, approval of action plans for all post-start findings, and validation of compliance with the LBIO requirements for each bay and cell, implementation of the DOE-approved controls related to the LBIO be considered satisfactory for safe conduct of operations. The team considered as a pre-start requirement conduct of a limited-scope Readiness Assessment by the contractor for facilities that were not prepared to be reviewed at the time of the Readiness Assessment. Pre-start issues were identified in the following areas:

- Improper flow-down of controls to implementing procedures.
- Failure to implement the LBIO task exhaust hose with a semiconductive feature in several bays/cells.
- Insufficient knowledge of requirements of the LBIO and the implementing nuclear explosive engineering procedure on the part of production personnel.
- Compromise of the marked stand-off distance in several facilities.
- Inadequate labeling of task exhaust insulators, semiconductive hoses, air and vacuum hoses, and surge-suppressed electrical outlets.
- Inadequate marking of stand-off distance in many facilities.

It should be noted that the improper flow-down of controls was noted as a finding in the MHC Readiness Assessment as well, indicating an inadequate effort by MHC in closing findings from the contractor Readiness Assessment. In the area of marking stand-off distances and maintaining these distances free of compromise, the team noted that the number of problems found indicated the inadequacy of the contractor’s verification of readiness in this area. Although not identified as a finding by the DOE Readiness Assessment, these two issues indicate a lack of proper preparation and evaluation of the state of implementation of lightning protection controls before declaring readiness for starting the DOE Readiness Assessment.

The findings of the DOE Readiness Assessment provided an adequate picture of the state of implementation of lightning protection controls. However, several issues were noted with personnel, the Readiness Assessment process, and the state of implementation of controls that limited the effectiveness and efficiency of the team. Personnel on the team lacked experience with the Readiness Assessment process and were distracted by routine work requirements. The contractor and DOE reviews were not consistent in scope, which caused differences in areas assessed and findings developed. This contributed to the significant number of issues raised during the DOE Readiness Assessment related to compromise of stand-off distances, incorrect stand-off marking, and lack of readiness of some facilities. Also, the uncertain and changing status of implementation of controls and the multiple documents used for implementation not only made it difficult for facility personnel to understand the status of implementation of controls, but also affected the team's ability to understand and evaluate the status.

**Issues Identified by the Board's Staff.** In addition to issues raised by the NES Master Study Group and the DOE Readiness Assessment team, the Board's staff continues to have concerns with respect to the lightning protection program at Pantex. In particular, a minority opinion to the DOE Safety Evaluation Report issued on the LBIO concluded that the boundary of the safety-class system for the lightning warning and detection system should include the communications equipment used to promulgate that warning to production facilities. The minority report concluded that the safety function for the lightning warning system should be not only to detect lightning, but also to warn affected facilities. For affected operations to be halted before lightning reaches the plant, not only must the lightning warning equipment detect lightning, but the plant communication systems must function to allow the warning to reach production operations.

The Board's staff is also concerned about the timely resolution of post-start issues raised by the NES Master Study, particularly the issue addressed by the NES Master Study minority opinion. In addition, several issues raised by the staff in past reports remain open. These include inadequate support on the part of the plant shift superintendent during night shift operations, a lack of design agency information on weapon response to lightning strikes, and the need for improvements to and better surveillance requirements for the lightning warning and detection system. In addition, the number of personnel available to support lightning protection analyses at both MHC and SNL remains limited. The backlog of analyses remaining per the LBIO is extensive and may require years to complete with the limited personnel resources available.