

January 11, 2000

Brigadier General Thomas F. Gioconda
Acting Assistant Secretary for Defense Programs
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0104

Dear General Gioconda:

Since 1997, the Defense Nuclear Facilities Safety Board (Board) has been following the efforts of the Department of Energy to enhance the protection of nuclear explosive operations from lightning hazards. During this time, significant improvement has occurred in the Pantex lightning protection program in response to the Board's suggestions and encouragement. In particular, the recently approved *Evaluation of Lightning Hazards and Justification for Continued Operation of Nuclear Explosive Operations*, if properly implemented, represents a sound initial effort at providing a set of uniform, technically justified controls for all nuclear explosive operations at Pantex.

The Department of Energy should consider the additional improvements discussed in the enclosed staff issue report as the Basis for Interim Operation for lightning protection is being finalized. As discussed in the enclosed staff issue report, the Department of Energy and its Pantex contractor should also give careful consideration to increasing the utilization of subject matter experts in lightning protection during the development of authorization bases for specific weapon activities.

The Board and its staff will continue to follow this issue at Pantex closely. If you have questions on this matter, please do not hesitate to call.

Sincerely,

John T. Conway
Chairman

c: Mr. Rick Glass
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

December 7, 1999

MEMORANDUM FOR: G. W. Cunningham, Technical Director
J. K. Fortenberry, Deputy Technical Director

COPIES: Board Members

FROM: W. White

SUBJECT: Lightning Protection for Nuclear Explosive Operations at Pantex

This report documents a review of the Pantex lightning protection project, performed by members of the staff of the Defense Nuclear Facilities Safety Board (Board) on November 16–18, 1999. Staff members A. Gwal and W. White attended a meeting of the lightning protection project team to discuss the recently issued *Evaluation of Lightning Hazards and Justification for Continued Operation of Nuclear Explosive Operations* (PX-JCO-99-002). The staff also discussed the development of lightning protection controls with personnel responsible for developing weapon-specific authorization bases.

Background. In September 1997, the Board requested that the Department of Energy (DOE) prepare a detailed technical report providing a comprehensive analysis of the hazards posed to nuclear explosive operations by lightning, the controls necessary to prevent and mitigate those hazards, and the path forward for implementing and preserving the identified controls. In response, DOE formed a lightning protection project team tasked to define a technically justifiable lightning protection control scheme for Pantex nuclear explosive operations. During the past 2 years, Mason and Hanger Corporation (MHC) has made progress in developing engineered and administrative controls for lightning protection of nuclear explosive bays and cells at Pantex. Recently, MHC issued and DOE approved a Justification for Continued Operation (JCO), which defines a set of lightning protection controls for all nuclear explosive operations at Pantex.

Justification for Continued Operation. As discussed in previous staff issue reports, MHC has had difficulty implementing a consistent set of controls for lightning protection, particularly with respect to transportation operations and special-purpose facilities. Multiple letters from Sandia National Laboratories (SNL) on the advisability of assuming that fully assembled nuclear explosives will protect themselves from lightning strikes prompted MHC to write a JCO for lightning protection. The original version of the JCO actually lifted many controls already in place for lightning protection of fully assembled nuclear weapons. DOE did not accept the original version, however, and requested that a more comprehensive and conservative JCO, covering all nuclear explosive operations, be issued. The final, approved version of the JCO represents an attempt to provide a comprehensive set of lightning protection controls for all nuclear explosive

operations. This JCO, which should be implemented by mid-January 2000, is consistent with SNL's guidance on lightning protection of fully assembled nuclear explosives. In accordance with DOE's direction, the JCO will be replaced by a Basis for Interim Operation (BIO), to be issued and implemented by April 2000. The JCO should be sufficient to ensure adequate protection of nuclear explosive operations from lightning until that time.

The following items highlight opportunities for improvement in lightning protection controls as MHC and DOE implement the JCO and finalize the BIO:

- The new MHC organization for running the lightning protection project team does not yet appear to have a firm grasp of the complexities of this project. All actions are not yet defined in the project plan, and personnel from SNL indicate that expected milestone dates for national laboratory work may not be realistic. MHC also does not appear to appreciate the difficulty of implementing some of the project requirements, especially those related to surveillance of lightning protection components. Continued close oversight of this project by DOE could help ensure that the schedule does not slip as Pantex transitions from the JCO to the BIO.
- Permissive action link and code-activated processor operations are exempted from certain lightning protection requirements. This exemption is too broad. It would be better to clearly define and justify individual exceptions as necessary for specific operations.
- The JCO requires that all electrical tests of nuclear explosives be suspended immediately during lightning warnings and that the testers be disconnected. For certain tests, a nuclear explosive safety rule exists that requires the test to be done once and only once. For all operations, a nuclear explosive safety rule requires that electrical testing be kept to a minimum. It was not clear that DOE and MHC have compared the risk of continuing an electrical test during lightning warnings with the risk of repeating the test.
- The JCO's rationale for Zone 4 staging relies on weapons being stored in magazines of steel arch construction. The JCO does not, however, prohibit MHC from staging weapons in modified Richmond magazines instead.
- The testing recently completed to verify the dielectric properties of the LIFTALL commercial hoist slings is a positive development. However, testing indicates a breakdown at approximately 170 kV, and certain facilities (such as 12-44) could experience interior voltages as high as 141 kV during a lightning strike, even with bonded penetrations. The current safety margin (a factor of 2) credited in facility lightning protection controls is part of the computed distance for isolation of operations from electrical penetrations. To maintain consistency, a similar safety margin could be included for insulation devices that replace the normal isolation distance.

- It was not clear to the staff that the JCO adequately addresses separation test facility operations. The Kevlar cable credited as an insulation device will need to be tested (as is being done with other insulators), and the separation test assemblies will have to be closely evaluated to determine whether and how the equipment connects to penetrations through the Faraday cage. A lightning analysis of the facility could also be completed to ensure that the assumed maximum voltage (141 kV) during a lightning strike is conservative.
- For certain operations (such as vacuum chamber or purge and backfill operations), the inability to proceed during a lightning warning could lead to exceeding quality-related controls for the nuclear explosive. It would be prudent for DOE to evaluate carefully the risk of allowing the operation to continue during lightning warnings against the risk associated with rebuilding a nuclear explosive.
- The JCO and the lightning protection project rely on eventually crediting bomb cases as Faraday cages for certain hazard scenarios. It is not clear that SNL is willing to support this position. It might be prudent for DOE and MHC to consider alternatives to crediting bomb cases as lightning protection controls.
- Implementation of surveillance requirements from the JCO and BIO may be more difficult than MHC or DOE anticipates. In some cases, MHC has not adequately identified all components requiring surveillance. For example, MHC's approach to surge suppression was to test only the first-level suppressor, not the 480 V suppressor (both are credited in the analysis). It would be advisable for MHC to identify and test all suppressors credited as providing lightning protection for nuclear explosive operations. In other cases, writing an adequate surveillance procedure for a component or system (such as the lightning warning and detection system) could be more complex than anticipated. Also of concern are the immediate actions to be taken when a component fails surveillance. For equipment such as bonds and suppressors, failure of the component (especially if it is not easily and quickly repaired) may necessitate the immediate evacuation of nuclear explosives from the facility. In general, care should be taken when developing the BIO to ensure that all components of credited systems are tested and that the surveillance frequencies and procedures are adequate.

Weapon-Specific Controls for Lightning Protection. Treatment of lightning protection in recent authorization basis documents for specific weapon programs (such as the W62 and W88) has been inconsistent. For both the W62 and W88, controls identified in the Hazard Analysis Report are not always consistent with the Activity-Based Controls Documents generated for these programs. Authorization basis documents for different programs have also adopted significantly different approaches to analyzing the risk from lightning. The W62 hazard analysis, for example, attempted to justify lightning protection from a probability standpoint, but in doing so, used controls that were never defined or maintained. The W88 hazard analysis, on the other

hand, emphasized a deterministic approach, but explained away risk in a qualitative manner.

Both programs have also relied on the dielectric properties of insulators without sufficient justification. In the case of certain insulators (such as the hoist slings), subsequent testing confirmed adequate dielectric strength. However, this has not been true for all insulators. The Ceramaseal® insulator used for purge and backfill operations had been rated for 40 kV and approved to stand off a facility voltage of 12 kV. Despite the staff's objections, DOE was prepared to accept the adequacy of this device with little technical justification. During the meeting of the lightning protection project team, specific technical objections raised by national laboratory personnel resulted in MHC's finally testing the insulator. Voltage breakdown tests under vacuum conditions similar to those experienced during purge and backfill demonstrated that the insulator was adequate to withstand only 6 kV. As a result of this test, MHC has decided to halt purge and backfill and establish the appropriate standoff distance if a lightning warning is issued.

Both DOE and MHC are aware of the problems discussed above. In these cases (especially the W62), involvement of subject matter experts in lightning protection during the development of weapon-specific lightning protection controls appears to have been limited. In the future, according to MHC and DOE personnel, generic lightning protection controls will be removed from weapon-specific authorization basis documents. Only controls that are unique to specific weapon systems will remain in the weapon-specific authorization basis documents. DOE and MHC would be well advised, however, to ensure that the appropriate lightning protection experts are integrated into future project teams for individual weapon programs. Doing so would assist MHC in providing consistent, adequate lightning protection controls for all nuclear explosive operations.

Lightning Warning and Detection System. As discussed in the staff's past issue reports, the lightning warning and detection system remains a key component of overall lightning protection at Pantex. A recent report of the lightning protection project team highlights several ways to improve this safety-class system. Recommended improvements include adding an additional night shift operator to provide better coverage during hours when the probability of lightning is significantly higher and enhancing the detection of fast-moving weather to improve warning times. However, improvements in the lightning warning and detection system are not part of the current project plan for lightning protection.

Conclusion. DOE and MHC continue to improve the lightning protection program for nuclear explosive operations at Pantex; however, additional room for improvement remains. The staff will continue to follow the lightning protection project as Pantex implements the JCO and then transitions to the BIO.