



Department of Energy
Washington, DC 20585

June 1, 1998

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

In my February 20, 1998, letter to you, I committed to provide a more definitive path forward to resolve the lightning hazard at Pantex. This was to follow the March 4, 1998, meeting in Albuquerque on this topic.

The purpose of the March 4, 1998, meeting at which your staff was well represented was to:

- a. Gain a common understanding of lightning issues at Pantex; and
- b. Agree on a path forward to resolve these issues at Pantex.

The Lightning Protection Project Team Project Plan (enclosed) is being implemented as the path forward. The following summarizes the key activities outlined in the Plan:

1. Pantex will continue bonding/surge suppression (includes reliability, surveillance, etc.). (Sandia National Laboratories (SNL) continue to work on Penetration Tester.)
2. The SNL/Lawrence Livermore National Laboratory (LLNL) will measure a cell at Pantex (to be compared to current models).
3. The Los Alamos National Laboratory/LLNL/SNL will apply best engineering judgment to develop a quantitative risk analysis to "BIN" lightning issues and develop a fault tree (including detonators) to identify credible scenarios. The Mason and Hanger Corporation (MHC) will act on any short-term improvement opportunities.
4. Pantex will determine the maximum voltage that could enter a facility if it was unbonded (i.e., determine range of breakdown voltages for penetrations into bays and cells and use to determine appropriate standoff distance requirements).

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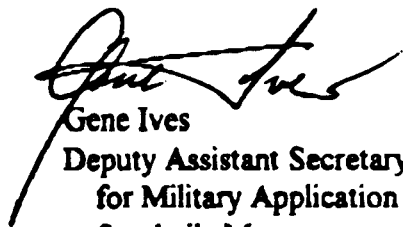
5. The MHC, with lab support, will evaluate weapons operations for lightning safety (covers, procedure hold points, devices, etc.) as well as minimization of risks (transportation, etc.).
6. The Department of Energy will host a "lightning expert" symposium, including armed services and academia invitees.
7. Pantex will review the lightning warning system at Pantex for adequacy.
8. Pantex will write the Basis for Interim Operation revisions to upgrade the Pantex authorization basis to address the lightning hazard.
9. Pantex will finalize and transmit the lightning report requested in your letter of September 12, 1997.

As discussed in my February 20, 1998, letter the hazard presented by lightning to the weapon systems stored in Zone 4 West, as well as any necessary additional lightning protection enhancements, will be addressed when the Lightning Protection Team evaluates the threat from lightning to explosive facilities.

We will continue to keep the Defense Nuclear Facilities Safety Board staff informed of our progress in this matter.

Should you have questions, please contact me or have your staff contact Mr. Steve Goodrum at (806) 477-3180.

Sincerely,



Gene Ives
Deputy Assistant Secretary
for Military Application and
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Defense Programs

Enclosure

cc:
M. Whitaker, S-3.1

Lightning Protection Project Team Project Plan

The Lightning Protection Project Team (LPT) was formed to address concerns that have been identified with regard to the adequacy of the protection provided to collocated explosives and nuclear materials within the nuclear explosives areas (NEAs) at Pantex. The objective of this effort is to determine the likelihood of a lightning strike within Zone 12 South; the electrical environment produced within the NEAs as a result of a strike; the measures necessary to protect weapon systems and components from the effects of lightning; and the implementation of any controls necessary to provide the required level of protection. The DOE Explosives Safety Committee, in cooperation with the Department of Defense Explosives Safety Board, is currently evaluating the threat from lightning to explosives facilities. As more progress is made in addressing the threat from lightning in the Pantex NEAs, the LPT will develop a plan to assess the risk from lightning to the Pantex explosive operations conducted in non-nuclear facilities taking into account any recommendations made by the DOE and DoD committees. The weapon storage magazines found in Zone 4 are identical to the explosive storage magazines used at many DoD and DOE sites. An evaluation of the threat posed by lightning to these structures will be included in LPT's follow-up effort to examine non-nuclear explosive facilities.

The current path forward consists of nine major elements. The following is a discussion of each element and current status of its implementation.

1. Pantex to continue with installation of bonding and surge suppression.

Based on the current understanding, the most effective approach for providing lightning protection in the Pantex NEAs is to utilize the structural steel of the facility as a Faraday cage. The Faraday cage formed by the rebar will limit the interior voltages to levels for which isolation or insulation can be provided without significantly impacting operations. To complete the Faraday cage, all metallic penetrations must be bonded to the cage and surge suppression must be provided on all electrical power and communication circuits entering the cage. This allows a "belt and suspenders" defense in depth approach to be applied to lightning protection; with the Faraday cage, including bonding and surge suppression, representing the "belt." The "suspenders" are achieved by providing isolation or standoff distance adequate for the voltage produced by an unbonded penetration wherever possible. Where this separation cannot be achieved, a methodology is applied in the following order of preference:

- (1) determine unbonded standoff distance for the penetration in question and determine if this standoff distance is adequate, if not
- (2) determine if the penetration in question has multiple intrinsic bonds as well as an engineered bond, if not
- (3) provide two engineered bonds and increase the surveillance frequency to increase assurance that the bonds remain in place.

Implementation of the Faraday cage/isolation approach for lightning protection appears to be necessary regardless of any additional protection systems that may be installed. Pantex is continuing to implement the elements of the Faraday cage/isolation methodology.

The installation of surge suppression, in accordance with LPT recommendations, for the AC power circuits has been completed in all of the Pantex NEAs. The LPT is still working on recommendations for surge suppression for the communication circuits entering these facilities.

Standoff requirements are currently being implemented with an Engineering Instruction (EI) instead of through the Basis for Interim Operation (BIO) or other authorization basis document. The EI addresses current requirements for standoff distances for bonded and unbonded facilities; operations, transportation, and use of AC powered testers during lightning warnings; protection requirements for full up units; and requirements for bonds.

With the exception of 12-98 cell 4, all of the Pantex cells that are used for nuclear explosive work have been bonded. Bonding of 12-98 cell 4 is targeted to be completed by September 25, 1998. The only operations being conducted in 12-98 cell 4 are those involving full up units, therefore, lightning protection is less critical.

Bonding of penetrations in 12-64 is 41%, 7 of 17 bays, completed.
Bonding of penetrations in 12-84 is 50%, 10 of 20 bays, completed.
Bonding of penetrations in 12-99 is 50%, 3 of 6 bays used as NEAs, completed.
Bonding of penetrations in 12-104 is 44%, 7 of 16 bays, completed.
Bonding of penetrations in 12-50 has not been initiated yet.
Bonding of penetrations in 12-60 is 50%, 1 of 2 bays used as NEAs, completed.

Some of the bays and cells are used for activities other than nuclear explosives operations and bonding is not necessary. In the bays and cells used as NEAs that have not yet been bonded, Mason & Hanger Corporation (MHC) is providing standoff distance adequate for the voltage produced by an unbonded penetration and suspending hoisting operations during lightning warnings. In addition, transportation through the ramps during lightning warnings is limited to full up units and partial assemblies that have been reviewed and approved by Sandia National Laboratories (SNL). The partial assemblies that have been approved for movement during lightning warnings are the B83, W79, W69, B61, and B53. In facilities that have not been analyzed for the voltage produced by an unbonded penetration, and have not yet been bonded, 84 inches of clear air standoff is being provided. The facilities that require the 84 inch standoff are 12-50 and 12-99 bays 2, 4, 6, 7, 8, and 9. The maximum voltage produced by an unbonded penetration has ranged from 144 kV to 356 kV in the facilities that have been analyzed so far.

The remaining bays are being bonded at the rate of four per month in accordance with the attached schedule. Bonding of the penetrations in the remaining bays is expected to be completed by December 31, 1998. In addition, MHC has committed to reassessing two facilities per month. The reassessment is being performed to properly document the integrity of each bond. The reassessment process, without the SNL penetration tester, involves disconnecting the bonds from the penetration and measuring the resistance back to the counterpoise of the facility lightning

protection system.

Before an operation or activity can be started up or moved to a different facility, MHC is required to provide the Amarillo Area Office (AAO) with 48 hours notice. As part of this notification, MHC is required to submit a completed PX-3322, "Weapon Process or Cycle Start Readiness Checklist." The checklist includes a verification that the enhanced lightning protection features (bonding, surge suppression, and isolation) are in place. The verification is performed using the criteria in procedure AAO-LPT-1, "Lightning Protection Interim Validation Procedure." AAO-LPT-1 was developed by the LPT to provide guidance for verifying the adequacy of the Faraday cage/isolation approach to lightning protection as it is currently being implemented at Pantex. The LPT is evaluating the appropriate controls for ensuring that appropriate standoff and bonding is utilized for all nuclear explosive operations.

Bonding across the discontinuity in the roof rebar in the bays, created by the venting design of the roof, has not yet been scheduled. Bonding across the roof discontinuity in 12-84 bay 16 was completed and the bay tested by SNL during the week of April 20. The results of the SNL testing effort are still being analyzed. If bonding of the roof discontinuity proves effective, a schedule will be developed for the remaining bays. The additional nine bonds is calculated to lower the voltage present in the bays by approximately a factor of 16, which should result in a maximum voltage of less than 10 kV for any bay.

SNL has procured all of the parts necessary to build a penetration tester. One technician will be required to assemble it. A prototype of the SNL penetration tester was evaluated during the week of April 20. The tester is expected to be completed by the end of May. If the tester proves effective, the reassessment process will be less intrusive because the bonds will not have to be disconnected to verify their electrical connection to the facility rebar. The prototype tester is being used to test all of the penetrations in 12-98 cell 1 in preparation for the W79 program. This is being done to determine the amount of bonding that is intrinsically provided by the facility (i.e., through supports, anchors, and direct connections to rebar) in addition to the bonds that have been added to all penetrations.

2. SNL/LLNL to conduct measurement of a bay and a cell at Pantex for comparison to the results obtained from the current models.

The I.P.T has performed an analysis of the potential lightning threat at Pantex. The analysis was used to determine the magnitude of the voltage/current that may be present in a nuclear explosive area, bay or cell, resulting from a lightning strike. Because of the availability of test data from similarly constructed facilities, this analysis relied extensively on existing data. The team based its conclusions on conservative (worst case) assumptions and maximum lightning parameters.

Analysis techniques developed by SNL have been used to determine the magnitude of the voltage/current that may be present in a nuclear explosive area, bay or cell, resulting from a lightning strike. The 99th percentile, worst case, lightning parameters were used in the SNL analysis. In order to ensure that there are no unique design features which have not been adequately modeled, SNL and LLNL will test a bay and cell to determine the voltage/current

environment produced by a lightning strike.

SNL tested two bays and a cell during the week of April 20, 1998. The preliminary test results indicate that the voltage environment in 12-44 and 12-84 is lower than expected. The preliminary results for 12-64 were similar those produced by the analytical model. SNL is currently analyzing the results of these tests to determine whether the differences between the test and calculated results are attributable to modeling assumptions that don't reflect actual facility construction or an inadequate test methodology.

LLNL began testing one facility per month in May. The LLNL testing will be on one bay and one cell protected by each type of lightning protection system, integral and overhead wire.

3. LANL/LLNL/SNL to apply best engineering judgment to develop a quantitative risk analysis to "BIN" lightning issues and develop a fault tree to identify credible scenarios for an ND caused by lightning. MHC will implement any short-term improvement opportunities.

MHC Risk Management is developing an event tree for an ND initiated by lightning using the draft event tree developed by SNL. The event tree will be provided to LLNL, SNL, and LANL for peer review by the June 2-3, 1998 "lightning expert" symposium. The event tree will then be used as the basis for developing the protection methodologies necessary to provide the desired level of safety.

4. Understand the maximum voltage that could be produced in a facility as the result of a lightning strike to an unbonded metallic penetration and determine the appropriate standoff distance requirements.

With the exception of 12-44, 12-85, and 12-99, the maximum voltage that could be produced has been determined for all of the Pantex NEAs. In the facilities that have been analyzed so far, the maximum voltage produced by an unbonded penetration has ranged from 144 kV to 356 kV. MHC is measuring the concrete thickness over the rebar so that the calculations can be performed for the remaining facilities. Currently, there are significant safety margins used for the dielectric strength of concrete when determining these voltages.

Given the conservatism built into the analysis, the LPT will be discussing the need for these safety margins at its May meeting. Without the safety margins, the unbonded standoff distances can be significantly reduced.

5. MHC, with lab support, evaluate weapons operations for lightning safety.

This effort will be initiated once the maximum voltage environment, bonded and unbonded, is determined for the NEAs. This effort is expected to start on July 17, 1998, after the each of the labs has reviewed the event tree and the events necessary for a lightning strike to result in an ND are more thoroughly quantified.

6. DOE to host "lightning expert" symposium, include/invite armed services and academia.

The purpose of the symposium is to develop a common understanding among the involved parties of the lightning phenomenon, the hazards presented by lightning, and the methodologies available for providing protection from its effects. DOE and SNL are arranging the symposium and locating outside experts. The symposium will be held on June 2-3 in Albuquerque. The symposium will include presentations on lightning phenomenology; shielding and protection; dielectric breakdown and arcing; the basis for the SNL analysis; rocket triggered lightning tests; as well as protection methodologies employed by the Department of Defense and the United Kingdom. The symposium will also include a panel discussion on the relative merits of the lightning protection methodologies employed by Pantex, the DoD, and the UK; the risk to a warhead at Pantex from lightning; and additional protective measures available to improve lightning protection at Pantex.

7. Review the Pantex lightning detection/warning system for adequacy.

Because adequate isolation may not be feasible for all operations, a reliable, accurate lightning detection/warning system that provides sufficient advance warning is essential to allow these operations to be suspended when lightning is in the area.

The review of the Pantex warning system will be the major agenda item for the LPT's June meeting. This topic was also discussed with representatives of the Indian Head, MD division of the Naval Surface Warfare Center during the LPT meeting of April 2, 1998.

The MHC Risk Management Department will determine if the warning provided by the existing detection systems is sufficiently accurate, reliable, and timely enough to allow operations to be put in a safe configuration. Should the warning time prove inadequate, enhancements to the existing warning/detection systems will be investigated.

8. Write Basis for Interim Operation (BIO) revisions to upgrade the Pantex authorization basis to address the lightning hazard.

Because the criteria for implementing the Faraday cage/isolation approach in the Pantex NEAs are continually being refined, the controls are being instituted with an Engineering Instruction (EI). The EI is a temporary procedure mechanism that will allow the controls to be easily modified as additional work is done to further refine the lightning induced electrical environment within the NEAs. When the testing/analysis phase is complete the controls will be moved to the Basis for Interim Operation (BIO), Critical Safety Systems Manual (CSSM), and the Activity Based Controls Documents (ABCDs). As the controls, and particularly the maintenance/inspection requirements, are more completely defined, the LPT will provide the necessary changes/additions to these documents to the Risk Management Department for processing.

The revisions to the BIO will be developed after the event tree, SNL/LLNL testing, and the determination of minimum standoff distances required for unbonded penetrations have been

completed. This effort is expected to start in June 1998.

9. Finalize and transmit the lightning report requested by the DNFSB on September 12, 1997.

The report will be ready to be completed after the results of the event tree, SNL/LLNL testing, and the minimum standoff distance required for unbonded penetrations have been incorporated. This effort is expected to begin in June 1998. Approximately three weeks will be required to review and revise the report.

A project plan detailing the actions and resources necessary to accomplish the previously discussed actions is attached.