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# DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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November 3, 2004

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:


The staff of the Defense Nuclear Facilities Safety Board (Board) recently reviewed a number of issues at the Pantex Plant related to electrical and lightning protection systems. Many of these issues were raised initially in an August 6, 2002, letter from the Board.

The Board is pleased to note the progress made in addressing many of the issues raised in that letter. In particular, the Pantex Plant contractor, BWXT Pantex, has completed activities to protect safety-class electrical equipment from spurious sprinkler activation and repair leaking roofs in electrical equipment areas. The Board is also pleased to note that progress has been made in publishing initial reports on low-voltage testing of nuclear explosive facilities. However, not all of these are as yet final, and efforts to repeat the results of these initial tests have not been successful. In addition, a number of significant issues related to lightning protection identified in BWXT project plans remain unresolved. The Board encourages the National Nuclear Security Administration (NNSA) and its contractors to finalize the outstanding items from these project plans expeditiously.

The Board is also encouraged that NNSA has decided to take the opportunity to address known deficiencies in the electrical distribution systems for Buildings 12-44 and 12-64 as part of the ongoing projects to upgrade these facilities. It would appear reasonable to address these known inadequacies in the surge suppression system while completing other significant upgrade work related to the electrical distribution systems for these facilities.

The enclosed report prepared by the Board's staff contains a number of observations concerning electrical and lightning protection systems at the Pantex Plant. This report is provided for your information and use as appropriate.

Sincerely,

A handwritten signature in black ink, appearing to read "John T. Conway". The signature is fluid and cursive, with a large initial "J" and a long, sweeping underline.

John T. Conway  
Chairman

c: The Honorable Everett Beckner  
Mr. Daniel E. Glenn  
Mr. Mark B. Whitaker, Jr.

Enclosure

# DEFENSE NUCLEAR FACILITIES SAFETY BOARD

## Staff Issue Report

October 22, 2004

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

**COPIES:** Board Members

**FROM:** W. White

**SUBJECT:** Electrical and Lightning Protection Systems at the Pantex Plant

This report documents a review performed by the staff of the Defense Nuclear Facilities Safety Board (Board) of electrical and lightning protection systems at the Pantex Plant. Staff members A. Gwal and W. White, with outside expert R. Collier, participated in this review during August 24–26, 2004. The report also documents follow-up discussions with the National Nuclear Security Administration's (NNSA's) Pantex Site Office (PXSO) in October 2004.

**Lightning Protection Systems.** In September 1997, the Board issued a reporting requirement to the Department of Energy (DOE) regarding the controls necessary to address the hazard posed by lightning to nuclear explosive operations. Following DOE's initial response to this reporting requirement, the Board reviewed this issue periodically at the Pantex Plant to monitor progress in addressing open and emerging issues related to lightning protection.

*Low-Voltage Testing*—In a letter dated August 6, 2002, the Board encouraged NNSA and its contractors to complete documentation of the low-voltage testing done to validate analytical models of the maximum facility voltages possible as a result of a lightning strike. The documentation of the initial testing has now been completed, although some of the reports have not been finalized. In addition, BWXT has worked to develop an internal capability to perform the required periodic low-voltage testing of facilities, reducing its reliance on the limited resources available through Sandia National Laboratories.

The periodic surveillance testing conducted thus far by BWXT has been problematic, however. The Technical Safety Requirements (TSRs) for Pantex facilities mandate that low-voltage testing be conducted on each facility type every 5 years to validate the facilities' Faraday cage characteristics. For Building 12-44, the initial testing, accomplished by Sandia in 1998, indicated certain facility characteristics that allowed the maximum potential voltage threat to be lowered from 141 kV to 25 kV. This testing should have been repeated in 2003. For a number of reasons, however, BWXT was unable to perform the testing until May 2004, taking advantage of a 25 percent grace period allowed in the TSRs.

BWXT was unable to correlate the results of its retest of Building 12-44 with the original test results documented by Sandia: the electric fields measured by BWXT were significantly

lower than those measured by Sandia. Since it is unlikely that the Faraday cage characteristics of the facility have improved significantly with age, BWXT considered the test results invalid. A Justification for Continued Operation (JCO) was written, which raised the facility voltage back to 141 kV. The BWXT JCO points to a number of differences between the BWXT and Sandia tests—including different equipment used, lower excitation levels, different drive points, and new facility weatherproofing—that may have contributed to the different results obtained.

In discussions with the Board's staff, PXSO and BWXT agreed that the low-voltage testing done for facilities needs to be repeatable and must be able to indicate significant changes in those facility characteristics credited for lightning protection in the safety basis. PXSO and BWXT were considering options that included creating a permanent test attachment point for each facility once such a point can be identified that provides credible information on the structure's response to a lightning strike. Care would need to be taken, however, to prevent such a test attachment point from becoming a preferential attachment point for real lightning strikes.

*Facilities without Adequate Surge Suppression*—In December 2003, a BWXT engineer questioned whether, in the event of a lightning strike to nuclear explosive facilities, alternative pathways exist that could bypass the surge suppression credited in the safety basis for mitigating the impact of a lightning strike. These alternative pathways include telephone circuits, exposed electrical outlets, heat trace elements, and other circuits that have the potential to provide a pathway to the electrical distribution system on the facility side of the existing surge suppression. In late February, BWXT determined that these circuits exist and could circumvent the surge suppression as designed.

Following this determination, a JCO was approved to address the issue. The JCO established several compensatory measures, including raising the maximum facility voltage considered possible in a lightning strike to 60 kV where the bonded voltage was less than 60 kV. The basis for this voltage limit was an analysis by BWXT concluding that voltages higher than 60 kV would cause arcing between conductors in electrical circuits, effectively limiting the maximum potential voltage.

A nuclear explosive safety review team suggested additional work to verify the dominant mechanism for voltage breakdown in these alternative pathways. During the staff's review, the Board's outside expert suggested that BWXT consider the potential time lag of any arc formation in the testing being planned to verify the dominant voltage breakdown mechanisms. It is possible that the voltage rise from a lightning strike could occur more quickly than the credited insulation breakdown and arc formation. Should this be the case, it is possible that the maximum voltage could be much higher than 60 kV. BWXT agreed to evaluate this scenario during the planned testing activity.

*Lightning Detection and Warning System*—In May 2004, one of the four lightning sensors (located in Pampa, Texas) for the lightning detection and warning system (LDWS) at the Pantex Plant began to experience frequent failures. These failures were identified by the Pantex Operations Center, and personnel appropriately entered a limiting condition of operation (LCO)

in the *Technical Safety Requirements for Pantex Facilities* (LCO 3.5.1). This LCO allows up to 14 days to return a failed sensor to operable status.

The sensor would typically recover from such failures within hours, but would fail again within a day. These spontaneous recoveries allowed BWXT to exit the LCO without addressing the cause of the failures—the telephone communications circuit between the sensor and the Pantex Operations Center.

BWXT has communicated with the vendor for telephone service to obtain a commitment to pursue the repair of the circuit diligently. BWXT is also working to obtain alternative sources of data from sensors that are part of the National Lightning Detection Network. BWXT hopes to integrate the data from four new sensors into the LDWS software without having to purchase or maintain the sensor hardware. This appears to be a reasonable, cost-effective approach to increasing the reliability of the LDWS.

*Lightning Protection Project Plans*—Open issues and areas for improvement are tracked at the Pantex Plant through the *Lightning Protection Authorization Basis Project Plan*. This plan contains key actions that remain open. Among these are an investigation into the potential for spalling of interior concrete surfaces as a result of a lightning strike and an evaluation of the impact of added inductance from facility bond wires. These issues were originally raised during a nuclear explosive safety study conducted in August 2000. The latest schedule for resolution of these issues is late 2004 or early 2005. The need to resolve these issues was noted in the report attached to the Board's letter of August 6, 2002, but progress toward addressing them has been limited.

The report forwarded by the Board also noted the need to address the potential for indirect coupling mechanisms from a lightning strike to impact nuclear explosive operations. Following receipt of the Board's letter, NNSA and its contractors developed a project plan, *Investigation of Lightning Initiated Indirect Effects at Pantex*. The progress made to date, however, has been limited. Sandia recently completed an analysis of the worst-case threats that could be posed by such mechanisms. This analysis indicated that the potential threat is marginal for main charge detonators, but may be problematic for other explosive initiators that pose hazards to worker safety. BWXT has transmitted this analysis to the design laboratories for weapon response.

**Electrical Systems.** The Board's staff reviewed several issues related to electrical distribution systems at the Pantex Plant. These issues related to a range of topics, from proposed facility upgrades to existing electrical distribution equipment.

*Upgrade Projects for Buildings 12-44 and 12-64*—The staff reviewed proposed modifications to the electrical systems for Buildings 12-44 and 12-64. At the time of the staff review in August 2004, the modifications to the electrical systems for these facilities did not address the known deficiencies discussed above in the surge suppression of electrical systems.

However, on October 7, 2004, NNSA directed BWXT to resolve the surge suppression issues for those facilities as part of the ongoing upgrade projects.

The staff also suggested that BWXT consider instituting a cable monitoring program as part of the upgrades for Buildings 12-44 and 12-64. Many of the electrical cables used in these buildings are approaching or past their intended service life. Replacement of aged and deteriorated cables should be considered at the time of a design modification of the distribution system. As cables age, their electrical characteristics may degrade to an unacceptable level, decreasing the reliability of both the cables and the systems they support. Because these cables supply power to a number of important facility systems (including radiation monitoring equipment and emergency lights), it may be prudent to establish a baseline for the remaining life of the cables and to incorporate a capability to monitor the condition of cables into the existing preventive maintenance regime.

*Electrical Equipment Rooms*—The staff walked down several facilities and equipment areas and noted significant progress in addressing electrical system issues raised by the Board in its letter of August 6, 2002. Vulnerable electrical equipment has been provided with raised covers to protect against fire suppression systems, nonrated electrical equipment has been screened and reviewed, and leaking roofs over equipment areas have been repaired.

During a walkdown of the electrical room in Building 12-99, however, the Board's staff observed an air-conditioning unit above the batteries supplying a safety-related uninterruptible power supply (UPS). The condensate water from the air-conditioning unit could leak on the batteries and disable the UPS. Additionally, PXSO senior staff expressed concern regarding the provision for load testing of a UPS in Building 12-116. Institute of Electrical and Electronics Engineers (IEEE) Standard 446-1995, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*, requires that a complete operational test of the UPS, including operation at full load, be performed biannually. BWXT has agreed to evaluate this issue.

**Electrical Safety.** The staff discussed the new draft version of the *DOE Handbook on Electrical Safety* with BWXT personnel. The electrical safety committee at the Pantex Plant appeared to have become less than fully functional since the staff's last review, apparently as a result of the reassignment of personnel on the committee. During the August 2004 discussions, BWXT identified two personnel responsible for reconstituting the committee and committed to recommence monthly meetings. One of the committee's functions will be to monitor electrical safety occurrences. There have been several significant occurrences recently, particularly for subcontractor work.

**Loss of Power.** In May 2004, the Pantex Plant suffered a significant power outage that impacted most plant operations. The outage resulted from activation of a protective relay at the south substation that occurred when the north substation was offline. All safety-class and safety-significant systems appeared to function as designed. However, a number of problems did occur during the outage that provided BWXT with valuable information on areas for improvement.

These problems included a lack of paper procedures should electronic ones become unavailable, the loss of backup power to emergency lighting, and the absence of formalized recovery procedures.

On a positive note, BWXT had initiated an effort well before the loss-of-power incident to develop and implement a procedure for such events. Draft checklists resulting from this effort were available to BWXT facility personnel during this occurrence. BWXT representatives discussed this continuing effort with the Board's staff during the review. The staff encouraged BWXT to finalize the procedures and checklists and to provide as much specific detail as possible.