DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 22, 2001

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

Dear General Gioconda:

Enclosed for your consideration and action, as appropriate, is a report summarizing observations made by members of the staff of the Defense Nuclear Facilities Safety Board (Board) concerning the implementation of lightning protection controls at the Pantex Plant. These observations are based on reviews of the Pantex *Lightning Basis for Interim Operations;* the associated Technical Safety Requirements (TSRs); the Pantex *Lightning Protection Authorization Basis Project Plan*; and discussions with personnel representing the U. S. Department of Energy, National Nuclear Security Administration (NNSA), and the Pantex contractor.

In the enclosed report, the Board's staff concludes that the latest revision of the project plan is incomplete and notes that many individual projects continue to fall further behind schedule. Of particular concern, only 5 of 14 groups of facilities currently have documented test results evaluating maximum interior voltages in the event of a design basis lightning strike. Further, retest requirements (every 5 years) for these facilities will begin coming due in the next 2 years, resulting in a considerable testing backlog. The report also identifies a lack of progress in this area due to complete reliance on Sandia National Laboratories (SNL) for the conduct of this testing.

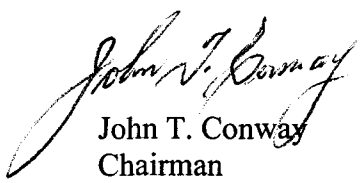
Additionally, the Board's staff report raises issues related to other possible energy transfer mechanisms, such as concentrated currents that generate a large magnetic field, inducing unknown current levels in nearby nuclear explosives. The evaluation of this issue may also require testing.

The Board believes a concentrated effort must be made to reduce or eliminate the testing backlog at Pantex. A lack of resources is contributing to the delays being experienced. The testing program, including analyses, essentially relies solely on one individual at SNL. Although the contributions this individual has made to lightning safety at Pantex are substantial, the work for which he is now responsible in the project plan appears to be too much for any one person to

perform. The failure of NNSA to prioritize his tasking adequately has impacted the schedule significantly. The Board has observed that nearly half of the lightning projects for which SNL is the lead organization are behind schedule. The problem would be mitigated at least partially if the Pantex contractor had an internal capability for facility testing and analysis.

The Board asks to be kept abreast of the Department of Energy's actions regarding the issues raised in the enclosed report.

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

June 8, 2001

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: A. K. Gwal

SUBJECT: Review of Lightning Protection Controls at Pantex Plant

The U. S. Department of Energy, National Nuclear Security Administration's (NNSA) Amarillo Area Office (NNSA/AAO) and the contractor for the Pantex Plant, BWXT, are continuing efforts to implement the controls developed in the site Lightning Basis for Interim Operation (LBIO) and codified in the site Technical Safety Requirements (TSRs). Members of the staff of the Defense Nuclear Facilities Safety Board (Board) T. Dwyer, A. Gwal, and W. White and outside experts R. Collier and
R. West reviewed the implementation effort, including the *Lightning Protection Authorization Basis Project Plan*, and toured site facilities to observe the lightning controls in situ.

Background. Pantex developed the LBIO to collect all site-wide lightning protection information and accident analyses into a single document. The LBIO provides the safety basis for lightning-related scenarios and will eventually serve as a module in the site Safety Analysis Report (SAR). The accident analyses in Chapter 3 of the LBIO led to the identification of controls appearing in the site-wide TSRs. The LBIO was initially approved by NNSA/AAO in a Safety Evaluation Report (SER) dated April 2000, with 13 conditions of approval. A subsequent Readiness Assessment in July–August 2000 and a Nuclear Explosive Safety (NES) Master Study in August 2000 resulted in additional findings that required corrective action. *The Lightning Protection Authorization Basis Project Plan* delineates these corrective actions through the end of fiscal year 2001 (FY01).

Issues. The Board's staff identified the following issues during its review of the *Lightning Protection Authorization Basis Project Plan* and the implementation of the controls developed in the LBIO.

Project Plan Deficiencies—The project plan was intended to delineate those activities necessary to fully establish the final end-state design features and associated surveillance and in-service inspection requirements. BWXT revised the project plan in February 2001 to incorporate comments from NNSA/AAO, provide cross-references to SER comments, clarify some task descriptions, include corrective action plans resulting from the NES Master Study, and update the list of completed items. The scope of the plan was changed to provide an integrated response to the findings of the SER and NES Master Study, but was based on NNSA priorities

and the capability of Sandia National Laboratories (SNL) to provide necessary resources during FY01. As a result, the plan's scope was changed to exclude activities beyond FY01 and did not include the full set of actions needed to complete implementation of the lightning protection program.

Project Plan Implementation—The Board's staff observed that progress had been made on implementation actions associated with validation of the effectiveness of the lightning warning system, installation of new task exhaust equipment, and periodic testing of insulators by BWXT. However, a significant number of major actions were overdue or were progressing at such a rate that they will not meet the current schedule. The actions required to validate the facility Faraday cage systems were far behind schedule, and no clear path forward existed. In particular, the low-voltage electromagnetic testing program has stalled. This delay is significant because the results of these tests are used to verify the mathematical analyses that establish the maximum expected interior voltage for each nuclear explosive facility and the standoff distance required to ensure safe operations. This testing is required for representative facilities from 14 distinct groups, but was completed for only 5 of these between 1997 and 2000, and test reports were provided for only 2 of these 5. Additional test demands will soon be added to this resource bottleneck: the first 5-year surveillance requirement (retest) will come due in 2002.

Resource Constraints—Contributing to the delays being experienced with this program is a lack of resources. The testing program, including analyses, is essentially dependent on one individual at SNL. This person's involvement with other production issues and the failure of NNSA/AAO to prioritize his tasking adequately have impacted the schedule significantly. Nearly half of the lightning projects for which SNL is the lead organization are behind schedule or overdue. BWXT and NNSA/AAO personnel indicated that BWXT needs to develop a capability for low-voltage electromagnetic testing and analysis, but has not established a plan to this end. Transfer of this capability to BWXT has been hindered further by failure on the part of SNL to complete tasks in the project plan associated with the development of standardized test protocols and procedures. Without the development of additional capabilities to accomplish and analyze the necessary low-voltage electromagnetic tests, it does not appear possible to accomplish those tests and associated analyses within the 5-year periodicity required by the authorization basis and continue to meet retest requirements.

Technical Issue Related to Bonding—The project plan contains a task to address additional mechanisms (such as bond inductances) that could contribute to higher voltages within facility Faraday cages and create worst-case conditions with respect to standoff isolation against direct arcing in air. This task grew out of a minority opinion associated with the Lightning Protection NES Master Study. However, it is not clear that this task has received proper priority. (The Board formally addressed prioritization of this task in a letter to the Deputy Administrator for Defense Programs dated October 23, 2000.) Further, the scope of the task may not include evaluation of the frequency dependence of the bond inductance, which could be a key contributor to the worst-case voltage developed under (transient) lightning strike conditions. Proper evaluation of this issue will require significant testing.

Technical Issue of Magnetic Coupling—SNL's analyses of potential lightning threat mechanisms occurring at the boundaries of "imperfect" Faraday cages have focused on three source effects: rebar impedance, gap aperture coupling, and penetration bonding. These effects have been related to the threat of a direct arcing path from a point of induced high voltage onto a susceptible weapon or part. However, another mechanism exists to transfer energy from a lightning strike to a susceptible weapon, part, or attachment: induced currents driven by magnetic field coupling. Indirect energy transfer by magnetic coupling could be further enhanced if the current path from a postulated lightning strike were concentrated along a single path, as opposed to being distributed over the entire facility Faraday cage. The structural design of individual bays or cells could lead to such concentration of lightning currents, as could existing bonded penetrations that involve large-diameter ductwork (e.g, heating, ventilation, and air conditioning ductwork). The Board's staff identified several examples of such ductwork during tours of the Pantex facilities.

Magnetic fields and induced currents had been considered early in the Lightning Protection Project, and Lawrence Livermore National Laboratory (LLNL) had begun to develop some facility testing protocols that were based on induced-current effects, though initial use in the field identified further developmental needs. However, these efforts have been largely overshadowed (or dropped altogether) as the implementation effort has focused on the threat of direct arcing. One task to evaluate the induced-current susceptibility of battery-powered equipment remains in the project plan, but appears to have minimal priority. Restoration of the LLNL facility test effort would serve several important functions: (1) address the issue of induced- current/magnetic-field energy introduction, (2) alleviate the demand on scarce SNL resources by providing alternative ways of collecting data, and (3) provide an independent check on the validity of the SNL model on which the entire lightning protection control set is based.

Lack of Peer Review—The lack of an independent check, or peer review, is particularly significant. Other mechanisms by which energy could penetrate the facility Faraday cages may exist, and could be brought to light through the involvement of appropriate experts. Recently, NNSA/AAO and BWXT have attempted to address this issue by entering into a contract with Texas A&M University to obtain access to independent lightning expertise. However, the statement of work associated with the contract and the qualifications of identified key personnel were not sufficiently detailed for the Board's staff to evaluate this effort.

Field Observations—The Board's staff observed the implementation of lightning controls in five Pantex facilities and identified five related deficiencies. Of note, four of the five deficiencies involved violations of administrative controls, lending credence to NNSA/AAO's stated long-term objective of replacing administrative lightning protection controls with engineered controls where possible.

NNSA/AAO and BWXT Proposal to Modify the Lightning Controls Philosophy—At the direction of NNSA/AAO, BWXT has submitted a proposal to modify (i.e., relax) site lightning controls. The proposed modifications are generally based on extending the previously proposed

changes to the W87 Stockpile Life Extension Program (that were the subject of a NES Study earlier this year) to other weapon systems. Although generic controls applicable to all weapon systems would be preferred, changes in the LBIO controls must be reviewed for each individual case in order to address any unique vulnerabilities of the specific weapon system.