DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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August 6, 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 conducted a review of the analysis of potential plutonium releases through leak areas in nuclear explosive cells at the Pantex Plant. These cells were specially designed to filter and entrap most of a radiological release when exercised. The potential release of plutonium would only occur in the extremely unlikely event of a high explosive detonation that lacks the necessary explosive force to lift the cell roofs. A summary report of the Board's review on cell leak path areas is enclosed.

In September 2003, BWXT Pantex declared a positive unreviewed safety question (USQ) as the result of the discovery of incomplete welds in cell boundaries, allowing for larger-than-expected cell leak areas. During subsequent facility walkdowns, BWXT Pantex personnel found additional leak areas.

Since September, BWXT Pantex has remeasured all the leak areas in each cell and recalculated the off-site dose consequences. The current analysis for the worst-case cell, considering leak area and plutonium loading, leads to an off-site dose of 19 rem. While the analysis incorporates many conservatisms, it takes credit for dispersal reductions that are not adequately justified. The analysis also includes dispersal reductions that result from repairs made to address the incomplete welds. These repairs may not be effective.

Without these reductions, the potential off-site dose consequence from the worst-case cell during single-unit operations will increase significantly, especially considering the significant amount of uncertainty inherent in such calculations.

Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests that the National Nuclear Security Administration (NNSA) provide a briefing and a report within 45 days of receipt of this letter on the status and path forward of efforts to address the issues detailed in the enclosed issue report. The Board requests that NNSA include in its report a list, prioritized with respect to safety, of actions designed to further mitigate potential off-site consequences in the event of a high explosive detonation in a Pantex cell.

Sincerely,

John T. Conway
Chairman

c: Mr. Steven C. Erhart
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

July 21, 2004

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: C. Goff and C. Martin

SUBJECT: Cell Leak Path Areas and High Explosive Accident Analysis at the Pantex Plant

This report documents a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the analysis of potential plutonium releases during an explosive event through leak areas in nuclear explosive cells at the Pantex Plant. This review was conducted June 22–23, 2004, by staff members C. Goff, D. Gutowski, T. Hunt, and C. Martin, and involved briefings by BWXT Pantex personnel, calculation reviews, and walkdowns of representative cells. A follow-up teleconference with Pantex Plant personnel was conducted July 7, 2004.

Background. The cell leak area includes assumed-sheared piping plus cracks and gaps around doors and penetrations that provide a pathway for plutonium to exit the cell in the event of a high explosive (HE) detonation. The postulated accident of greatest concern is a detonation of less than 70 pounds of HE, which does not produce the explosive force necessary to lift the composite roof of the cell. When lifted, the specially designed graded gravel overburden of the roof filters and entraps greater than 99 percent of the plutonium involved in an explosive release. In the event the roof does not lift, pressure created by the explosion is relieved by the air, containing plutonium aerosols, exiting through the leak areas in the cell without benefit of any filtration.

In September 2003 it was determined that the cell leak areas were larger than originally accounted for in the Pantex safety basis. This determination resulted in a positive unreviewed safety question (USQ) determination. The sources of the larger cell leak areas were insufficient welds around the equipment doors of some cells. Instead of welding in a continuous bead along the entire door and frame joint, 3-inch welds were made every 6 inches, resulting in "stitch" welds. The unwelded areas contribute from 6 to 8 in^2 of additional leak area per cell. These stitch welds were first discovered in 1997, and a work order was generated but never completed. Nuclear explosive operations in the cells were terminated in September 2003 after it was discovered that the work order was still open after 6 years. A commercial sealant was procured and used to seal the stitch-welded joints, and explosive operations were resumed. BWXT personnel explained that the joints had not been welded because of concerns regarding door deformation upon exposure to the high temperatures of welding.

Since September, BWXT has remeasured all of the leak areas in each cell and recalculated the off-site dose consequences. The newly calculated leak areas are more than triple the areas originally reported: 160 in^2 as compared with 42 in^2 for the cell with the largest leak path. As part of the task to reverify the leak areas, the contractor estimated the cost of further reducing the leak areas to be $15–20 million.

Cell Gap Analysis. Sandia National Laboratories (SNL) performed cell leak area dispersal calculations in 1996 to support the preparation of a Justification for Continued Operation (JCO) for the Pantex cells. In the calculations, a factor of 2 reduction in the plutonium release fraction was taken because of inertial deposition of the particles at knife-edge interfaces, such as under equipment doors. Depending on the cell, knife-edge interfaces can account for up to 54 percent of the cell leak area. This reduction was taken based on a 1996 computational analysis performed by Battelle Memorial Institute (BMI) using the COMPACT-2D computer code. The analysis was validated by a "back-of-the-envelope" calculation that appears to have ignored important physical considerations, such as surface roughness, sticking coefficients, and the effects of moisture and temperature on these variables. A factor of 3 reduction was suggested by the BMI calculation, but SNL preferred a more conservative approach and chose to take a factor of 2 reduction. The Board's staff reviewed BMI's calculations and concluded that the computer analysis is not sufficiently compelling to justify any knife-edge reduction.

BWXT has assumed responsibility for the off-site consequence calculations, and is using a calculation methodology similar to that employed by SNL. The most recent calculation (Calculation 3079, Revision 4, Addendum 4) incorporates the larger leak areas and uses unit-specific amounts of HE and plutonium. The BWXT calculations do incorporate a number of conservatisms, including the assumption that all plutonium transported through the leak areas is considered part of the plume source term. This assumption is conservative because it takes no credit for hold-up in the ramps outside the cell. However, the calculation also includes the BMI knife-edge reduction, taking credit for a factor of 3 reduction in plutonium aerosols. BWXT personnel were unable to provide further justification for allowing the reduction beyond giving the Board's staff BMI's summary report.

Sealant Procurement. The Board's staff reviewed the procurement process for the commercial sealant used to supplement the stitch welds in the cells. The sealant, Rebond 907 Gasket Former from Cotronics Corporation, was identified as a Class 1 (safety-class) component, but procured as a commercial-grade item without a commercial-grade dedication process. No confirmatory testing was performed on the sealant, and the procurement document lists no required specifications, such as temperature and pressure ratings.

During a walkdown of one of the cells, the Board's staff observed that the sealant used to patch unwelded joints was peeling and detaching from the door structure. The manufacturer's installation instructions for the sealant required application onto clean steel surfaces, but the door frame had only been wire-brushed, not stripped of paint, before application. BWXT personnel noted that a maintenance order had been filed to reapply sealant to the gap. They were not particularly concerned about the detaching sealant because, as they explained, the sealant on the outside of the door frame is not credited with sealing the stitch welds. Because of the placement of a door gasket, however, the credited sealant on the inside of the door frame was inaccessible for inspection. The peeling and detaching of the external sealant raises concern as to the ability of the sealant to perform its intended safety-class function on the inside joints of the doors.

Dose Consequences. The worst-case off-site dose consequence was reported (in Calculation 3079) to be 19 rem for single-unit operations in a cell. This estimate includes the factor of 3 reduction on knife-edge gaps and the repairs recently made to the cells using the commercial sealant. Without these reductions, the off-site dose consequence from the worst-case cell during single-unit operations could challenge the site boundary evaluation guideline of 25 rem, especially considering the significant amount of uncertainty inherent in dose modeling. The results of a calculation for two-unit operations yielded a 43.2 rem dose at the site boundary. Multi-unit operations are not currently authorized, but are being considered.

Conclusions. In light of the postulated dose consequences, improvements need to be examined and prioritized with respect to minimizing cell leak areas. In addition, while inertial deposition along knife-edge interfaces in the cell almost certainly occurs to some degree, credit for this effect ought to be limited to that which can be demonstrated in a compelling technical argument, through either a more rigorous calculation or benchmark experiments demonstrating deposition. In the same vein, the commercial sealant used to repair the stitch weld gaps should not be credited with reducing the leak path until it has been adequately tested to ensure that it will fulfill its required safety-class function. It would be advisable to investigate other stitch weld repair options, such as low-temperature welding.