DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004
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June 25, 1998

The Honorable Victor H. Reis
Assistant Secretary for Defense Programs
Department of Energy
Washington, D.C. 20585-0104

Dear Dr. Reis:

The Defense Nuclear Facilities Safety Board (Board) has been following the Department of Energy's (DOE) efforts to improve the facility assignment process at Pantex by more explicitly considering the impact on safety. One of the Pantex buildings that has been a focus of Board attention is Building 12-64. Bays in this building exhibit unusually wide roof cracks that possibly indicate structural distress. Enclosed for your consideration are observations by the Board's staff concerning expanded W-69 dismantlement operations in Building 12-64.

In a letter dated August 8, 1997, the Board observed that Building 12-64 has weaknesses compared with other facilities at Pantex that might have been chosen for this activity. The DOE response, dated February 27, 1998, stated that the facility assignment process used prior to the introduction of current procedures did not clearly evaluate the relative hazards and capabilities of facilities. The DOE letter and its enclosures indicated that, pending satisfactory resolution of the roof cracking issue, W-69 dismantlement operations would be expanded into more bays in Building 12-64 so that this campaign could be completed by the end of the year. Furthermore, DOE indicated that these would be the last nuclear explosive operations for these bays, other than staging in sandbag bays.

The enclosed report by the Board's staff indicates that DOE and the site contractor, Mason and Hanger Corporation, have engaged in an extensive structural investigation since February 1998, which has concluded that the bays are safe for continued operations. Therefore, DOE has recently begun the expansion of operations. These investigations have shown that margin for static loading exists for the expected duration of the W-69 campaign, although dynamic structural performance under extreme accident conditions is still questionable.

The Board understands that unanticipated programs and contingency planning may lead to reexamining the option of using Building 12-64 for future nuclear explosive operations. The enclosed report describes some of the longer-term safety issues that need to be examined if such a path is pursued. These and other safety issues associated with this aging facility appear to be significant. Also, other safer options may be identified if planning begins now in earnest. The Board should be kept informed of any decisions or options to use Building 12-64 for future nuclear explosive operations.

Please feel free to contact me or Jim McConnell of my staff if there are questions on this matter.

Sincerely,

John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.
Mr. Bruce G. Twining

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

May 28, 1998

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: A. Hadjian and C. Keilers

SUBJECT: Pantex Building 12-64 Bays: Roof Cracking Issue

This memorandum documents an issue reviewed by the staff of the Defense Nuclear Facilities Safety Board, based on information provided by the Department of Energy (DOE).

DOE has decided to expand the number of Building 12-64 bays used for W-69 dismantlement operations, even though these bays have unusually wide roof cracks that may indicate structural distress. DOE has indicated that no nuclear explosive operations are planned for these bays after the W-69 dismantlements, although this decision may be reconsidered at a later date. Regardless, these bays will likely continue to be used for staging weapons in protected configurations and for nonweapon activities, such as pit repackaging.

In an August 1997 letter to DOE, the Board observed that Building 12-64 has weaknesses compared with other facilities at Pantex that might have been chosen for this activity.[1] These are the oldest bays used for nuclear explosive operations in the DOE complex, and they have known safety and operational deficiencies. In February 1998, DOE responded to the Board's letter, stating that the facility assignment process used prior to the introduction of current procedures did not clearly evaluate the relative hazards and capabilities of facilities.[2] However, pending satisfactory resolution of the roof cracking issue, Pantex has been planning to expand the number of 12-64 bays used for dismantlement in order to complete the W-69 campaign in November 1998 and meet a production commitment (i.e., to dismantle 1000 units this fiscal year).

Since the roof cracking issue was identified in January 1998, DOE, Mason and Hanger Corporation (MHC), and their consultants have performed extensive investigations to characterize deflections, crack patterns, material properties, and expected margin of safety of the bays. A crack monitoring program is also being considered. Although the staff does not agree with every conclusion drawn in recent reports, some conclusions are evident and are discussed below.

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[1] Letter from J. T. Conway, Defense Nuclear Facilities Safety Board to V. H. Reis, U. S. Department of Energy, August 8, 1997.

[2] Letter from E. G. Ives, U. S. Department of Energy to J. T. Conway, Defense Nuclear Facilities Safety Board, Attachment 3, February 27, 1998.

Two significant design and construction deficiencies have been identified in these bays:

- The roofs have no bottom reinforcement over the center half of their area, resulting in tension cracks and potential spalling. Some cracks extend to anchor points for lights and appurtenances over weapon work areas. Last year, inspection of anchors was a post-start finding for W-69 dismantlement startup. Visual inspections from the floor were completed at the end of April 1998.

- The reinforcing detail for the moment-carrying joints along two of the four walls is faulty, resulting in significantly less capacity than would have been achieved by a proper detailing. The other two walls are not tied to the roof and provide no moment capacity. The existing detail was a change from design made in the field to simplify construction. The faulty detail is critical since—under limiting conditions—these two wall-to-roof connections are all that is holding up the roof.

Within the last 2 months, the following information became available:

- The cracks most likely resulted from construction loads on the roof overburden (e.g., graders, water trucks) about three decades ago. The increase in deflections since then is probably due to concrete shrinkage and creep; however, the staff believes an alternate mechanism of diagonal yield lines has not been ruled out.

- Some bays are larger than others, and some have more overburden than others of similar design, essentially providing a load test. Ratios of measured deflections are consistent with elastic calculations, providing increased confidence that static margin exists.

- Calculations based on recent radiographic measurements of rebar splice length indicate that the two critical wall-to-roof connections are adequate for the existing *static* loads. Specifically, the rebar in the splice is larger and has longer embedment than was originally anticipated. However, the staff believes it does not meet code detailing requirements,[3] as discussed further below.

Based on the above, the staff believes that adequate *static* margin exists for the expected duration of the W-69 campaign (i.e., to the end of November 1998).

Regarding future use of these bays for nuclear explosive operations, the staff believes significant evaluations and upgrades may be required. DOE is planning to review the 12-64 bays as part of an upcoming site-wide assessment of seismic hazards for nuclear explosive facilities (i.e., part of Basis for Interim Operation upgrades). The staff has the following observations:

- Dynamic margin has not been established for the cracked roofs under extreme loads (e.g., tornado, missile impact, earthquake). Analyses to date may also have missed the

[3] ACI 318-95, *Building Code Requirements for Structural Concrete,* American Concrete Institute, 1995.

predominant failure mode, which may be dynamically induced crack growth (i.e., delamination) initiated between the reinforcement bars in the higher stressed region of the wall-to-roof joint. The critical factor here is the small clearance (1.1 inches) relative to the large rebar diameter (1.4 inches), leading to high concrete bond stresses that potentially fracture the concrete between bars.[4]

- Remaining safe service life is unknown and may be foreshortened, even under static loads (the bays are now 27 years old). Concrete is susceptible to slow crack growth effects, also referred to in fracture mechanics as subcritical cracking. Slow crack growth contributes to inelastic creep and usually occurs in the form of many micro-cracks. However, in this case, creep deformation may be coalescing in a few large cracks or delaminations, potentially leading to premature failure.

- Blast protection may need to be reexamined. Compared with newer bays at Pantex, the 12-64 bays have no blast door interlocks, potentially exposing people to high blast pressures. Pantex has compensated for this by reducing its allowed high-explosive (HE) inventory. Even so, full-scale tests have shown that in the event of an accidental explosion, large missile fragments (i.e., thousands of pounds) could be projected out hundreds of feet. Reducing the HE inventory may reduce this distance, but still leaves other 12-64 bays—with cracked roofs—at risk of large missile impact.

- The visual inspections made of anchorages for appurtenances over weapon work areas are the minimum required to establish static margin. More thorough inspections ought to be considered to establish dynamic margin if these bays continue to be used after this year (i.e., using standard procedures that rely on seismic experience data[5]).

- In the long term, there appear to be other, safer options than using these bays for nuclear explosive operations. For example, several modern bays are currently being used for nonexplosive activities, such as pit repackaging. Furthermore, a recent DOE decision not to pursue surplus pit storage in Building 12-66 (a large hardened warehouse) may make this building available for consolidated pit repackaging operations. If planning begins now, reassignment of these or other facilities could free up newer bays for nuclear explosive operations in the future.

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[4] D. Darwin, S. McCabe, E. Idun, S. Schoenekase, "Development Length Criteria: Bars Not Confined by Transverse Reinforcement," *ACI Structural Journal*, November-December 1992, pp. 709-720.

[5] Seismic Qualification Utility Group, *Generic Implementation Procedure for Seismic Verification of Nuclear Power Plant Equipment*, Revision 2, 1991.