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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 4, 1996

Mr. Mark B. Whitaker, Jr.
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0119

Dear Mr. Whitaker:

Enclosed for your information and distribution are three Defense Nuclear Facilities Safety Board staff reports. The reports have been placed in our Public Reading Room.

Sincerely,

George W. Cunningham
Technical Director

Enclosures (3)

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

January 29, 1996

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: C. H. Keilers, Jr.

SUBJECT: Pantex - Review of Unreviewed Safety Question to Increase Nuclear Weapon Staging in Zone 12 (PX-USQD-95-39-A)

1. **Purpose:** This report documents a review by the Defense Nuclear Facilities Safety Board's (Board) staff of modifications to permit increased staging of nuclear weapons in Pantex Building 12-64. The review focused on worker safety and propagation concerns and was performed by staff members F. Bamdad, C. Keilers, J. McConnell (site representative), C. Miller, M. Moury, J. Preston, and H. Waugh (site representative).

2. **Summary:** This unreviewed safety question addressed modifications to two bays in Pantex Building 12-64. These modifications permit increased nuclear weapon staging by dividing each bay into five compartments separated by sandbag barriers. In effect, each bay's inventory of high explosive and plutonium could increase by factors of up to two and five, respectively, compared to previous limits.

   The Department of Energy (DOE) considers the proposed staging activity to be lower risk than the disassembly operations currently permitted in these bays. The proposed sandbag configuration is currently used in Department of Defense (DoD) and Pantex Zone 4 magazines and has been demonstrated to effectively avoid propagation across sandbag compartments in DoD tests. The staff agrees that these tests demonstrated the effectiveness of the sandbag barriers within the bounds of what was tested. However, the protection provided by the weapon shipping containers may be more significant than commonly realized. Also, it is not clear how effective the barriers would be if larger quantities of high explosive were detonated than those tested. The high explosive limit may need to be reevaluated if other weapon systems are considered.

3. **Background:** In October 1995 Mason and Hanger Silas-Mason (M&H) proposed modifications to increase weapon staging in two bays of Building 12-64. M&H considers this would increase efficiency in weapon disassembly and reduce cross-site transportation

and handling risks.[1] However, the proposed activity also exceeded the amount of high explosive (HE) and plutonium (Pu) allowed in each bay. In November 1995 DOE approved the change for W48 weapon systems only.[2]

4. Discussion:

Because of the potential consequences of releasing up to five times more Pu than previously evaluated, the Board staff has been closely monitoring progress on the M&H recommendation. Following DOE approval, the Board staff still had unanswered relevant questions. Therefore, the staff met and discussed these questions with DOE and M&H in Washington, D.C. on December 12, 1995 and performed an on-site review on December 19, 1995. This memorandum summarizes the basis for the M&H recommendation and DOE action, as documented in the references and discussed during the above meetings. Major staff concerns are also identified, together with their resolution.

Description of the Modifications: The modifications consist of installing sandbag barriers that divide each bay into five compartments and of deactivating radiological detection systems that M&H considers no longer needed because of reduced personnel access. In effect, these modifications permit increasing the allowable HE/Pu inventory above that previously allowed in the Authorization Basis.

	old bay limit	new sandbag compartment limit	new bay maximum allowable inventory
High Explosive (lbs)	230	105	525
Plutonium (kg)	25	25	125

Justification: DOE and M&H consider increased staging acceptable for the following reasons:

a. *Reduced accident risk:* The proposed staging activity is considered lower risk than the disassembly operations currently permitted in these bays. Staging accidents, particularly for weapons in shipping containers, have a low probability that is difficult to quantify because few accidents have occurred (i.e., insufficient data). Operational restrictions, such as keeping forklifts out of these bays, will further

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1 Unreviewed Safety Question PX-USQD-39-A, "Sandbag Partitioning and Weapon Staging for Building 12-64, Bays 13 and 16," October 12, 1995.

2 B. G. Twining (Mgr, DOE-AL) memo to G. W. Johnson (Area Mgr, DOE-AAO), "Approval of Positive Unreviewed Safety Question," Nov 9, 1995.

reduce the probability and consequence of an accident.

b. *Avoiding accidental propagation:* The proposed sandbag configuration is currently used in Department of Defense (DoD) and Pantex Zone 4 magazines and has been demonstrated to be effective in avoiding weapon-to-weapon propagation across sandbag compartments in a series of DoD magazine tests.[3]

During these tests, weapon systems without Special Nuclear Material (SNM) were detonated in magazines. In general, the magazines were completely destroyed, but the detonation did not propagate to weapons in shipping containers in other sandbag compartments - proving the sandbag barrier concept. In all cases, the magazine ceiling collapsed or was thrown. Some "acceptor" weapons were translated in their shipping containers and effectively slammed against the wall. Pictures indicate that the shipping containers took considerable punishment but remained relatively intact. The acceptor weapons within shipping containers appear unaffected.

Earlier in their test program, DoD also tested sandbag configurations using HE hemispherical charges in thin-wall containers. During three of four tests (each with a different configuration), propagation did occur for undetermined reasons to one or more acceptor charges in other sandbag compartments. Resulting damage indicates that the acceptor charges did not translate before detonating. Even though these charges were less robust than an actual weapon system, M&H interprets these test results to indicate that quasistatic overpressure could be a leading cause of propagation for the sandbag configuration.

Staff Observations:

1. The staff agrees that the DoD magazine test demonstrates the effectiveness of the sandbag barriers for avoiding weapon-to-weapon propagation, within the bounds of what was tested. However, the plastic deformation and crush of the shipping containers may be more significant in avoiding propagation than commonly realized. Also, it is not clear how effective the barriers would be if larger quantities of HE were detonated than those tested. Charge weight limitations may need to be reexamined if and when other weapon systems besides W-48 are considered.

2. There appear to be no quantitative criteria for what blast-related environmental conditions are necessary to cause a weapon-to-weapon propagation across

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[3] Picatinny Arsenal, "Establishment of Safety Design Criteria for Use in Engineering of Explosives Facilities and Operations." Tech Report 3256, Report 4, Subdivided Igloo Weapon-to-Weapon Test, Hastings, Nebraska, Jan 16, 1964 to Feb 14, 1965.

sandbag compartments. Pressures were measured during the DoD tests, but measurements at the acceptor locations were considered inconsistent and hard to interpret. Since no criteria exist, M&H addressed several propagation mechanisms by comparing the post-detonation environment expected for the bay to that calculated for the magazine tests, as discussed below.

c. *Bay-to-magazine comparison:* Following a postulated detonation of all the weapons in one compartment, the environmental conditions that might cause propagation to another compartment are either comparable or less severe for the bay than for the magazine tests. Specifically, M&H considered quasistatic overpressure, shock, fragments, translation, and thermal effects as potential initiators for propagation. Each is summarized below:

- *Primary fragments:* The DoD magazine tests showed the effectiveness of the sandbags at stopping primary fragments that could cause propagation.

- *Secondary fragments:* Robust weapon shipping containers appeared to be key to preventing propagation from collapsing structure during the DoD test. Also, although the bay roof is heavier than the magazine roof, the bay roof is designed to open up and vent outward if a detonation occurs. The bay roof should not collapse inward on the shipping containers.

- *Shock:* The DoD tests demonstrated that direct shock waves should be adequately dissipated by the sandbags. Also, the bays are physically larger than the magazines, so reflected shock waves in the bays should be lower than those in the DoD magazine tests.

- *Quasistatic Overpressure:* The bays have a larger volume than the DoD magazines tested and should have a lower peak quasistatic overpressure for the same charge weight. M&H performed comparative analyses to determine the venting and pressure histories in the bays and the DOD magazines. These analyses neglected the sandbags, which should be conservative since the sandbags displace a larger volume fraction in the magazines than in the bays.

- *Thermal effects:* Since the bays are larger than the DoD test magazines, heat loss is expected to be more rapid and temperatures lower in a bay than a magazine.

- *Translation:* Since the predicted blast impulses on the bay and magazine walls are comparable, the impulses on shipping containers and the resulting translation in a bay should be similar to those experienced during the DoD tests.

Staff Observations:

1. The staff has been concerned that the bays were not designed to protect internal equipment, such as weapons in shipping containers, from an internal blast. They were designed to protect people within each bay from an external blast. In fact, during the full-scale bay test, the wall nearest the charge collapsed into the donor bay, which would have damaged internal equipment.[4] A similar wall survived a subsequent half-scale test.

   This concern has been resolved. First, the DoD tests indicate propagation will not occur and that the shipping containers can absorb considerable punishment without a weapon detonating, even if the surrounding structure is destroyed. Second, the compartment HE limit is less than that tested during the bay full scale test (105 and 300 lbs, respectively), and the weapons will be staged further from exposed walls than the charge location for the full scale test (about 11 feet vice 3 feet, respectively). These combined effects would reduce the blast load on the nearest exposed wall and reduce the extent of structural damage, compared to the full scale bay test.

2. The staff has also been concerned that a small detonation may not fully open the roof and may then allow roof debris to fall back into a bay. In particular, the full scale bay test indicates that most of the venting could occur through the doors before the roof sections fully rotate.[4] Therefore, the M&H projection that a small charge weight (5 lbs) would rotate the roof sections may be unrealistically low. However, the staff does agree that a realistic charge weight from a weapon system(s) should provide sufficient energy to rotate the roof sections and that the roof should remain relatively intact, based on photographs from the bay half-scale test. Therefore, this is no longer a concern.

3. Even though the 12-64 bays will be normally unoccupied and will be entered using the same precautions as Zone 4 magazines, the staff believes that the radiological monitoring and alarm systems should not be deactivated. Unlike the Zone 4 magazines, these bays do have personnel in the vicinity nearly all the time (e.g., going to and from adjacent bays and buildings). The bay radiation monitoring and alarm systems serve an important function in protecting these personnel.

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4 US Army Engineer Waterways Experiment Station, "An Evaluation of the Separated Bay Concept for a Munition Assembly Complex: An Experimental Investigation of the Department of Energy Building 12-64 Complex," Tech Report SL-83-6, September 1983.