Appendix A: Plutonium Pit Storage at Pantex

For more than four decades, plutonium pits from nuclear weapons disassembled at Pantex were stored in concrete bunkers[1] prior to shipment to the Rocky Flats Plant in Denver. The same concrete bunkers were also used for briefly storing pits fabricated or recycled at Rocky Flats (30). After weapons disassembly, plutonium pits are placed in drums and transported to bunkers for storage in rows 3 drums wide and 23 drums deep on one side of the bunker, and 2 drums wide and 23 drums deep on the opposite side (19). A 4-foot aisle separates the rows of drums (24). The brief storage of plutonium pits at Pantex is commonly referred to by Department of Energy (DOE) officials as "staging."

Recent reductions in the weapons stockpile and in weapons component production, downsizing of the Nuclear Weapons Complex, closing of plutonium processing facilities at Rocky Flats for environmental and safety reasons, and the little additional storage space available at other facilities, all have contributed to a shortage of pit storage space throughout the Nuclear Weapons Complex (7). This in turn has placed additional pressure on DOE to store plutonium pits at the Pantex Plant.

DOE predicts that once the storage capacity provided by the "most preferable configurations' in use has been reached, all weapons still in the custody of the Department of Defense and planned for disassembly at Pantex will have to remain stored at military installations. Weapons delivered to Pantex that were not disassembled because of pit storage limitations will remain in the particular bunkers where they are staged. This storage limit may be reached in late 1993, and even if packing density is increased, the limit will be reached in mid-1994 (24).

EFFORTS TO INCREASE STORAGE CAPACITY

Consideration of the National Environmental Policy Act Process

To increase the pit storage capacity at Pantex and avoid delays in the dismantlement process, DOE plans to increase the storage capacity of the Pantex bunkers. As part of the National Environmental Policy Act (NEPA) process to institute this change, DOE has prepared a draft Environmental Assessment (EA) under the act. This EA evaluates any environmental impact that might result from increasing both the number of bunkers that can be used for pit storage and the total number of pits that can be stored per bunker. To achieve this objective, DOE had planned to issue

[1] Originally designed to protect conventional ammunitions from bomb blasts during World War II, bunkers are two-room storage facilities made of concrete, covered with earth-except for the front door—with a floor capacity of approximately 1,040 square feet. These concrete bunkers are technically known as Modified Richmond. A double-leaf steel door with two sets of security locks is used in each room to prevent unauthorized entrance. Portable radiation monitors must be carried by personnel when entering bunkers.

Because the number of concrete bunkers now dedicated to plutonium pit staging is insufficient for the increasing number of pits that will result from planned weapons dismantlement operations, the Department of Energy has proposed using some of Plant42's steel arch construction storage facilities-also known as SAC magazines-that stage nuclear weapons or sensitive weapons components (26).

for public comment, by August 1992, a draft Environmental Assessment evaluating plutonium reconfiguration. Because of delays, the draft EA was not issued until December 1992, and as of this writing, DOE has received and is evaluating numerous public comments on that draft.

Earlier in 1992, DOE officials indicated that if the EA identified any significant environmental impact associated with the proposed expansion of plutonium pit storage at Pantex, a more detailed Environmental Impact Statement would be prepared. According to the same officials, implementation of multiple stacking configurations for plutonium pit storage will not begin until the proper environmental and safety documentation on plutonium storage has been completed (15). If no potential impacts are identified, DOE will implement its proposed expanded storage configuration for plutonium pits following the issuance of a Finding of No Significant Impact (19).

Preparation of a Safety Analysis Report

To evaluate the safety of bunkers proposed for expanding plutonium pit storage, DOE prepared a Safety Analysis Report (SAR) in 1992. As part of the study, DOE examined the structural safety of bunkers, the potential causes of accidents, and their consequences to plant workers, the environment, and the general public. Some of the accident scenarios evaluated in the report include those initiated by earthquake, human error, aircraft collisions, tornadoes, and fires. Access to this document for public review has been restricted by DOE's information classification rules.[2]

Improvements in Storage

DOE is funding several projects to increase its understanding of the handling, safety, and design requirements of plutonium pit storage. For example, a computer model was developed by Sandia National Laboratory to identify ideal packaging configurations and optimal space use for storing pits in bunkers (8).

Pantex is also working with the national laboratories to improve the safety of plutonium pit storage at bunkers and reduce radiation exposure of personnel during loading, unloading, handling, and inventorying operations. One such effort is the project known as "Stage Right," in which several Sandia National Laboratory scientists are studying the potential application of robotics in activities such as handling and monitoring pits inside the bunkers. First, the project is to assist the development of a manually operated, shielded forklift to handle pallets of pit-containing drums and thus reduce radiation exposure (13). It is estimated that radiation exposure levels could be reduced by a factor of five (3,24). Completion of the first forklift development project is expected in 1993 (14).

The next step in the forklift project would be to design and manufacture an unmanned forklift to remotely control the loading and unloading of pit containers in bunkers. Eventually, an automatically guided vehicle could be developed, capable of handling and monitoring containers, thereby reducing radiation exposures even further (3,13).

Sandia National Laboratory is responsible for two additional projects relevant to plutonium pit storage at Pantex. One involves the design, fabrication, and demonstration of the system to be used by the forklift during multiple stacking of plutonium pits. The other project concerns the development of a system for performing plutonium accountability activities, such as inspections, without having to enter the bunkers. All of these development programs, however, must await a decision by Pantex management before being incorporated into actual operations.

CHANGES EXPECTED IN STORAGE

Pantex has disassembled more than 50,000 weapons in the last four decades (15). Although the manner in which disassembly activities are conducted has not changed, storage practices and facilities at Pantex will have to change. Some of the changes likely to result from increased plutonium pit storage include the following:

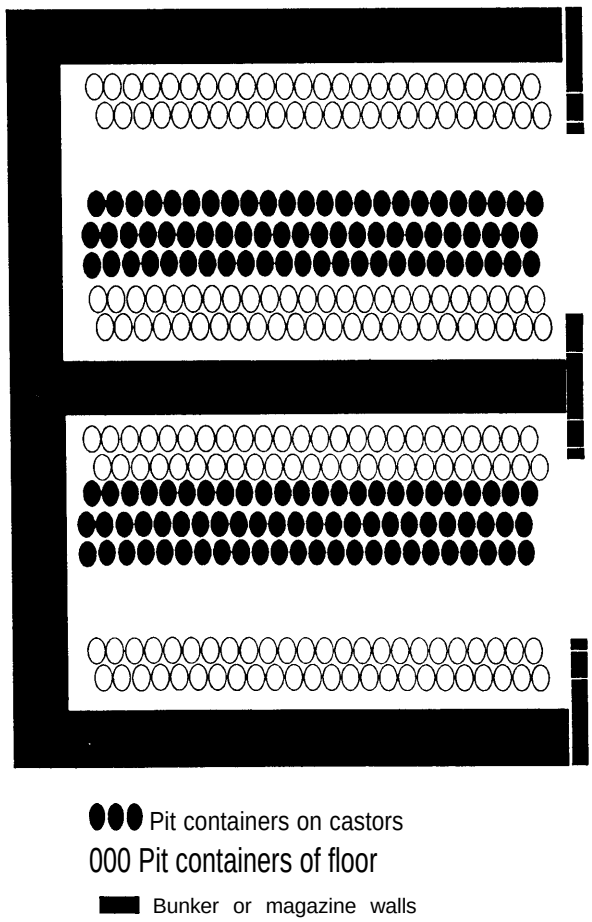
- Under the planned increase in weapons disassembly rates, the number of bunkers employed for pit storage could more than double, while the number of pits stored could reach a total of 20,000 (24). The bunkers to be added for this purpose (known

[2] The SAR was determined to contain Unclassified Controlled Nuclear Information (UCNI). DOE orders restrict the distribution of UCNI documents mainly to Government officials or certain other official groups who have been designated to have a need to know and will also agree to control the document.

as steel arch construction or SAC magazines) have been used to store weapons and weapons components.

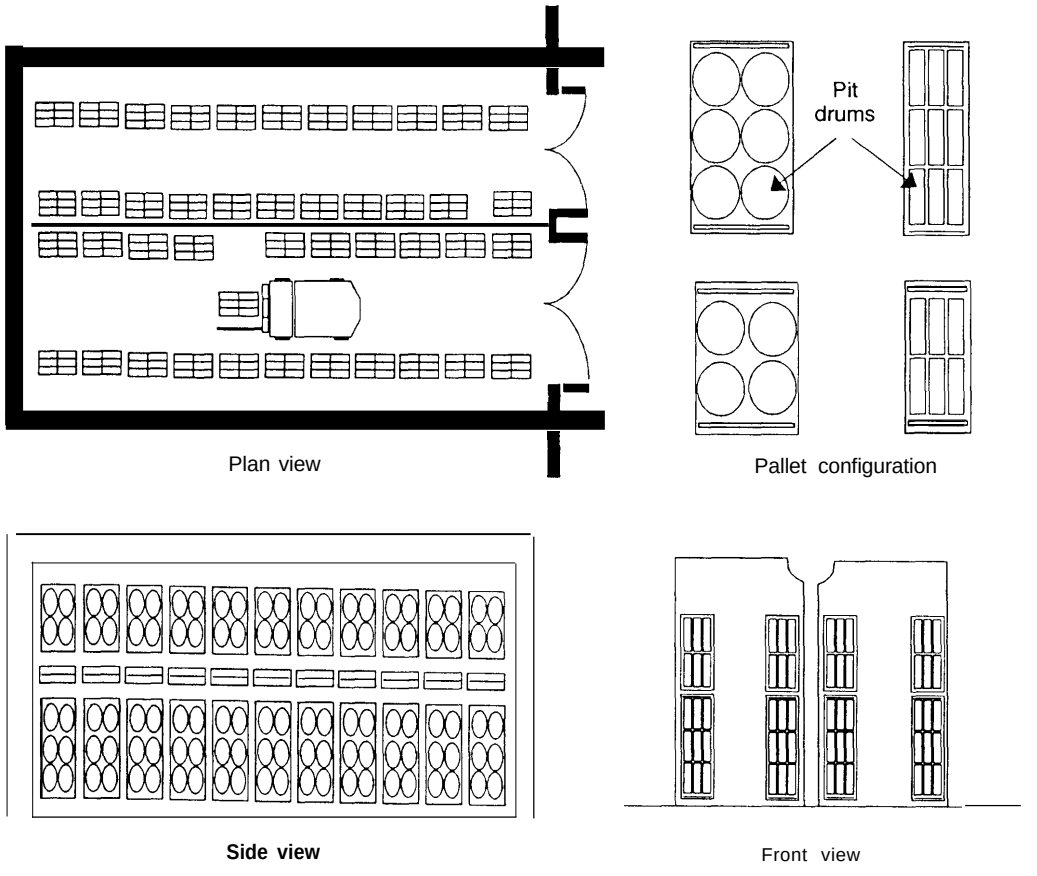
- In its Environmental Assessment, DOE proposed to increase storage capacity using a "horizontal palletized multiple configuration" to store up to 440 pits per bunker (24). Figures A-1 and A-2 show, respectively, the single and multiple stacking configurations associated with plutonium pit storage at Pantex.
- The increased emphasis on weapons disassembly and pit storage at Pantex may result in operational changes at the plant; however, little information exists regarding the type and extent of such changes. According to a draft internal policy letter, the plant operating contractor (Mason & Hanger) expects radiation exposure for a worker involved in weapons dismantlement operations "... to be significantly greater than the collective dose that radiation worker received in 1991 [primarily as a result of] dismantling more weapons from programs with higher dose rates.' According to this document, Mason & Hanger plans to institute measures to ensure that individual exposures do not reach more than 20 percent (or 1 rem) of the maximum allowable DOE radiation dose limit (l).
- Total radiation exposures of workers responsible for conducting periodic inspections and inventories of drummed pits could increase. If interim storage were to involve all 60 bunkers with a single-layer vertical configuration, storage of up to 20,000 pits would result in an annual collective dose of 100 to 200 person-rem-an increase of four to eight times the levels measured in 1987-91. However, DOE calculates that the use of a palletized multiple stacking configuration will result in a collective dose of 50 to 100 person-rem per year, or only two to four times the 1987-91 levels.
- If no changes occur in current inspection practices, workers could also experience increased radiation exposure levels if: 1) the protective equipment (lead apron) worn does not protect a worker's back and extremities; 2) radiation exposure is not monitored and reported in terms of real time but rather on a monthly basis; or 3) workers experience difficulty in identifying specific pit-containing drums and thus increase work time (3). Plans are under way to reduce these occupational radiation exposures through the use of shielded forklifts, bar codes and bar code readers, and eventually, unmanned vehicles and robots (24).
- Available information about pit storage configurations used in the past is unclear. The information provided to public officials and communities about the configurations used for pit storage at bunkers has led many to believe that the maximum number of pits that could be safely stored under the single-layer, vertical position configuration was 240 per bunker. DOE, however, has used other configurations and has stored more

Figure A-l—Pit-Filled Concrete Bunker With Single-Layer Storage Configuration



SOURCE: U.S. Department of Energy.

Figure A-2—Multiple Stacking Configuration Proposed for Plutonium Storage at Concrete Bunkers



SOURCE: U.S. Department of Energy.

pits by putting additional drums in the space available between the rows of stored drums (19,25). This has led to public concerns about what other configurations DOE might use to extend available pit storage capacity at operating bunkers.

PUBLIC CONCERNS

In December 1992, DOE submitted a predecisional draft of the Environmental Assessment for interim storage of plutonium components at Pantex to the State of Texas for review and comments. The Texas Governor's office, in turn, distributed the EA to a number of public and private parties with concerns about this issue. The Governor's office submitted all comments received to DOE by March 1993, and is awaiting a response by DOE to its request for a meeting and consideration of certain modifications to the EA before it is completed. The following are some of the major public concerns about expanded pit storage:

. *The current lack of interim storage capacity throughout the Nuclear Weapons Complex may keep plutonium pits at Pantex.* Many citizens note that DOE itself has claimed it will be difficult to get approval to move plutonium pits from Pantex to another site because many facilities are old, deteriorated, or technically obsolete. Most DOE facilities were built between the 1940s and the mid-1960s with a strong emphasis on production activities and little emphasis on maintenance.

Upgrading to meet environmental, safety, and health standards is difficult and expensive. Shutdowns and prolonged outages are common at some sites. Often, DOE's "piecemeal improvement" approach has proved inadequate (27).

Furthermore, the criteria used for designing and building many of these facilities cannot meet today's standards for seismic design, fire protection, environmental safety, worker protection and safeguards, and security (27).

Other factors have also reduced the number of possible storage options. For instance, new approaches to risk and safety analyses have forced more stringent operating requirements. Therefore, the process of achieving compliance at old facilities is more difficult (27).

- *The lack of a clear timetable for siting and building a long-term plutonium storage facility has led to public skepticism about the estimated duration of pit storage at Pantex.* Many citizens, as well as State and local officials, believe that the lack of storage options for plutonium pits throughout the Nuclear Weapons Complex will result in Pantex becoming a de facto long-term storage facility (19,31).

  The major reason for this concern is the uncertainty associated with the timetable for interim storage at Pantex. No definitive schedule has been developed to date regarding implementation of the Programmatic Environmental Impact Statement (PEIS) for reconfiguration of the Nuclear Weapons Complex. DOE has indicated in its draft Environmental Assessment that interim storage at Pantex will range from 6 to 10 years; however, some DOE officials have suggested that the storage period may last from 12 to 20 years or until a permanent storage site becomes available (23). To date, there is little coordination and integration between efforts to address interim storage of plutonium pits (EA) and long-term plutonium storage (PEIS).

- *Only limited information has been provided to the public about the analyses performed by DOE to support the conclusions reported in the Environmental Assessment.* Some have suggested that DOE release more data to the public. See box A-1 for comments obtained from the recent public review of DOE's Environmental Assessment.

OTHER FACTORS

Criticality Safety

Because plutonium is a fissile material, especially when present as plutonium-239, considerable attention must be paid during its handling to the prevention of criticality accidents.[3] According to a 1992 Technical Safety Appraisal Team report, the control of criticality accidents at Pantex is helped by the fact that the plutonium handled there is present in large metal components and weapons assemblies. To ensure effective criticality control, weapons assembly and dismantlement activities are required to comply with strict limits based on measurable control parameters. As part of the efforts to reduce the risk of criticality accidents, personnel are required to maintain fissionable materials inside containers when not in use. All storage and shipping containers used are certified as criticality safe. In addition, personnel must provide sufficient space (3 feet from center to center) between the nuclear weapons components and limit the number of components (not more than three in most cases) that can be left outside their containers in weapons assembly/disassembly areas (16,28).

Although most problems identified during the 1989 Tiger Team assessment of Pantex were found to have been addressed, a 1992 Technical Safety Appraisal Team review still indicated that the level of formal authority given to the ALARA (as low as reasonably achievable) coordinator was minimal regarding concurrence over programs that could either affect radiation levels or ensure that ALARA calculations and

[3] A criticality accident can occur due to the expansionof fissionable inventories or the removal of nonfissionable materials useful to prevent or terminate a criticality event. Such events can result in potentially lethal doses of neutron and gamma radiation to facility personnel, generate heat and fission products, and in certain situations, release radioactive materials to the outside environment. Unlike a nuclear reactor facility in which a criticality accident could release large quantities of fission products, some have estimated that the environmental releases caused by accidental criticality at DOE plutonium storage facilities would be negligible. Of much greater concern, a recent study concludes, would be the significant impact of a criticality accident on workers' health (22).

Box A-I–Expressed Public Concerns/Opinions About Plutonium Components at Pantex

- Limited information was provided about other locations as possible storage options (9,12).
- DOE estimates of the time workers would need to thoroughly inspect and inventory pits in bunkers could be longer than projected and result in higher radiation exposures of workers (10).
- The analysis of possible environmental impacts disregards current radioactive contamination of nearby soil (10).[1]
- Information on tornado analysis appears to exclude the high-frequency, potentially damaging tornadoes experienced in the Pantex area (20).
- The methodologies used for aircraft accident analyses have not been defined, and the data provided do not seem to reflect the density of air traffic (commercial and military) in the area or the proximity of Pantex to the airport (10,18)
- The basis for considering the storage of pits at Pantex for 6 to 10 years was not evaluated (9).
- The use of national security considerations to limit the information available for an open public debate is troubling.
- The decision to limit the Environmental Assessment to plutonium storage, without regard to other dismantlement activities at the site (2), is also a concern.
- DOE's efforts to integrate the Environmental Assessment with its PEIS for the Weapons Complex reconfiguration are lacking (9).
- The true degree of safety of nearby communities that can be guaranteed by DOE and State governments is unclear (6).

[1] Independent reviews of some of the limited public data available indicate that incorrect estimates of large aircraft crash rates and less than comprehensive estimates of air traffic in the region may have been used in the EA (11).

SOURCE: Office of Technology Assessment

procedures were followed. The review also stated that a certified external dosimetry system was lacking (28)

Plutonium Containers and Their Availability

The drums in which pits are contained for staging at bunkers, also known as AL-R8 containers, are made of carbon or stainless steel with an internal cage for holding or clamping the pits. To increase pit protection—and criticality safety-the drum is lined with 3 inches of cushioning and insulating material (24,28).

AL-R8 drums are characterized by excellent integrity and stability for a period of about 50 years. Identification and tracking are also efficiently provided. Knowledge of the performance of such containers over Ionger time periods (e.g., 100 years) is limited. Experts suggest that drum stability for longer periods be evaluated since the dynamic nature of plutonium in pit form may adversely impact the integrity and stability of the storage drums (5).

After having used AL-R8 containers to ship plutonium pits for nearly 30 years, DOE recently issued a policy abolishing this use and recommending instead the adoption of drums that more clearly comply with design criteria promulgated by the Department of Transportation and the Nuclear Regulatory Commission (17). One such design requirement is that there be an inner container vacuum system. DOE's newly designed pit shipping container satisfies this and all other criteria, but its cost (about $5,000) is significantly higher than that of AL-R8 drums (about $300) (16,26). Efforts to design a cheaper container are being carried out at the Savannah River Site and at Sandia National Laboratory (14). The limited availability of shipping containers could become a serious concern if a large number of pits require off-site transport for processing.

Accident Analysis

The EA accident analysis evaluated the potential of certain events to initiate accidents that could adversely affect the bunkers, or even worse, the drums in which the pits are contained.

DEFINITION OF INCREDIBLE EVENT

In the accident analysis, several events were dismissed as incredible and not considered in DOE's analyses of plutonium pit storage facilities at the Pantex Plant.[4] Examples of these include criticality events, internal/external explosions, internal fires, and meteor strikes. Other potential events, though evaluated, were also considered highly unlikely, including structural damage and/or penetration of the bunker by: 1) an explosion-generated missile from a hypothetical explosion of 50,000 pounds of high explosives stored at nearby bunkers; 2) a crash by a light, general aviation aircraft, with a weight of 3,500 pounds and an impact speed of 80 miles per hour; and 3) a tornado with speeds exceeding 140 pounds per square foot or about 340 miles per hour (24).

Events found to be most relevant to the proposed expanded pit storage at Pantex included:

- **Explosion hazards.** Explosions from other buildings at Pantex were evaluated to determine their potential to affect the plutonium pits stored inside bunkers. The results indicated that these pits would not be affected.
- **Structural hazards. Analyses in** the EA indicate that earthquakes, tornadoes, and external explosions would have no significant effect on the bunkers and their contents.
- **Operational accidents. The** operational event of most concern involved accidental puncture of a pit-containing drum, followed by crushing of the plutonium pit by a forklift moving at 5 miles per hour. Based on its analysis, DOE anticipates that the plutonium-containing dust escaping from the damaged container would: 1) have no immediate or long-term health effect on the worker involved in the accident; 2) cause only marginal radiation exposures to workers present in the immediate vicinity of the bunker where the accident took place; and 3) release no radiation to the public or the environment.
- Aircraft **crash.** The EA also contained an aircraft hazard analysis, which concluded that the probability of bunkers being impacted by an airplane was less than one in a million (24). According to some concerned citizens and public officials, DOE's decision to evaluate the risk of general aviation by using probability methodology designed to include all aircraft types may limit the validity of the results obtained (18) .
- **Accidents impacting groundwater** sources (Ogallala **Aquifer). According to** DOE **estimates,** no operating or accidental activities at Pantex were found capable of releasing plutonium at levels high enough to impact the underlying Ogallala Aquifer. A similar conclusion was reached in an independent study conducted by Los Alamos National Laboratory.
- Internal/external fire hazards. On the bases of the fire hazards analyses performed on Zone 4 (the highly secured storage area where the bunkers are located) as part of the Safety Analysis Report, DOE concluded that fires would have no impact on the bunkers or on the plutonium pit drums stored inside. The absence of combustible materials inside bunkers was also considered a major factor in further reducing fire risks (24).

CONCERNS ABOUT DOE'S ACCIDENT ANALYSIS

Reviewers have made the following comments about DOE's accident analysis:

> The term 'incredible' connotes an event that is too improbable to be believed. Even though the DOE analysis states that an incredible event is one of very low probability, it also eliminates events that are categorized as such from further consideration. It would be more helpful and accurate if these events—especially when they have significant consequences—were included in a full analysis as "very low probability' events.

[4] DOE terns an event as ''incredible'' when its occurrence is too improbable or inconceivable due to the location of the facility, the environmental characteristics of the area surrounding the facility, and the nature of the materials used and operations conducted at the particular facility. Statistically, an event is called incredible when its probability of occurrence is calculated to be less than one chance in a million,

The Federal Aviation Administration's comment (21) on aircraft accidents makes the following point:

> The Aircraft Hazard Analysis Data on pages 6-5 through 6-8 and Appendix E of the Environmental Assessment prepared by the United States Department of Energy has no resemblance to the data provided by this offie. Therefore, I am unable to comment on any information contained in the Assessment. For your information, the total aircraft operations for the Amarillo area in the CY 1992 was 91,800. Any further restrictions to flight or changes of airspace to the Pantex Prohibitive area would have an immediate and adverse impact on the utilization of Amarillo International Airport.

The Pantex Safety Analysis Report, on which the EA was based, was prepared by a DOE contractor under the guidance of the Albuquerque Field Office. It was reviewed by a technical safety review panel, all of whose members were from either DOE Defense Programs (DP) or the Albuquerque Field Office and approved by the Assistant Secretary for DP. The report was *not* prepared under the new safety analysis guidelines. No review by any internal DOE or external oversight group was done or sought. All accident analyses were accomplished with this Safety Analysis Report (4).

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