III. DESCRIPTION OF THE U.S. DISMANTLEMENT PROCESS

A. FACILITIES

This study focuses only on the DOE facilities primarily involved in nuclear warhead dismantlement: the Pantex Plant and the Y-12 facility. A brief description of the facilities relevant to the dismantlement process is provided below. In addition, a brief description of the Device Assembly Facility (DAF) at the Nevada Test Site is also included. Although the DAF does not currently perform dismantlement activities, it could be used as a dedicated dismantlement facility in the future as a means of minimizing the impact on ongoing operations at the Pantex Plant.

PANTEX PLANT

The Pantex Plant is located approximately 17 miles east of Amarillo, Texas. It is operated for DOE by the Mason & Hanger Corporation. The Pantex Plant is the only U.S. facility currently authorized for the disassembly of nuclear warheads. In addition to nuclear warhead disassembly, the Pantex Plant is responsible for several other operations involving warheads, including:

- High Explosive (HE) development, fabrication (processing, machining, and subassembly) and disposal;
- warhead assembly and stockpile rebuilds;
- new material and stockpile surveillance testing;
- Joint Test Assembly preparation; and
- stockpile maintenance.

In addition there are non-DOE activities that occur at Pantex. Currently, warhead throughput at Pantex is approximately 118 warheads per month or about 1,400 warheads per year for dismantlement plus additional warhead throughput for other activities.

The Pantex Plant consists of two key areas: Zone 4 West (hereafter referred to as Zone 4), which contains facilities and operations for the storage and inspection of both warheads and pits, and Zone 12 South (hereafter referred to as Zone 12) which contains the facilities and operations required for nuclear warhead production, testing, maintenance, and dismantlement. Zone 12 North is a support area and is not relevant to this discussion. Figure 5 shows an aerial view of Zone 4 and Zone 12. A schematic of Zone 4 is shown in Figure 6, and a schematic of Zone 12 is shown in Figure 7. For warhead dismantlement the key operations occur in those areas labeled as "weapon assembly, disassembly, and test areas," "HE to pit assembly," and "SNM staging." The buildings involved in these key operations are known as disassembly bays and dismantlement *cells* (the latter are also known as "gravel gerties"). A layout of a typical bay and cell is shown in Figures 8 and 9, respectively. In general, operations involving conventional high explosives, such as the removal of the high explosive from the pit, occur in the cells; other mechanical assembly and disassembly operations occur in the bays.

Figure 5: Aerial View of Zone 4 and Zone 12 at the Pantex Plant.

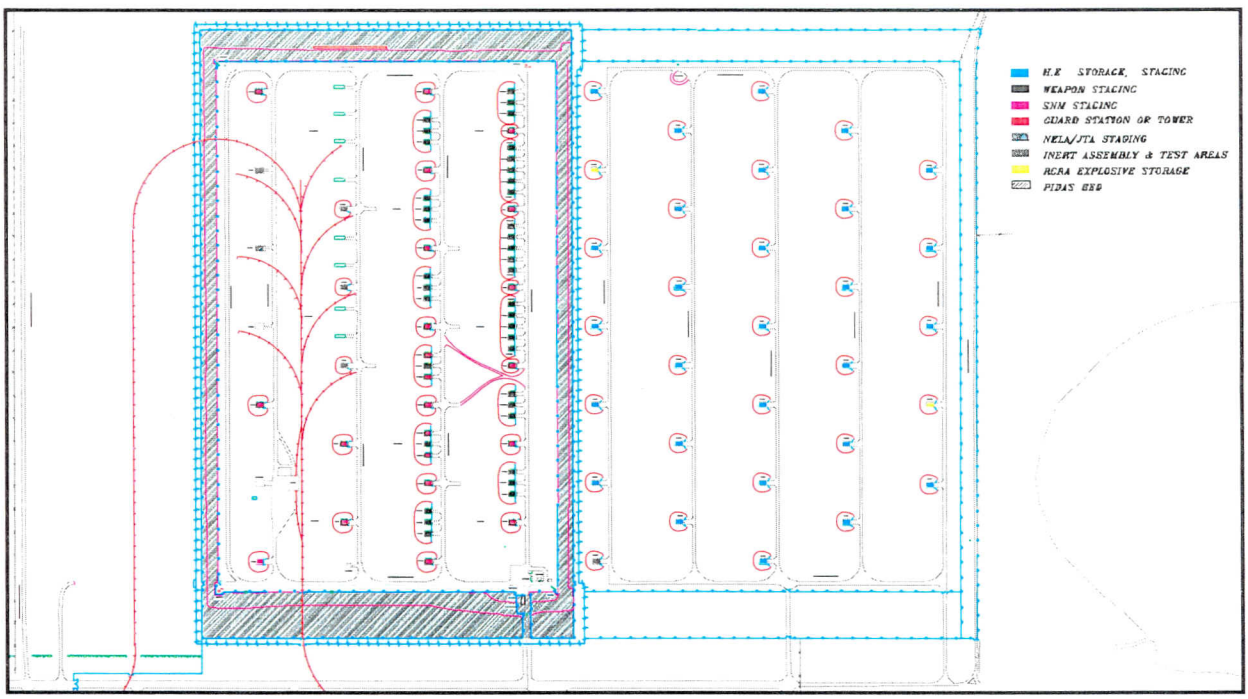

Figure 6: Schematic of Zone 4 at the Pantex Plant.

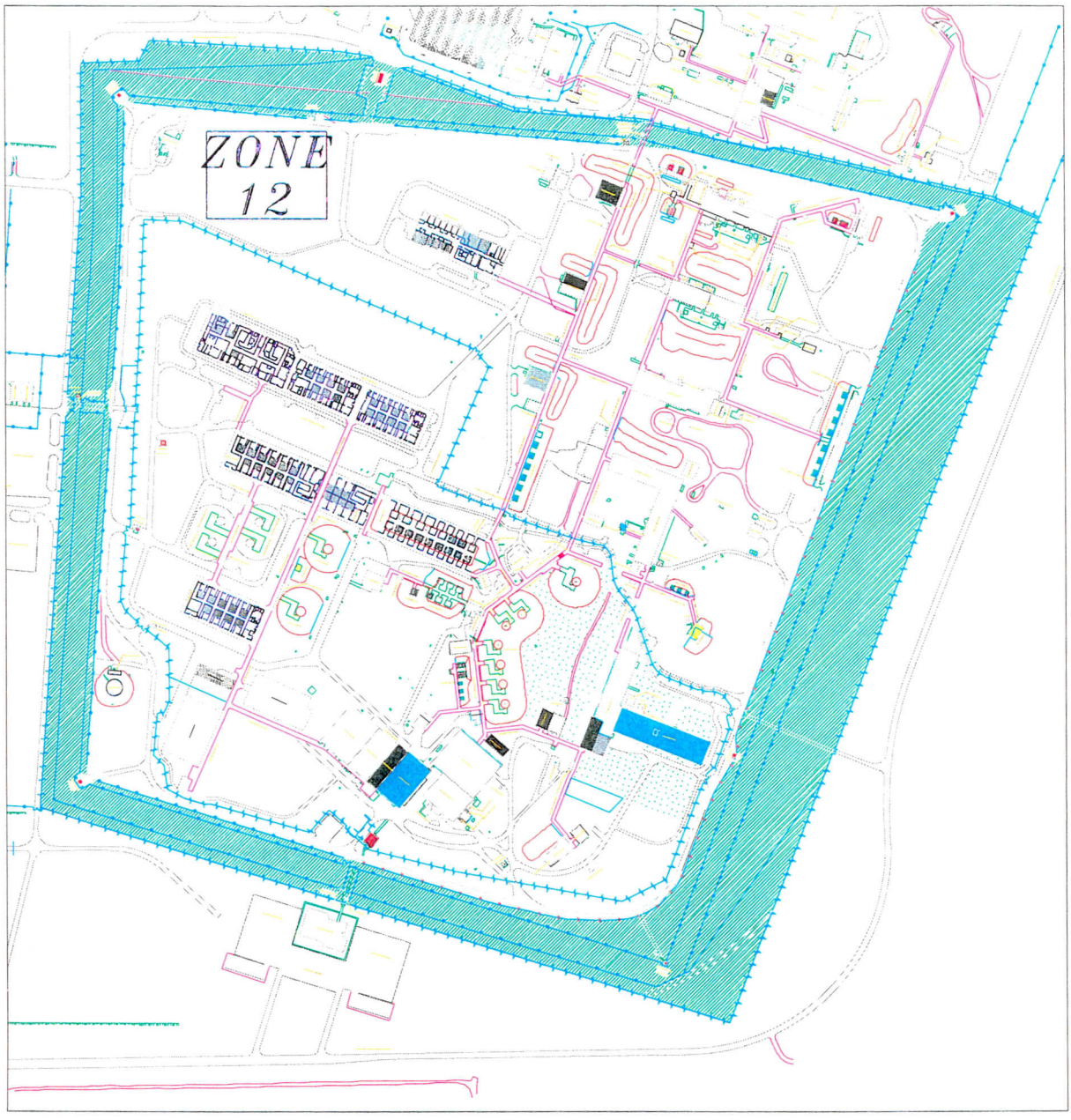

Figure 7: Schematic of Zone 12 at the Pantex Plant.

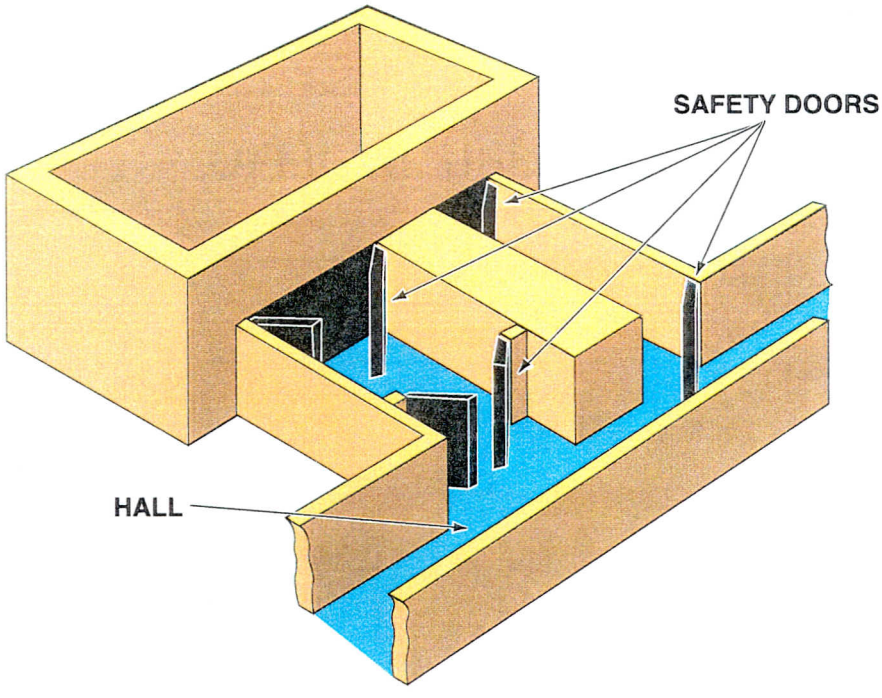

Figure 8: Layout of a Typical Disassembly Bay in Zone 12 at Pantex.

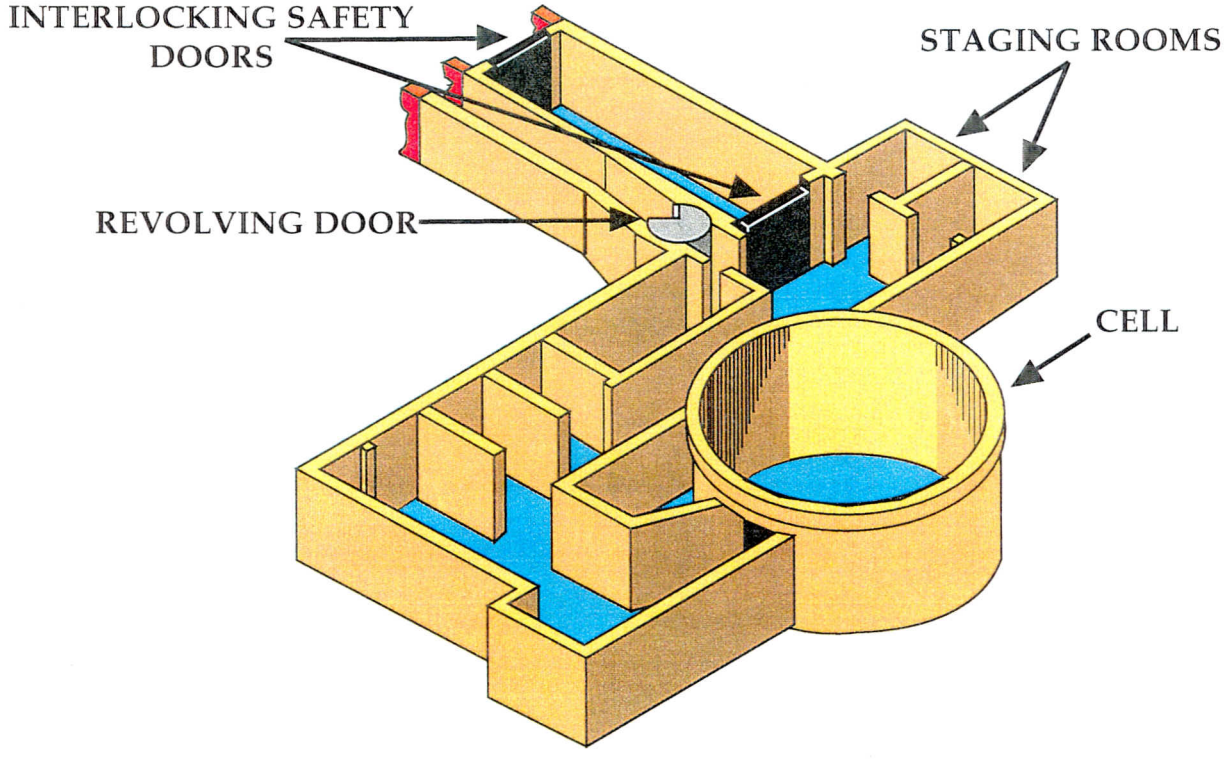

Figure 9: Layout of a Typical Dismantlement Cell in Zone 12 at Pantex.

While the layout of Zone 12 shows separate bays, cells, and other buildings, all these facilities are connected by enclosed hallways (commonly called "ramps"). Once inside the facility, it appears to be much like a single large building with various rooms.

There are 13 cells and 60 bays, all located in the southern portion of Zone 12. In addition, Zone 12 has SNM staging facilities and a loading dock for transferring weapons, components and materials in and out of Zone 12. Zone 4 is a staging area for weapons and components, consisting of 61 storage magazines of various types and a shipping and receiving building.

From a monitoring standpoint a number of facts concerning Pantex are important:

- Bays and cells are scattered throughout Zone 12, and dismantlement activities share space with other activities. It would greatly facilitate the monitoring process to isolate these facilities from others in which non-dismantlement activities occur.

- Dismantlement of warheads does not take place one at a time in serial fashion. Warheads are "campaigned" throughout the disassembly and dismantlement areas in Zone 12, with several warheads in various stages of disassembly and dismantlement in the bays and cells at any one time. This could make it necessary to use tags, seals, and radiation signature methods to track the dismantlement of individual warheads through the process.

- For explosive safety reasons, bays and cells have limited personnel access. In cells the limits are 8 operators and 8 observers; in bays the limits are 6 operators and 4 observers.

- Bays, cells, and connecting ramps do not contain a large amount of excess space for conducting monitoring procedures.

- Nuclear material is currently staged/stored in a number of different buildings.

Y-12 PLANT

The Y-12 facility is located in Oak Ridge, Tennessee. It is operated for DOE by Lockheed Martin Energy Systems. The Y-12 Plant is the only U.S. nuclear weapons facility authorized for the disassembly of nuclear warhead Canned SubAssemblies (CSAs), also known as secondaries. In addition to disassembly of CSAs removed from nuclear weapons, the Y-12 Plant has many other nuclear warhead missions, including:

- Highly Enriched Uranium (HEU) fabrication of complex components and assemblies;

- Safe and secure storage of nuclear materials;

- National Repository for non-irradiated HEU;

- Sole supplier of lithium hydride and lithium deuteride fabricated components; and

- Stockpile surveillance testing, evaluation, and assessment of warhead components.

In addition, there are non-DOE activities ongoing at the Y-12 Plant. Currently, disassembly throughput at Y-12 is approximately 22 disassemblies per month or about 260 disassemblies per year, plus additional stockpile stewardship activities. As with the Pantex Plant, disassembly activities, which comprise the largest share of the current Y-12 plant work, occur in the same buildings as assembly activities.

The Y-12 Plant includes three key facilities related to disassembly. The Nuclear Material Safeguarded Shipping and Storage Facility, Building 9720-5, is where retired warhead CSAs are received from Pantex. Building 9720-5 is also the facility principally utilized for long-term storage of HEU material. Building 9204-2E contains facilities and operations required for nuclear weapons component production, testing, storage, and disassembly. The 9212 complex contains facilities and operations used to convert HEU metal shapes into unclassified right circular annular cylinders. These cylinders are the configuration used for long term storage of HEU at the Y-12 Plant.

All disassembly activities at Y-12 occur within the area of the plant designated as the Western Exclusion Area. This area, located at the western end of the Y-12 reservation, is surrounded by a Perimeter Intrusion Detection and Assessment System (PIDAS), and entry is restricted and controlled through security portals. All activities associated with nuclear material occur within the boundaries of the Western Exclusion Area. The layout shown in Figure 10 highlights the major Y-12 facilities where disassembly and related activities occur.

All Y-12 operations associated with the disassembly of retired subassemblies from dismantled weapons have been consolidated into Building 9204-2E. Disassembly and inspection activities at Y-12 associated with the DOE Stockpile Quality Evaluation and Surveillance Program occur in Building 9204-4.

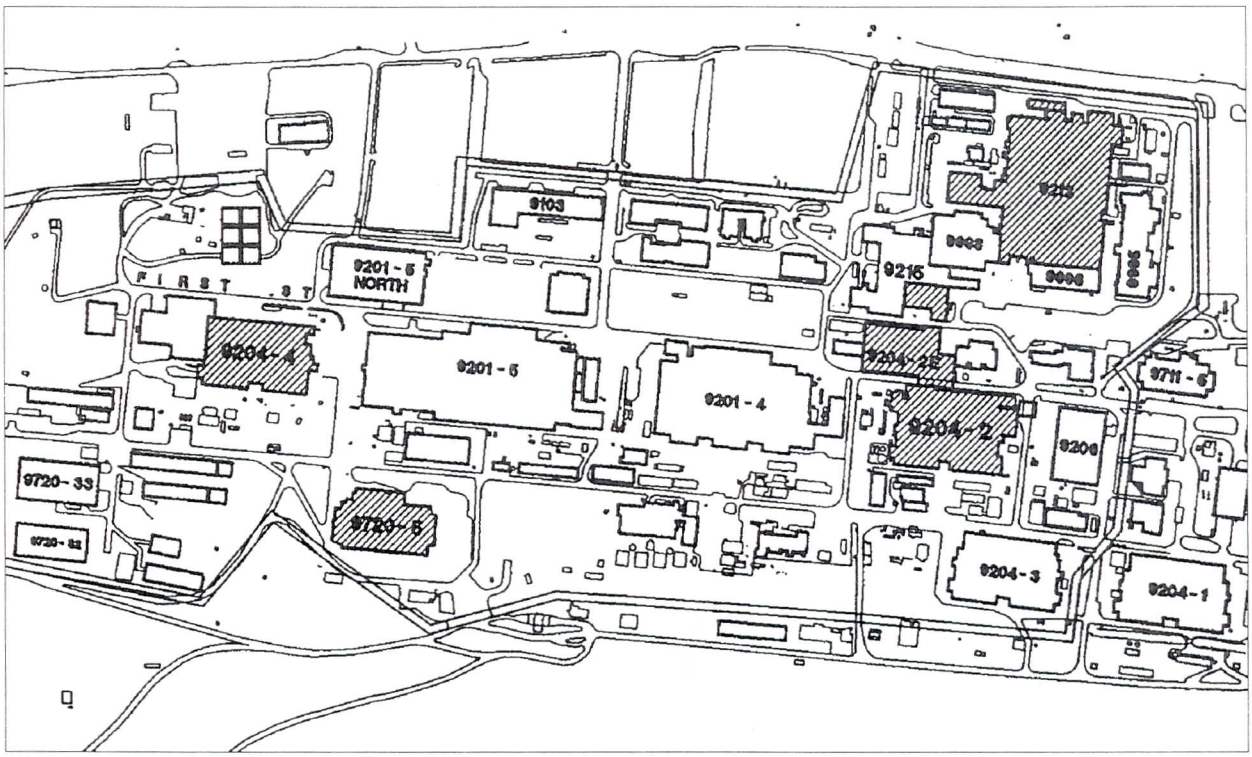

Figure 10: Diagram of the Oak Ridge Y-12 Plant.

DEVICE ASSEMBLY FACILITY

The Device Assembly Facility (DAF) is located in Area 6 at the Nevada Test Site (NTS), approximately 90 miles northwest of Las Vegas, Nevada. Prior to signature of the Comprehensive Test Ban Treaty (CTBT), the primary purpose of the DAF was to consolidate the LANL and LLNL Nuclear Test Device Assembly Operations in a single location at the NTS to provide optimum security features and provide structures that meet DOE Safety Standards for the assembly of nuclear and high-explosive materials.

The current status of the DAF includes:

- Five (5) cells of gravel gertie design to minimize release of radioactive contamination in the event of a high-explosive detonation;
- Five (5) staging bunkers with a single door for personnel and equipment (minimal processing utilities are available);
- Four (4) high bays with interlocking blast doors for personnel, and blast security doors for equipment;
- Three (3) assembly bays with interlocking blast doors for personnel and blast security doors for equipment;
- Two (2) radiography bays, with interlocking personnel and equipment doors, and areas for control equipment, film reading, a darkroom, and a processing space lab;
- Two (2) shipping and receiving bays with a loading dock and hydraulic leveling platform in place;
- Two (2) decontamination areas.

The DAF is not yet fully operational to perform nuclear explosive operations. The requirements to start up a facility such as the DAF include an approved Final Safety Analysis Report (FSAR), Nuclear Explosive Safety Studies (NESS), Environmental Assessment (EA), the successful completion of an Operational Readiness Review (ORR), and possibly, a security Inspection and Evaluation (I&E). The DAF is scheduled to have its DOE Operational Readiness Review in the Summer of 1997.

As a whole, the NTS offers considerable assets for supporting nuclear weapon dismantlement activities at the DAF. The DAF includes both bays and cells (gravel gerties) which are essential for performing dismantlement activities. Figure 11 shows the DAF at NTS.

In order to fully evaluate the cost, impact, and schedule issues associated with using DAF to support START III dismantlement and transparency activities, DOE will undertake a more detailed analysis of the DAF as part of a follow-on study to this report.

Figure 11: The Device Assembly Facility at the Nevada Test Site.

B. DISMANTLEMENT PROCESS

Dismantlement is commonly defined as the separation of the high-explosive materials from the fissile materials. More generally, dismantlement is a part of a four-step process of retirement, return, disassembly of weapons, and disposal of nuclear warhead components. The retirement of a nuclear warhead by DoD is an administrative action. During retirement, weapons may be moved from one DoD facility to another for interim DoD storage. Eventually, retired weapons are returned to the Pantex Plant by the DOE Transportation Safeguards Division (TSD) in DOE-owned and operated Safe Secure Trailers (SSTs). Weapons returned to Pantex go through a change of custody from DoD to DOE at the time they are picked up at a DoD facility. Once at the Pantex Plant, retired weapons are disassembled and the resulting components and materials are disposed of either at the Pantex Plant or at one of the other DOE nuclear weapons complex facilities, contract vendors, or DoD. The discussion of the dismantlement process below focuses on the current disassembly process that occurs at Pantex (for warheads) and at the Y-12 facility (for CSAs).

Appendix D provides a flow diagram of the dismantlement steps at Pantex for the B-61 and the W-56. It also includes a further breakdown of the major dismantlement steps for gravity bombs (weapons such as the B-61) and for reentry vehicles (weapons such as the W56). For simplicity, we have only provided an overview of the major dismantlement steps below.

DISMANTLEMENT AT PANTEX

Warhead Staging Prior to Disassembly

Retired weapons arriving at Pantex are taken to the plant's staging area in Zone 4, where custody is transferred from TSD to the plant's operating contractor, Mason & Hanger Corporation. These weapons are placed in one of the magazines until they are transferred to Zone 12 for disassembly. Zone 4 is a Material Access Area (MAA) with associated levels of security protection.

Safeguards Inspection

Within 72 hours of arrival at Pantex, gamma spectrometry and/or neutron detection verification of each warhead is performed by the Safeguards Confirmation Measurements Section of the Safeguards Department either in Zone 4 or in Zone 12. If the procedure is done in Zone 12, it is typically done in one of the linear accelerator (LINAC) facilities.

Security Inspection and Radiography

Some weapons having security features must be taken to a special facility, a gravel gertie set aside for performing the necessary operations prior to dismantlement. These inspections involve extremely sensitive aspects of warhead operation and are only accessible to limited personnel. Following these security inspections, weapons are sent to one of five LINAC facilities for radiographic safety inspection to determine the status of the weapons and components (e.g., positions of switches, the status of valves and other electro-explosive devices, the integrity of components and sub-components, and the detection of any cracks which might have developed in the high explosive). Currently, two LINAC facilities are devoted full time (one shift) to supporting dismantlement activities.

Mechanical Disassembly

The next step in the disassembly process is to move the warhead to a bay for disassembly. Mechanical disassembly includes:

- Removal from the shipping container;
- Removal of non-nuclear components (tail fins, parachute canister, pre-flight packages, etc.);
- Removal of the AF&F (arming, fusing, and firing) component;
- Removal of tritium containers (if not already performed); and
- Removal of the nuclear explosive physics package.

This is not an all-inclusive list, and not all weapons have all of these components. There are typically 2 to 4 bays associated with mechanical disassembly operations for each warhead program. However, some older warhead types lacking modern safety features are disassembled completely in the gravel gerties, where more hazardous dismantlement steps are usually performed.

Disassembly of the Nuclear Explosive Physics Package

When mechanical disassembly is complete (i.e., when the physics package consisting of the nuclear components and high explosives has been removed), the physics package is moved to a gravel gertie for "dismantlement" (i.e., separation of the high explosive from the nuclear components). When the high explosive and the nuclear components are separated, the warhead ceases to exist for accounting purposes (and for nuclear explosive safety purposes), and the nuclear components are accounted for individually from that point forward.

Component Staging

When the physics package disassembly is complete, the nuclear components are staged in several buildings in Zone 12 and the magazines in Zone 4 until they are returned to other DOE nuclear weapons complex facilities. Radioisotopic Thermal Generators (RTGs) are transported to the Los Alamos National Laboratory, tritium containers are transported to the Savannah River Site in Aiken, South Carolina, and CSAs are transported to the Y-12 Plant in Oak Ridge, Tennessee.

Pits are currently being stored in Zone 4 at Pantex in both modified Richmond magazines and Steel Arch Construction (SAC) magazines. Currently a total of 26 magazines are used for the storage of pits, and up to 425 pits may be stored in each of the modified Richmond magazines. In response to personnel radiation exposure considerations, the physical protection in and around these magazines has been upgraded to allow for extended physical inventory periods of 18 months. Generally only one or two magazines undergo physical inventory each month, requiring approximately one eight hour shift to inventory each magazine. As part of the physical inventory each item (and its tags and seals) within a magazine can be visually inspected by remote cameras, and bar codes are automatically read from a shielded fork lift as part of the Stage Right inventory system. In addition, a statistically significant population of items are selected from the population of containers within the one to three magazines selected for physical inventory during the month, and Pantex performs confirmatory NaI radiation measurement on these items to complement the container accounting described above.

Disposal

All other parts removed from dismantled warheads are categorized, disfigured, and/or rendered unusable (if required to satisfy classification and/or nonproliferation concerns), and then staged for disposal through appropriate waste streams. These efforts require significant portions of 6 warehouses at Pantex (more than 14,000 square meters). Of particular note are the high explosive components, removed from the nuclear explosive physics package, which are presently destroyed by open-air burning.

Observations on the Pantex Dismantlement Process

From the standpoint of monitoring dismantlement, several observations regarding the process described above are worth mentioning:

- The process is not uniform, varying considerably from one warhead type to another.
- The process occurs in a number of different buildings.
- The process takes considerable time. HE removal alone can take a day or longer per warhead for certain warhead types.
- Some level of monitoring by international inspectors is possible at the unclassified or Confidential/ National Security Information level at each major step of the dismantlement process.
- More confidence in dismantlement verification could be gained by the exchange of limited amounts of Restricted Data or Formerly Restricted Data with the inspecting party, if the legal mechanism for doing so (an Agreement for Cooperation) were in place.

DISASSEMBLY AT Y-12

Component Staging Prior to Disassembly

Retired warhead CSAs are shipped from Pantex to Y-12 by DOE's TSD in SSTs. These subassemblies are delivered to the Nuclear Material Safeguarded Shipping and Storage Facility, Building 9720-5. Depending on storage space availability, some CSAs may be moved to another storage facility to await disassembly. All of these facilities are located in MAAs.

Safeguards Inspection

Within 24 hours of receipt, shipments of CSAs are subjected to a transfer check, which consists of confirmation of shipping container or item count, validation of tamper-indicating device (TID) integrity, and identification.

Within 72 hours of receipt, shipments are subjected to material confirmatory measurements by non-destructive assay (gamma ray spectral measurements by multi-channel analyzer) and by gross weight checks.

Transfer to Storage Containers

CSAs removed from dismantled nuclear weapons arrive at Y-12 in containers specially designed and certified. After unloading into an MAA, some CSAs are unpacked and transferred to in-plant storage containers. Empty shipping containers are refurbished, re-certified, and are returned to the Pantex Plant for reuse.

Disassembly Operations

Per disassembly schedules, CSAs are moved to the Building 9204-2E disassembly area. Disassembly activities include:

- Unpacking from the storage or shipping container;
- Disassembly of CSAs using lathes, special disassembly tooling, presses, hand tools, and mechanical disassembly devices;
- Accountability measurements consisting of assay checks, part number verification, and part weight verification;
- Packing of nuclear material for interim storage or transport for melting and casting; and
- Processing and packaging of non-fissile classified and unclassified components.

Disassembly operations and the total duration of the disassembly process differ for each warhead type. Some CSAs are completely disassembled in one day and other, more complicated, CSAs may require several days for complete disassembly.

Component Staging after Disassembly

Following disassembly, nuclear material is assayed, verified for weight and part number identification, and entered into the Y-12 plant's accountability system. HEU is loaded into specially designed containers (birdcages) for interim storage within vaults, and eventually transported to the Building 9212 MAA for melting and casting.

Other materials are handled in various ways depending on part configuration, classification, material type, and contamination level. Depleted uranium parts are assayed, verified for weight and part number, and marked with white paint to prevent potential misidentification in later processing. Depleted parts are placed in tote-pans with lids and are moved out of the MAA to await further processing. Components manufactured from lithium compounds are checked by health physics technicians for potential contamination with enriched uranium. Contaminated and uncontaminated components are packaged separately into plastic bags and into 55-gallon metal drums.

After casting, HEU is packaged into sealed metal cans which are placed in interim storage or moved to the MAAs for long-term storage in one of the three concrete-encased tube vaults, each having a storage capacity of 40 metric tons of (approximately 93% enriched) HEU or into Modular Storage Vaults (MSVs), each having an HEU storage capacity of approximately 1.9 metric tons in a 5-layer configuration.

C. U.S. DISMANTLEMENT SCHEDULE

Table 2. U.S. Dismantlements Completed.

Fiscal Year	Programs Completed	Associated Delivery Vehicles	Total Dismantlements
1989	W-45	Terrier, Bullpup B	1,208
1990	None	N/A	1,154
1991	B43, B54, W44, W50, W85	USN Tactical, Davy Crockett, ASROC, Pershing I, Pershing II	1,595
1992	B28, W33	USN Tactical, 8" AFAP	1,856
1993	None	N/A	1,556
1994	None	N/A	1,369
1995	B57, W71*, W68, W70	ASW Depth Bomb, Spartan, Poseidon C-3, Lance	1,393
1996	W48, B61-0	155 mm AFAP, Strategic Bomb	1,064
Total			11,195

* The quantity dismantlement of W71 units was completed in 1995.

Table 3. U.S. Dismantlement Schedule.

Fiscal Year	Programs Completed	Associated Delivery Vehicles	Total Dismantlements
1997	B61-2, W55, W71**	Tactical Bombs, SUBROC, Spartan	944*
1998	TBD	TBD	1,319*
1999	TBD	TBD	418*
2000	TBD	TBD	150*
Total			2,827*

* Dismantlements scheduled according to the current Long Range Planning Assessment.
** A single W71 unit remained until 1997.

Table 4. Remaining Warhead Programs.

Status	Warhead Type	Associated Delivery Vehicles
In Dismantlement	B61-5	Tactical Bombs
Scheduled for Dismantlement*	W69	SRAM
	W79	8" AFAP
	B53*	Strategic Bombs
	W56*	Minuteman II
Canceled Programs	W82	155 mm AFAP
	W89	SRAM II
	B90	ND/SB
	W91	SRAM T
Enduring Stockpile**	W62**	Minuteman III
	W84**	GLCM
	B61-3***, 4***, 7, 10, 11**	Tactical & Strategic Bombs
	W76**	Trident I
	W78**	Minuteman III
	W80**	SLCM/ALCM
	B83**	Strategic Bombs
	W87**	Peacekeeper/Minuteman III
	W88**	Trident II

* Scheduled for dismantlement in the current Long Range Planning Assessment.
** Potentially subject to monitored dismantlement under START III.
*** A portion of the B61-3 and B61-4 units have been retired and will be dismantled.

Table 5. Time Required for Dismantlement.

Warhead Type	Status	Process Time,[1] person hours	Cycle Time,[2] 8 hr. shifts	Throughput,[3] Units/month
B61-5	In dismantlement	29.4	1.5	14 - 15
W69	Scheduled for dismantlement	55.2	2.8	7 - 8
W79	Scheduled for dismantlement	165.2	8.6	2 - 3
B53[4]	Scheduled for dismantlement	175	9	2 - 3
W56[4]	Scheduled for dismantlement	120	6.5	3 - 4
W62[4]	Enduring Stockpile	95	5	4 - 5
W84[4]	Enduring Stockpile	160	8.5	2 - 3
B61-3, 4, 7, 10, 11[4]	Enduring Stockpile	30	1.5	14 - 15
W76[4]	Enduring Stockpile	60	3	7 - 8
W78[4]	Enduring Stockpile	70	3.5	6 - 7
W80[4]	Enduring Stockpile	60	3	7 - 8
B83[4]	Enduring Stockpile	90	5	4 - 5
W87[4]	Enduring Stockpile	95	5	4 - 5
W88[4]	Enduring Stockpile	85	4.5	4 - 5

Notes:

1. Process time is the actual hands-on dismantlement time in person hours, with no down time for breaks, waiting for transfer of parts between bays and cells, etc. Under the Pantex Reader, Worker, Checker system, a minimum of 3 technicians are involved at each step of the dismantlement process.
2. Cycle time is the time required for dismantlement including breaks, waiting for transfers between bays and cells, etc. For the purposes of this report cycle time is measured in 8 hour shifts of 3 technicians each. With no lost time for breaks, transfer between bays and cells, etc., 24 hours of process time would require 1 shift of cycle time.
3. For the purposes of this report, throughput assumes one dedicated dismantlement cell, one warhead system in dismantlement at a time, and one shift per day, 5 days per week.
4. Dismantlement time required for these systems has been estimated.