DCN 5860
Executive Correspondence

Congress of the United States

Washington, DC 20515

July 26, 2005

The Honorable Anthony J. Principi
Chairman – Defense Base Closure and Realignment Commission
2521 South Clark Street, Suite 600
Arlington, VA 22202

Re: Deseret Chemical Depot, Utah

Dear Mr. Chairman:

We are writing to request Commission approval of two proposed modifications to the 2005 Defense Base Closure and Realignment (BRAC) recommendation issued by the Department of Defense (DoD) on May 13, 2005 relating to the Deseret Chemical Depot, Utah. That recommendation called for the closure of the depot and the dismantling of its incineration facility upon completion of its current chemical munitions disposal mission. Our two proposed recommendations are as follows:

1. The report cited an incorrect date regarding the completion of the depot's current mission which should be corrected.

2. The depot should be utilized for conventional munitions disposal activities after its chemical mission is completed.

First, the DoD recommendation stated that Deseret's mission would be completed by the 2nd quarter of 2008. This assumption is simply not accurate. On July 18, 2005, some of our staff members were able to confirm through Mr. Dale Ormond, Deputy Assistant Secretary of the Army for the Elimination of Chemical Weapons, that the mission completion date for the Deseret Chemical Depot would be, at the earliest, sometime in the year 2012, and possibly beyond. These delays are due to further modifications to the industrial incineration plant, as well as process changes, associated with the switch-over to its final workload of mustard gas.

Therefore, we would appreciate the Commission correcting the COBRA information with regard to the mission completion date for Deseret Chemical Depot.

Second, we strongly support the concept of using the Deseret incinerator for conventional munitions disposal activities at the culmination of its chemical mission. The Deseret facility represents over $1 billion in prior U.S. taxpayer investment, when considering the total costs of its engineering, design, construction, equipment, licensing, and demonstration. This large investment should not be abandoned. It would be a more responsible use of taxpayer funds, as well as more environmentally-friendly, to consider converting the chemical destruction plant to a conventional munitions disposal operation rather than completely dismantling and tearing-down this facility.

The Department of the Army, at the request of Congress, contracted with the MITRE Corporation in 1991, to complete a feasibility study on possible alternative uses of its chemical demilitarization incinerators. (See Enclosure 1 – CD-ROM). While that report is nearly 14 years old, the engineering studies it is based upon are still valid in support of the technical viability of converting such facilities to a conventional mission. Further, while this study called into question the economics of such a conversion, we believe that the report's economic arguments should be re-evaluated and balanced in light of the ever-growing stockpile of obsolete conventional munitions, and greatly increased environmental restrictions against most forms of existing conventional disposal methods during the intervening years since that report was completed.

The Tooele Army Depot (TEAD) located adjacent to the Deseret facility, currently has a conventional munitions storage and disposal mission. TEAD is prepared to support the Deseret facility by assuming a significant amount of this growing conventional workload from the Department of the Army, as well as other services. Under the DoD recommendation, TEAD is already slated to receive additional conventional munitions work from the proposed closure of the Army's Hawthorne, Nevada facility.

Although a conversion of the Deseret incinerator to conventional disposal would ultimately require: (1) a change in federal law; (2) support from the Governor of Utah through a modification in the current Memorandum of Agreement with the Army, and; (3) funding provided by the Congress, the period which remains in Deseret's chemical mission of at least seven more years will allow the Congress and the Department of Defense ample time to investigate and study such a conversion in greater detail.

Therefore, we propose that the Commission include language similar to the draft (See Enclosure 2) provided with this letter, granting the Congress and the Department of Defense flexibility in pursuing these ideas more fully and not precluding them all-together under the original DoD recommendation which will have the force and effect of law unless altered by the Commission's final report.

Thank you for taking our views into consideration.

Sincerely,

Rob Bishop
Member of Congress

Orrin G. Hatch
United States Senator

Chris Cannon
Member of Congress

Robert F. Bennett
United States Senator

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Engineering Analysis for Future Use of Chemical Agent Demilitarization Plants: Feasibility and Desirability

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DCN 5860
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DOCUMENT TITLE: Engineering Analysis for Future Use of Chem. Agent Demil. Plants: Feasibility + Desirability

	Change/Rev.	Entered By	Date
Initial Document	June 91	[illegible]	May 96

DCN 5860
Executive Correspondence

Engineering Analysis for Future Use of Chemical Agent Demilitarization Plants: Feasibility and Desirability

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MTR-91 WOO010

SPONSOR:
U.S. Army
CONTRACT NO.:
DAAA15-86-D-0012

Approved for public release: distribution unlimited

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ABSTRACT

The U.S. Army is responsible for the destruction of the U.S. stockpile of unitary chemical munitions and lethal agents. Facilities containing disassembly equipment, incinerators, and pollution control equipment are scheduled to be constructed to complete this mission by the end of 1998. Congress has requested an investigation and report on the feasibility and desirability of using the disposal facilities for other purposes after the primary mission is completed. This report presents the results of the study carried out in response to that request. For each facility, the technical feasibility of each candidate future use is investigated and the desirability of these uses is assessed in terms of economic, regulatory, and public perception considerations.

Suggested Keywords: Chemical Agent Demilitarization Facilities, Desirability, Feasibility, Future Uses, U.S. Army,

ACKNOWLEDGEMENTS

Many individuals have made important contributions to this paper. We especially wish to thank Mr. William Brankowitz of the U.S. Army, Office of the Program Manager for Chemical Demilitarization for his guidance, direction, contacts for information, arranging of informational meetings, and his insightful comments on drafts of the text. Thanks also are due to Mr. Abu Talib, Mr. Greg Vogel, and Ms. Arlene Wusterbarth of The MITRE Corporation for serving as peer reviewers, providing guidance and sharing their expertise. Thanks also to Mr. Douglas Medvflle, our Project Leader, for his leadership and guidance, and for significant input to the contents of the report. We are also grateful to the numerous individuals from the Army for their cooperation in providing the information from which this report was prepared and for helping to assure its accuracy through their careful review of the draft versions of this report. And finally, last but not least, many thanks are due to the MITRE secretarial staff, and in particular Ms. Sheila McHale, for spending many hours so that this report could be published and delivered on time.

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

In 1985, the U.S. Congress directed the Department of Defense (DOD) to destroy the remaining U.S. stockpile of obsolete unitary chemical warfare agents and munitions (Public Law 99-145). A plant for destruction of a variety of weapons that are part of the stockpile was constructed on Johnston Island in the Pacific Ocean and is currently undergoing operational verification testing. The Johnston Atoll Chemical Agent Disposal System (JACADS) employs disassembly and incineration technology developed at the Chemical Agent Munitions Disposal System (CAMDS), which is a chemical demilitarization technology research and testing facility at Tooele Army Depot. A Chemical Disposal Facility (CDF) employing the JACADS technology is under construction at the Tooele Army Depot, Tooele, Utah. Seven additional facilities are planned to be constructed in the continental United States at Anniston Army Depot, Anniston, Alabama; Umatilla Depot Activity, Umatilla, Oregon; Pine Bluff Arsenal, Pine Bluff, Arkansas; Newport Army Ammunition Plant, Newport, Indiana; Pueblo Depot Activity, Pueblo, Colorado; Aberdeen Proving Ground, Aberdeen Proving Ground, Maryland; and Lexington-Blue Grass Army Depot, Lexington, Kentucky.

In addition, the Army has completed disposal of the incapacitating agent BZ in a plant constructed for this purpose ***at*** Pine Bluff Arsenal. An alternative technology involving the cryofracture and incineration of chemical munitions is also being developed by the Army. Successful testing of this process is a necessary condition if a decision is to be made to construct a facility, called the Cryofracture/Incineration Demonstration Plant (CIDP), at Tooele Army Depot adjacent to the CDF currently under construction there.

In November 1989, the House and Senate Appropriations Committee of Conferees* directed the Army "to investigate and report on the feasibility and desirability of using chemical weapons disposal facilities for other purposes" after the stockpile is destroyed. The Army subsequently awarded a contract for this study to The MITRE Corporation.

Potential future uses for the chemical disposal facilities, CAMDS, JACADS and the CIDP were identified by MITRE through discussions with Army personnel at the installations where these facilities will be operating, and at nearby DOD installations that may have an interest in the potential

*Title VI of the 1990 Defense Appropriations Conference (DAC) Report 101-345, entitled "Chemical Agents and Munitions Destruction, Defense."

future uses of the demilitarization facilities. The technical literature was reviewed to obtain information on available technology for proposed future uses and to identify competing methods. Based upon the technical suitability of the equipment, environmental and institutional issues, existing alternatives to the use of the CDFs, and the quantity of the potential feedstock available at a site, the following future uses were examined for their feasibility and desirability:

- Demilitarization of conventional munitions.
- Demilitarization and/or decontamination of nonstockpile and range recovered chemical items.
- Decontamination of buildings and equipment that are considered potentially contaminated with agent or other hazardous substances.
- Remediation of contaminated soils.
- Disposal of DOD and non-DOD industrial hazardous wastes.
- Disposal of municipal non-hazardous wastes.

Definitions of feasibility and desirability were developed to provide a basis for selecting future uses for the CDFs that are both feasible and desirable. These definitions are as follows:

Feasibility. This is the basic technical capability of equipment to perform a proposed task with a minimum of design or operating changes. The feasibility of using a chemical demilitarization plant for the disposal or decontamination of a particular item is determined by evaluating the ability of the equipment to destroy or decontaminate the item within acceptable environmental parameters, taking into account the magnitude of the necessary equipment or operating changes.

The feasibility of using a CDF for a particular purpose is site specific because not all sites are equipped with a full capability CDF. For example, Aberdeen Proving Ground (APG) only has agent ton containers to demilitarize and, therefore, will not be equipped with a full capability for demilitarizing rockets, mines, and projectiles. Thus it will be feasible to thermally decontaminate non-stockpile items such as surface decontaminated ton containers, but it is not feasible to demilitarize range-recovered projectiles in the APG CDF without extensive modification and facility additions.

Desirability. This is the advisability of using a plant for a particular purpose, taking into account the following factors:

- The necessity of the proposed activity (Army and public need).
- Alternative methods of disposal or decontamination.
- Regulatory requirements.
- Economics, including efficiency, capital costs, operating and maintenance costs, and the cost of obtaining permits.
- The amount of the potential feed material.
- Transportation issues.
- Public support or opposition.
- Uncertainties about any of these factors, especially costs and future state and local regulations or requirements.

The desirability of using a CDF for a specific purpose is primarily site specific. A particular feedstock for which the CDF is suited may not exist at the site of the plant or may not be available in sufficient quantity to render the operation economical. In other instances, the quantity of the potential feedstock may be so large that it would take an inordinate amount of time to process it in the CDF as it is currently configured, and excessive costs would be incurred to modify the facility in order to process the feedstock. In these cases, total costs may be lower if a separate facility was designed for that feedstock. Public attitudes at a particular location will also affect the desirability of using the CDF for another purpose. For example, a local community may oppose the incremental risk that may be associated with handling and incinerating feedstock other than those for which the facility was designed.

These factors were grouped into three major desirability categories: (1) regulatory desirability, i.e., taking into account regulations at both the federal and state level; (2) public perceptions, i.e., taking into account the public's attitudes concerning use of the demilitarization facilities; and (3) economic desirability, i.e., taking into account potential alternative disposal methods, transportation costs, the volumes of feedstock, and relative throughput rates.

In this report, several future use options at specific locations are described as being "desirable" in terms of the categories given above; however, this does not imply that recommendations are being made to implement these uses at each applicable location. It should be recognized that a designation of desirability only indicates that a future use

appears to be potentially suitable and not that the future use should be carried out. Furthermore, use of the facilities for other purposes will be subject to broad and comprehensive regulation arising from federal, state and local laws. Amendments or supplements to existing Environmental Impact Statements (EISs) or Environmental Assessments (EAs) would have to be prepared. Public reaction to these documents may affect the schedule and technical requirements for the prospective future use of these facilities.

For all of the facilities addressed in this report, several years will elapse before their primary mission--destruction of unitary chemical munitions and agent--is completed. During this time, estimates of the volumes of feedstock materials will change, alternative processes for disposal of these feedstocks may evolve, and the relative economics for disposal will change. Also, the desirability of future use with respect to public perceptions and regulatory requirements is likely to change over the next several years. Thus, it is premature to reach decisions concerning future uses of the plants based solely on the information contained in this report.

Although feasibility and desirability are evaluated separately, there is, of necessity, a certain amount of overlap. For example, costs are considered primarily when evaluating desirability, but cannot be ignored when determining feasibility. Also, the factors affecting desirability are interrelated. For example, compliance with regulatory requirements affects costs, and the economics of using the chemical demilitarization equipment must be evaluated with respect to the economics of alternative technologies.

2.0 POTENTIAL FUTURE USES FOR THE CHEMICAL DISPOSAL FACILITIES

Six general categories of potential future uses for the chemical disposal facilities are investigated in this study.

Conventional Munition Demilitarization

There are over 121 million individual items (almost 200,000 short tons) of conventional munitions in the U.S. demilitarization stockpile. Additional inventory is generated at a rate of about 23,000 short tons per year.

Demilitarization of these munitions is currently carried out by reclamation, destruction, or a combination of both. The means of destruction include open burning (OB), open detonation (OD), and controlled incineration. Biodegradation, catalytic oxidation, electrochemical reduction, and chemical conversion processes are also being investigated.

Reclamation processes involve the disassembly of the munition and extraction of energetic materials for either recycling/reuse in explosives manufacture, or as a fuel supplement.

Small arms ammunition, primers, fuses, bursters, detonators, grenades, shredded hardware from pyrotechnics, white phosphorous (WP), hexachloroethane (HC) and colored smoke munitions, small explosive items, and bulk energetic material, are demilitarized in deactivation furnaces similar to the deactivation furnace used in the chemical weapons demilitarization process.

Thermal Destruction/Decontamination of **NonStockpile** Chemical Items

Nonstockpile chemical items include range-recovered (filled or empty) chemical munition items; chemical agent identification sets; empty ton containers that have been surface decontaminated (XXX); protective clothing, rags, decontamination solutions, and tools used in maintenance of chemical surety items; and unwanted or excess chemical surety material **(e.g.,** bulk agent in excess of that required for experimental or research and development needs). These items were not included in the list of chemical stockpile items existing on the date of enactment of PL 99-145, and, for this reason, are not scheduled for destruction/decontamination under the Chemical Stockpile Disposal Program (CSDP).

Building and Equipment Decontamination

Numerous buildings at various military installations are no longer needed and may have to be torn down or converted to other uses. Some of these buildings might be contaminated by hazardous substances, including chemical surety materials. In order to safely dispose of the building or convert it to other uses, it is necessary to decontaminate it. The internals of such buildings--piping, tanks, ductwork, wiring, building supports, and assorted furnishings--can usually be dismantled, cut up, and subjected to thermal decontamination in a rotary kiln or metal parts type furnace. Contaminated structural materials and building rubble may also be thermally decontaminated.

Soil Decontamination

As a result of the Installation Restoration Program (IRP) activities at defense installations, many sites are being identified where toxic and hazardous wastes have been buried. Contaminated soil is readily treated in rotary kilns. Successful thermal decontamination of soil contaminated with explosives has been demonstrated at several Army installations. Rotary kilns have been used in all these cases; the major advantage being that as the kiln rotates, the soil is constantly agitated and fresh soil surface is continually exposed to combustion gases.

Toxic, Hazardous, and NonHazardous Waste Disposal

A waste is characterized as toxic or hazardous if it possesses certain characteristics, or it has been so defined and listed by the EPA in their regulations (40 CFR 260). Some states may also regulate additional wastes as hazardous even though the EPA did not list them as hazardous. These hazardous wastes are generated during routine daily activities of industrial and commercial operations, laboratories, and the military. In addition, remedial action at former hazardous waste landfills is adding to the volume of hazardous wastes requiring disposal.

Methods for managing wastes include waste reduction/minimization efforts, treatment, destruction, containment, and land disposal. Thermal destruction by incineration is effective for many toxic, hazardous, and nonhazardous wastes.

Other Potential Uses

The chemical demilitarization plants will include a variety of support activities with specialized facilities and equipment. These facilities and equipment are likely to continue to be used if the demilitarization plants are to be used for other purposes. However, if the demilitarization equipment is dismantled, the support facilities could be turned over to the host installation to fulfill their requirements for new or replacement of equivalent facilities. In cases where the host installation is scheduled for closure, the structures may be attractive to the private sector for commercial or industrial use.

3.0 FEASIBILITY OF POTENTIAL FUTURE USES OF CHEMICAL DISPOSAL FACILITY SYSTEMS

In order to evaluate the technical capability of all or part of the chemical demilitarization plants for other purposes, the demilitarization plants are considered to be composed of eight subsystems or building blocks. The applicability of each of the building blocks to a potential future use was then determined. The eight building blocks are:

- Pre-Incineration - includes the machines in a chemical demilitarization plant that are used to disassemble, punch, drain, shear, or crush munitions. The CSDP and the CAMDS demilitarization plants contain one or more of the following demilitarization machines: the rocket shear machine (RSM), the mine machine (MIN), the bulk drain station (BDS), the projectile/mortar disassembly machine (PMD), and the multipurpose demilitarization machine (MDM). The CIDP plant contains cryopretreatment, material transfer robot, and cryofracture press systems.

- Deactivation Furnace Svstem (DFS) - includes a munitions feed chute, a rotary kiln, a heated discharge conveyor, a hot cyclone, and an afterburner. Also included is a pollution abatement system (PAS). This building block is used to incinerate explosives, propellant, and explosive components and to thermally decontaminate munition bodies with residual agent and sheared rockets. The PAS consisting of a quench tower, venturi scrubber, packed tower, demister, and an induced draft fan is used to cool and clean exhaust gases.

- Metal Parts Furnace (MPF) - includes a munitions feed mechanism, a primary volatilization/burn out chamber, an afterburner and associated PAS that is similar to the one used with the DFS. This building block is used to decontaminate munition bodies and bulk agent containers containing residual agent by volatilizing and thermally destroying the agent.

- Liauid Incinerator (LIC) - consists of a two-chamber liquid injection incinerator with the chambers connected by a crossover duct. The associated PAS is similar to the one used with the DFS and MPF. This building block is used to incinerate chemical agent and decontamination solutions used in munition processing.

- Dunnaae Incinerator (DUN) - consists of a primary combustion chamber and an afterburner. Also included is a PAS consisting of a quench tower, a baghouse, and an induced draft fan. This building block is used to incinerate non-metallic wastes, including protective garments, wooden pallets, packaging material, and charcoal filters.

- Toxic Cubicle Area - Brine Reduction Area (TOX-BRA) - includes a toxic cubicle that consists of storage tanks and pumps, and a brine reduction area that consists of holding tanks, pumps, evaporators and dryers. This building block is used to process a variety of process brines and brines from the PAS.

- Other Ooerational Facilities - include the munitions holding area (MHA), the unpack area (UPA), the environmental monitoring laboratory, and the central decontamination system (CDS).

- Support Facilities - include facilities not handling chemical agent or munitions such as chemical storage, fuel storage, control room, and utilities.

Table ES-l provides a summary of the applicability of the various building blocks of a CDF to each of the potential future uses discussed in this report. The information in this table indicates that one or more building

Table ES-l. Technical Feasibility of Future Uses of CSDP Plant Building Blocks

Potential Feedstocks	DUN/PAS Primary/ Afterburner, Quench Tower, Baghouse	TCE/BRA Liquid Agent Storage, Brine Storage, Brine Evaporator	Other Operational Facilities MHA, UPA, Laboratory	Support Facilities Chemical Storage, Fuel Storage, Utilities	Pre-Incineration RSM, BDS, MIN, PMD, MDM, Cryobath, Cryopress	DFS/PAS Rotary Kiln Cyclone, Afterburner, Demister	MFF/PAS Primary Chamber, Afterburner, QT-VS-ST Demister	LIC/PAS Primary Chamber, Secondary Chamber, QT-VS-ST Demister
1a. Small conventional munitions	N, 15	Y, 11	Y,12	Y, 12	NA, 1, 14	Y, 5, 12	NA	NA
1b. Smoke, riot agents		Y, 15	Y, 11	Y, 13	Y, 12	Y, 2, 4	Y, 6, 12	Y, 9
1c. Large conventional munitions	N, 15	Y, 11	Y, 13	Y, 12	Y, 3, 4	Y, 12	Y, 9	NA
1d. Bulk energetics	N, 15	Y. 11	Y, 13	Y, 12	Y, 1, 3, 4	Y, 7	Y, 9	NA
2. Non-stockpile chemical items	N, 15	Y, 12	Y, 12	Y, 12	Y, 12	Y, 12	Y, 12	Y, 12
3. Agent contaminated building material	N, 15	Y, 11, 12	Y, 11, 12	Y, 12	NA	Y, 7	Y. 7. 9	NA
4. Soil contaminated with hazardous substances	N, 15	N	Y, 11	Y, 12	NA	Y, 7. 8	Y, 10	NA
5. Industrial hazardous waste (DOD and Non-DOD)								
Examples:								
a. Painting Wastes		N	NA	Y, 11. 17.	Y, 12	NA	Y, 6. 7	Y, 6, 7. 10
b. Solvent, TCE	N	Y, 12	Y, 11, 12	Y. 12	NA	Y, 7	N	Y,7
c. Solvent, DS_2	N	Y, 11	Y, 11	Y, 17.	NA	Y. 7	N	Y, 7
d. Petroleum, Oil, Lubricants	N	Y, 11	Y, 11, 12	Y, 12	"A	N	N	N
e. Heavy Metals-Hg		N	N	N	N	NA	Y, 7. 10	Y. 7. 10
6. Municipal Non-hazardous waste	Y, 10	NA	Y, 11	Y, 12	NA	Y, 7, 10	Y, 7, 10	N

Table ES-l. Technical Feasibility of Future Uses of CSDP Plant Building Blocks (Concluded)

Key:

1. Generally no disassembly is required.
2. Most need disassembly (punch only), disassembly of pyrotechnics could be a problem.
3. May use cryopress for size reduction of bulk and some large explosives.
4. Specialized equipment
5. Excludes thermites.
6. Upgrade PAS to remove organic carcinogens and other combustion products (may require electrostatic precipatator).
7. Modify feed mechanism.
8. Refractory lining for DFS is desirable.
9. The MPF is used to thermally decontaminate metals with residual explosives.
10. But not practical.
11. Limited use.
12. Generally, equipment is suited with no changes necessary.
13. Minor modifications necessary in UPA and MHA.
14. Some grenades and mines in this group need to be disassembled (remove fuze and punch) and some mines contain about 20 pounds of explosives that could be removed in a washout/meltout facility.
15. Dunnage associated with feedstock.
16. Use Ammunition Peculiar Equipment (APE).

Y = Yes (equipment can be used for this feedstock).
N = No (this equipment cannot be used for this feedstock).
NA = Not applicable.

DUN = Dunnage Incinerator
PAS = Pollution Abatement System
TOX = Toxic Cubicle
BRA = Brine Reduction Area
MHA = Munition Handling Area
UPA = Unpack Area
RSM = Rocket Shear Machine
BDS = Bulk Drain Station
PMD = Projectile/Mortar Disassembly Machine
MDM = Multipurpose Demilitarization Machine
QT = Quench Tower
VS = Venturi Scrubber
ST = Scrubbing Tower
DFS = Deactivation Furnace System
MPF = Metal Parts Furnace
LIC = Liquid Incinerator
HDC = Heated Discharge Conveyor

blocks of the CDFs, with hardware modifications in some instances, can be used for each of the potential feedstocks listed. Occasionally, a future use may involve several building blocks in sequence. As stated earlier, if a full capability CDF is not present at a particular site, it may not be feasible to use that CDF for an application even though it contains one of the building blocks that is used in that application.

4.0 DESIRABILITY OF FUTURE USES OF CHEMICAL DISPOSAL FACILITIES

Three major aspects of desirability have been considered: the impact of regulations on future use, public perceptions of the risks associated with such use, and economic aspects of use of the plants, taking into consideration the existence of technological alternatives to these plants for each application.

Regulatory Aspects

The alteration and use of the chemical demilitarization plants beyond their current mission to destroy the U.S. stockpile of obsolete chemical munitions will be subject to broad and comprehensive regulation, arising from federal, state, and local laws. U.S. Army regulations will also affect the conduct of various future demilitarization plant uses.

Federal Regulations

Table ES-2 summarizes the applicable federal environmental laws according to three generic future use functional categories: incineration of obsolete conventional munitions; incineration of hazardous wastes recovered from previous, uncontrolled waste disposal practices; and incineration of hazardous wastes from current operations. The second category--hazardous wastes site remediation--includes all hazardous wastes recovered from Installation Restoration Program (IRP) cleanup actions at military facilities. Also included is incineration of range-recovered chemical and conventional munitions, contaminated building debris and hazardous building materials, and other wastes from hazardous waste site cleanup. The third category includes disposal and incineration of hazardous wastes resulting from current operations and sources. In all cases, incineration is considered to be the only treatment or disposal operation undertaken in demilitarization plants.

In addition to environmental regulations, the following federal laws also apply to some future uses:

Table ES-2. Applicablity of Major Federal Environmental Laws and Regulations to Demilitarization Plant Future Uses

Law/Regulations	Conventional Munition Destruction	Hazardous Waste Site Remediation	Other Solid/Hazardous Waste
National Environmental Policy Act of 1969 (NEPA)	Applies to all Federal actions with potential to affect tbr • nviroment • Legislative changes • Demil plant mission changes All proposed changes require environmental analysis (EAs, EISs)		
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended under the Superfund Amendments and Reauthorization Act of 1986 (SARA)	Not applicable ucept for range-recovered items and items excavated during remediation of landfills	Defines overall procedures for implementation of waste site cleanup at federal facilities Incorporates othu federal, environmental requirements and regulations as applicable or relevant and appropriate (ARAR)	Not • [illegible]
Resource Conservation and Recovery Act of 1976 (RCRA), as mended under the Hazardous end Solid Waste Amendments of 1984 (HSWA)	• Applies to obsolete munitions at the time they are designated as waste for destruction or disposal (Army Reg. 200-l) Overall regulatory framework for all hasardoua waste treatment and disposal activities	• Technical standards for on-site remediation • Technical standards applied through permits for off-site treatment, disposal Applies to CERCU actions as an ARAR	Applies to 411 aspects of hazardous waste management • Technical environmental standarda, regulations • Permits

Table ES-2. Applicablity of Major Federal Environmental Laws and Regulations to Demilitarization Plant Future Uses (Concluded)

Law/Regulations	Conventional Munition Destruction	Hazardous Waste Site Remediation	Other Solid/Hazardous Waste
Clean Water Act of 1977 (CWA), as amended in 1967 (Water Quality Act) (Replaces Federal Water Pollution Control Act of 1972)	NPDES permits required for all "Point Source" discharges to surface waters • Treatment requirements are technology related and determined on a pollutant and site-specific basis • Newly enacted NPDES storm water requirements		
Clean Air Act of 1955 (CAA), as amended	NSPS, PSD, and NESHAP enforced through permitting process a Removal requirements are technology related and determined on a pollutant and site-specific basis		
Toxic Substances Control Act of 1976 (TSCA), as amended	Not applicable unless PCBs are discovered in soil, dunnage or other items associated with munitions	CERCLA actions involving PCBs and asbestos must comply with TSCA as an ARAR • Incineration standards • Residue disposal	Applies to handling, disposal of PCBs and asbestos • Incineration standards • Residue disposal
Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA), as amended	Not applicable	CERCLA action5 involving pesticides subject to FIFRA as an ARAR • Incineration guidelines	Applies to storage and disposal of pesticides and containers • Incineration guidelines

Key:

NPDES = National Pollution Discharge Elimination System
NSPS = New Source Performance Standards
NESHAP = National Emission Standards for Hazardous Air Pollutants
PCB = Polychlorinated Biphenyls
ARAR = Applicable, or Relevant and Appropriate Regulation
PSD = Prevention of Significant Deterioration

- Public Law 91-121, as amended by Public Law 91-441, restricts the transportation and disposal of any lethal chemical or biological warfare agent by requiring that the Secretary of Defense determine that such transport and disposal is necessary to national security; that the Public Health Service review the transport and/or disposal to identify potential hazards to public health and safety, and recommends precautionary measures; and that these precautionary measures be verifiably implemented before transportation and/or disposal takes place.

- Public Law 98-407 (§ 2692) prohibits the Department of Defense from using any DOD installation for the storage or disposal of any hazardous or toxic materials "...not owned by the Department of Defense."

- Hazardous Materials Transportation Act (HMTA) of 1975 (P.L. 93-633). As with major federal environmental laws, regulatory responsibility for the HMTA is delegated to individual states, and this results in considerable variation in requirements between them. Unlike environmental regulations, however, the HMTA places limitations on states developing more comprehensive or stringent regulations if they are determined by the Secretary of Transportation as being "inconsistent" with federal law. Nevertheless, states may and do implement additional requirements, such as routing restrictions, curfews, notification, and public right-to-know requirements.

U.S. Army Regulations Affecting the Future Use of Demilitarization Plants

Two major Army regulations will affect the selection of future use options and the operation of demilitarization plants. They are: AR 200-1, Environmental Protection and Enhancement; and AR 200-2, Environmental Effects of Army Actions. Of these, AR 200-l is most significant at the operations level as it sets forth the detailed environmental operating and management requirements for all Army activities. AR 200-2 is the Army's NEPA compliance document which details the procedures and requirements for analyzing all environmental consequences of Army actions.

State Regulatory Roles

The Federal Government is delegating an increasing amount of the responsibility (and burden) of environmental regulation to individual states. In so doing, federal environmental protection initiatives are developed as national standards for minimum compliance by the states.

States may apply for delegation of authority and, upon federal approval, may undertake responsibility for their own environmental regulation. In addition, most federal environmental statutes allow states to develop both more stringent requirements or other additional regulations so long as the federal requirements, as a minimum, are met. It has also been the Army's experience that even when it has designed facilities with state-of-the-art technology for environmental protection, the environmental requirements have changed by the time the facility becomes operational. These changes have prevented full use of the facilities and equipment for their intended purpose as a result of the cost of further redesign and modification of the facility. For this reason, redesign of the chemical demilitarization facilities to encompass future uses is probably best deferred until after the primary mission is accomplished. Retrofitting of these facilities at that time will enable them to incorporate state-of-the-art technology that conforms with those regulations that will be applicable. Also, development of alternative technologies to dispose of the feedstocks discussed in this report may take place while chemical munitions are being destroyed. Use of these technologies may be preferable to modifications in the design of the demilitarization facilities.

Table ES-3 summarizes the relationship of federal laws to regulation at the state level for those areas of federal regulation with greatest potential significance for the various future use options. As is evident, both the scope and potential impact of state regulation on future use initiatives are extensive. Indeed, state regulations may become the limiting factor in determining future uses at some locations. Also, the continuing evolution of both federal and state regulations, and the variations in requirements and regulatory approaches from state to state, combine to introduce considerable uncertainty into the project planning cycle.

Acceptability to the Public of Future Uses of the Chemical Demilitarization Plants

The acceptability to the public of potential future uses for the chemical demilitarization plants varies among the nine plant sites and also depends on the generic types of future uses considered. In general, patterns of public opinion about future use parallel those for the CSDP itself, although the basic concept of future use has not yet received widespread consideration in the communities involved because of the lack of publicity and the longer time frames involved (post-CSDP operations).

Among communities that are supportive of future use of the demilitarization plants, some concern has been raised over the potential use of the CSDP plants for treatment of hazardous wastes brought from outside the specific community or region.

Table ES-3. Overview of State Roles in Environmental Regulation

Federal Law	State Role(s)	Relationship of State Regulations to Federal Laws	Provisions for Broader, More Stringent Regulations
National Environmental Policy Act (NEPA)	Moderate: • Review Draft, Final EIS, comments to federal agencies	• Comply with NEPA process	Not Applicable
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Potentially major: • Party to Record of Decision (ROD) at all federal facilities • Regulation of cleanups through ARARs • Issue permits if RCRA applies (off-site remediation)	• Must comply with federal rules, procedures to decide cleanup (RODs) • Must meet federal standards as a minimum for RCRA-regulated cleanups	• ARARs on RCRA-regulated cleanups may include all additional state regulations (more comprehensive or stringent
Resource Conservation and Recovery Act (RCRA)	Major: • Issue permits and enforce regulations for all treatment and disposal facilities	• Must be federally authorized program • Equivalent to and consistent with federal programs as a minimum • States must not restrict interstate hazardous waste transport • State regulations must be "consistent with federal laws"	• Additional state regulations may be more stringent and comprehensive

Table ES-3. Overview of State Roles in Environmental Regulation (Continued)

Federal Law	State Role(s)	Relationship of State Regulations to Federal Laws	Provisions for Broader, More Stringent Regulations
Clean Air Act (CAA)	Major: • Develop air quality state Implementation Plans to enforce National Ambient Air Quality Standards • Issue permits and enforce regulations - NSPS - NESHAPS	• Federal Government retains authority to develop new national standards • States must meet all requirements for National Air Quality Standards	• May adopt more stringent regulations or control strategies than necessary to meet federal requirements - Toxic Air Pollutants (TAP) Program
Clean Water Act (CWA)	Major: • Issue NPDES permits and enforce all provisions in accordance with national effluent limitations guidelines	• Federal government retains authority for national effluent guidelines • States must meet all federal requirements	• May adopt more stringent regulations
Toxic Substances Control Act	Insignificant: • States may receive federal funding for independent programs to address chemical hazards - Complement, but not replace federal regulation	• Federal Government retains most regulatory authority	• No state regulatory authority

Table ES-3. Overviev of State Roles in Environmental Regulation (Concluded)

Federal Law	State Role(s)	Relationship of State Regulations to Federal Laws	Provisions for Broader, More Stringent Regulations
Federal Insecticide. Fungicide. and Rodenticide Act (FIFRA)	None	None	Not applicable
Hazardous Materials Transportation Act (HMTA)	Limited: • Some enforcement of federal regulations • States may develop some regulations over intrastate shipments	• Federal government retains primary authority for regulations • State regulations must not be inconsistent: - Preempted by federal standards - Subject to DOT review, judicial process	• None

NSPS = New Source Performance Standards
NESHAPS = National Emission Standards for Hazardous Air Pollutants
NPDES = National Pollution Discharge Elimination System
EIS = Environmental Impact Statement
ROD = Record of Decision

Other concerns have been expressed about public safety and environmental protection. Even in areas that are supportive of the demilitarization program, public attention is focused on the need to assure safe and environmentally sound plant operation.

In cases where community opinion is negative, opposition is not directed specifically toward the program approach chosen by the Army for the CSDP plants as much as toward the concept of hazardous waste incineration in general. Residents appear to be as concerned about incineration as a remediation process as they are about the potential risks of continued storage of hazardous wastes.

Also at issue in communities opposed to the demilitarization plants is credibility concerning the ultimate scope of uses for the plants. Initially, the stockpile destruction effort was to have been limited to M55 rockets, but Congress and the Army expanded the program to include other obsolete unitary munitions. Congress then enacted Public Law 99-145 requiring that the plants be dismantled after the CSDP. Now, Congress has directed the Army to study future uses of the plants, a third potential change in mission.

To evaluate public perceptions concerning potential future uses of the CDFs, public affairs officers were contacted at PM Cml Demil and at the eight locations where chemical disposal plants will be built. Their input was supplemented with reviews of media files at each location and, in some instances, with phone interviews with representatives of local organizations involved in evaluating potential future uses of military installations and demilitarization plants in their communities. These public perceptions are summarized in table ES-4.

Economic Aspects of Future Use of Plants

Cost estimates were obtained and compared for using the chemical demilitarization facilities and the alternative methods for each of the uses described previously. The cost estimates have high uncertainties and are only useful for comparative purposes. More detailed estimates based on site-specific engineering analysis might be significantly different. However, more accurate cost figures are unlikely to change the conclusions derived from the cost estimates used in this study.

To examine desirability from an economic standpoint, MITRE estimated the unit operating and maintenance cost of using the CDFs for each purpose at each site. From the volume of each feedstock at each location, a total operating and maintenance cost and total operating time was determined.

Table ES-4. Summary of Public Perceptions Concerning the CSDP and the Proposed Future Use of Demilitarization Plants

Plant	Use Category: CSDP in General?	Other Installation Wastes?	Local Hazardous or Municipal Waster?	Military or Civilian Hazardous Wastes from Outride Areas?
Aberdeen Proving Ground. MD	-1	-1	-1	-2
Lexington/Bluegrass Army Depot, KY	-2	-2	-2	-2
Newport Army Ammunition Plant, IN	-1	-1	-1	-2
Anniston Army Depot, AL	2	2	0	-1
Pine Bluff Arsenal, AR	2	2	2	1
Pueblo Depot Activity, co	0	0	0	-1
Tooele Amy Depot. UT	1	1	-1	-1
Umatilla Depot Activity, OR	1	1	1	1
Johnston Atoll Chemical Agent Disposal System	-1	-2	NA	-2

Key: 2 = Strongly Supportive, 1 = Supportive, 0 = Neutral, -1 = Opposed, -2 = Strongly Opposed.

Estimates of the cost of obtaining permits and of any needed modifications were added to the operating and maintenance cost to obtain a total estimated cost. This cost was compared with the cost of using alternative processes or technologies for disposal of the feedstock considered in order to make a judgement about the economic desirability of using the CDF for these feedstocks.

Tables ES-5 and ES-6 summarize the results of the cost analysis. Table ES-5 compares, on a unit operating and maintenance basis, the generic CSDP plant types and competing commercial or alternative methods for those future uses where such alternatives exist. Table ES-6 summarizes the total cost and operating times for most future uses on a site-specific basis.

Because of the variability of materials composition and volumes generated for DOD industrial wastes (e.g., solvents, petroleum products, metals), it was not possible to develop precise costs and disposal times on a site-specific basis. The same is true for municipal non-hazardous wastes. Thus, this information is not given in table ES-6.

The economic analysis carried out in this study indicates that for many potential future uses, the demilitarization facilities are not economically viable options. For most conventional munitions and explosives, currently available alternatives, such as deactivation furnaces and open burning/open detonation, would cost less (although capacity limitations and environmental considerations limit the use of these alternatives). The use of existing incinerators and, ultimately, the CDF incinerators at Pine Bluff Arsenal for disposal of smoke and riot agents, and of grenades is relatively economically favorable. Because of its large capacity in comparison with the APE 1236 and the CSDP rotary kilns, the use of the CIDP for demilitarization of smoke and riot agent munitions also appears to have favorable economics. Offsetting this, however, is the fact that the CIDP incinerator has yet to be built and thus, is untested for this use. Also, the CIDP is only scheduled for construction at TEAD, and the cost of transporting munitions to TEAD from other locations might offset the potential savings of using the CIDP at TEAD as a center for demilitarization of munitions. However, if the current test and evaluation program of the CIDP leads to consideration of the use of the cryofracture/incineration process for demilitarization of chemical warfare stocks at other locations, the potential future use applications of the plant should be factored into such consideration.

At a majority of locations, it may be economically desirable to use the demilitarization facilities for disposal of a variety of nonstockpile chemically contaminated items, such as surface decontaminated ton containers, and range recovered and buried chemical munitions. At several

Table ES-S. Comparison of Estimates of Unit Operating and Maintenance Costs for Alternative Future Uses - Demilitarization Plants and Competing Technologies (Costs in Thousands of Dollars per Ton)

Application/Feed	Unit O&M Cost							
	APE 1236	EWI	CSDP	CAMDS	CIDP	OB/OD	Commercial Incinerator	Landfill
Conventional Munitions								
• Small Arms			5.5	1.4	4.8	--	--	--
• Smokes, Riot Agents	2.0	--	2.0	0.6	0.7	--	--	--
• Large Munitions	--	--	a.9	4.3	a.4	0.8	--	--
• Bulk Lnergetics								
- Bulk Propellant	--	0.8	11	2.7	9.6	--	--	--
- Bulk Explosives	--	6.6	57.9	21.5	83.8	--	--	--
Hazardous Wastes								
• Contaminated Soil	--	--	3.3	2.0	0.7		0.2-1.5	0.2-0.3
• Sludges	--	--	9.3	5.6	2.3	--	0.5-1.5	0.2-0.3
• Solvents:								
- General	--	--	2-13	3-13	N/A	--	0.2-0.5	N/A
- DS2	--	--	10.5	10.4	N/A	--	1.0	N/A
Municipal and Other Nonhazardous Wastes								
• Municipal Waste	--	--	3.3	2.0	0.7		0.02	--
• Medical Waste	--		3.3	2.0	0.7	--	0.22	
Contaminated Buildings and Equipment	--	--	3.8-10.5	- -				
Nonstockpile Chemical items								
-- Empty Tcs	--	--	2.4-3.1	1.4	--	--	--	
-- Range Recovered Munitions	--	--	2.4	0.2	0.4	--	--	--

Table ES-6. Summary of Estimates of Total Costs and Disposal Times Required for Future Uses of CSDP Plants for Disposal of DOD Wastes (Dollars in Millions; Time in Months in Parentheses Unless Otherwise Noted)

	Site/Facility										
Application/Feed	TEAD	CAMDS	CIDP	LBAD	ANAD	PBA	PUDA	UMDA	APG	NAAP	JACADS
Conventional Munitions											
• Small Arms	10-12 (6)	5-7 (3)	9-11 (3)	5-7 (1)	8-10 (3)	33-35 (13)	5-7 (1)	12-14 (4)	--	--	
• Smokes, Riot Agents	4-5 (0.2)	3-4 (0.4)	3-4 (0.1)	3-5 (0.04)	5-6 (0.8)	10-11 (3)	3-4 (0.02))	4-5 (0.2)	--	--	
• Large Munitions	304 (128)	149 (163)	286 (99)	33-34 (13)	51-52 (21)	81-82 (34)	117 (49)	124 (52)	--	--	
• Bulk Energetics											
- Propellants	10-11 (3.5)	4-5 (5)	9-10 (2.5)	10-11 (3.2)	7-8 (2.5)	25-26 (9.9)	24-25 (9.4)	12-13 (4.4)	--	--	
- Explosives	15-16 (11)	8-9 (14)	26-27 (8.3)	12-13 (5.8)	2-3 (0.1)	11-12 (5.7)	15-16 (8.3)	8-9 (3.8)	--	--	
Non Stockpile Chemical Items											
• Range-Recovered Munitions	1.3 (0.1)	1.0 (0.1)	1.1 (0.02)	--	--	3.7 (0.7)	--	--	--	--	
• Empty (3X) Ton Containers	10.8 (5.2)[a]	5.4 (10.2)[a]	--	--	--	9.5 (5)	--	--	5.3 (3)	0.8 (0.03)	1.6 (0.3)
• Filled Ton Containers	--	--	--	--	--	--	--	--	1.2 (5 hrs.)	--	
• Other Agent Contaminated Metal Items	--	--	--	--	--	--	9 (4)[b]	1 (<1)	119 (81)	86 (58)	
Hazardous Wastes											
• Hazardous Waste-Contaminated Soils	--	--	--	--	--	--	--	--	--	--	29-82 (8-24)
• Potentially Agent-Contaminated Soils	8,741(4,525)[c]	4,601(10,407)[c]	1,612(1,001)[c]	13 (6)	13 (6)[d]	1 (<1)	26 (13)	38 (19)	1,156 (1,223)	156 (84)	--
• Potentially Agent-Contaminated Sludge	6 (3)	4 (7)	3 (1)	--	--	--	--	--	--	2 (2)	--
• Potentially Agent-Contaminated Concrete Building Material	--	--	--	--	--	--	1,284 (664)	20 (10)	1,567 (849)	43 (23)	--

a: Includes empty XXX ton container from RMA.
b: Includes contaminated metal items from RMA
c: Includes Dugway Proving Ground.
d: Includes Redstone Arsenal.

locations, specifically the Newport Army Ammunition Plant and Umatilla Army Depot Activity, it could be economically desirable to use the facilities for disposal of potentially chemically contaminated building materials and equipment in the buildings. It may also be economically desirable to do this at Aberdeen Proving Ground and at Pueblo Depot Activity (for building material transported from Rocky Mountain Arsenal). However, for both of these locations, the volume of building materials involved and the resulting long processing times using demilitarization plant incinerators, make the economic desirability of such use more questionable. More detailed analysis is required to explore these options in greater depth.

The other potential future use feedstocks considered--hazardous wastes, municipal solid waste, and contaminated soils--do not appear to be economically attractive candidates for the demilitarization plants. This is due to a variety of factors, including large volumes of material (e.g., contaminated soils), low demilitarization plant throughputs when compared with commercial alternatives, and unpredictability of composition and volume of other feedstocks (e.g., hazardous wastes).

5.0 MANAGEMENT OPTIONS FOR FUTURE USES OF THE CHEMICAL DISPOSAL FACILITIES

Management options for the demilitarization facilities consist of alternative approaches for their ownership and operation following the completion of their initial missions of carrying out the Chemical Stockpile Disposal Program. Management options fall into three basic categories:

1. Government ownership and operation
2. Government ownership and contractor operation
3. Transfer to nongovernment ownership and operation

Table ES-7 summarizes the relative advantages and disadvantages of each management option.

6.0 CONCLUSIONS

The overall findings of this study are given in table ES-8. In this table, both the feasibility and the three aspects of relative desirability of future uses of the demilitarization plants are summarized. This is done for each potential future use (i.e., feedstock) and for each facility considered in this study. Feasibility is given in terms of yes/no, with plant-specific caveats and exceptions footnoted. Desirability

Table ES-7. Summary of Management Options for Future Uses of the Chemical Disposal Facilities

Option/Variant	Advantages	Disadvantages	Comments/Issues
1. Government owned, government operated ("GOGO") ▪ Includes transfer to other government organizations	• Remains under full government control and is available for additional future uses/missions	• Need to maintain permanent government personnel slots for operation	• Optimum situation for small, versatile facilities (e.g., CAMDS) for future R&D or other small-scale specialized uses
2. Government-owned, contractor-operated ("GOCO") ▪ Includes leasing to private firms	• Remains under government control and is available for additional future uses/missions	• Liability controversy over worker safety and environmental concerns ▪ Poor DOE, DOD GCCO performance and public perception (e.g., DOD arsenals and plants, DOE weapons production complex)	• Regulatory compliance requirements and indemnity concerns must be worked out in advance and specified in contracts
	• [illegible] constrained by government ceilings		• Can leased facilities be used for non-DOD purposes as well? (Change P.L. 98-407?)
	• Flexibility in hiring and compensation to obtain required personnel skills	• Current DOD policy is divestiture of GOCOs	
	• [illegible] corporate capabilities not found or difficult to duplicate in government	• Process DOD wastes only	
	• Cost effective • pay only for services needed over the time required	• Still requires core of government technical and management personnel (QA, auditors, administrative)	
	• Leasing could provide revenues		

Table ES-7. Summary of Management Options for Future Uses of the Chemical Disposal Facilities (Concluded)

Option/Variant	Advantages	Disadvantages	Comments/Issues
3. Transfer to non-government ownership - Excessing of plant and lands - Demolition, salvage of plant and equipment	• Ownership (operation, maintenance) costs eliminated after CSDP • Revenues from sale of facility • PL 99-145 would not have to be changed in cases where plant is decommissioned and salvaged • [illegible] new enterprise opportunity for private sector investment • Could process non-defense waster	. Plant/land must undergo Army and RCRA clean closure before sale or transfer - All facility equipment "5X" tantamount to destroying much of the plant's value - Excessing of plant property not practicalable if installation not being realigned	• Only option for realigning installations

Table ES-8. Overall Study Findings

Potential use or Feedstock	CSDP										
	APG	LEAD	NAAP	ANAD	PBA	PUDA	TEAD	UMDA	CAMDS	JACADS	CIDP
Conventional Munitions small Arms											
Tech.	N	Y	N	Y	Y	Y	Y	Y	Y	NA	Y
Econ.	U	U	U	U	U	U	U	U	SD	NA	U
Reg.	su	U	N	SD	D	Nt	SD	SD	SD	NA	SD
Public	su	U	su	D	D	Nt	SD	SD	SD	NA	SD
Smokes, riots, grenades											
Tech.	N	Y	N	Y	Y	Y	Y	Y	Y	NA	Y
Econ.	U	U	U	U	D[1]	U	U	U	SD	NA	SD
Reg.	su	U	N	SD	D	Nt	SD	SD	SD	NA	SD
Public	su	U	su	D	D	Nt	SD	SD	SD	NA	SD
Large munitions											
Tech.	N	Y	N	Y	Y	Y	Y	Y	Y	NA	Y
Econ.	su	U	su	U	U	U	U	U	Nt	NA	U
Reg.	su	U	N	SD	D	Nt	SD	SD	SD	NA	SD
Public	su	U	su	D	D	Nt	SD	SD	SD	NA	SD
Bulk Propellent end Explosives											
Tech.	N	Y	N	Y	Y	Y	Y	Y	Y	NA	Y
Econ.	su	U	su	U	U	U	U	U	SD	NA	su
Reg.	su	U	N	SD	D	Nt	SD	SD	SD	NA	SD
Public	su	U	su	D	D	Nt	SD	SD	SD	NA	SD
Non-stockpile chemical items (XXX TCs, ID sets, range recoverd munitions)											
Tech.	Y[9]	Y	Y[9]	Y	Y	Y	Y	Y	Y	Y	Y
Econ.	D[6]	U	D[6]	Nt	D[5]	D[7]	D[5]	D[6]	D[5]	D	D[4]
Reg.	SU	U	Nt	SD	D	Nt	SD	SD	SD	Nt	SD
Public	SU	U	SU	D	D	Nt	SD	SD	SD	Nt	SD

Table ES-8. Overall Study Findings (Concluded)

Potential Use or Feedstock	APG	LBAD	NAAP	ANAD	PBA	PUDA	TEAD	UMDA	CAMDS	JACADS	CIDP
Local Hazardous Wastes (DOD and commercial)											
Tech.	Y[9]	Y	Y[9]	Y	Y	Y	Y	Y	Y	NA	Y
Econ.	U	U	U	U	U	U	U	U	U	NA	U
Reg.	su	U	Nt	Nt	D	su	su	D	su	NA	su
Public	U	U	U	lit	D	Nt	su	SD	su	NA	su
Agent and Explosive Contaminated Soils											
Tech.	Y[9]	Y	YQ	Y	Y	Y	Y	Y	Y	Y	Y
Econ.	U	U	U	U	U	U	U	U	U	Nt	su
Reg.	su	U	Nt	SD	D	Nt	su	SD	su	U	su
Public	su	U	su	D	D	Nt	SD	SD	SD	U	SD
Chemically Contaminated Buildings and Equipment[10]											
Tech.	Y[9]	NA	Y[9]	NA	NA	Y	NA	Y	NA	NA	NA
Econ.	SU[8]	NA	D	NA	NA	SU[8]	NA	D	NA	NA	NA
Reg.	SU	NA	Nt	NA	NA	SU	NA	SD	NA	NA	NA
Public	SU	NA	SU	NA	NA	Nt	NA	D	NA	NA	NA
Local Municipal Wastes											
Tech.	Y[9]	Y	YQ	Y	Y	Y	Y	Y	Y	NA	Y
Econ.	U	U	U	U	U	U	U	U	U	NA	U
Reg.	su	U	Nt	SD	SD	Nt	Nt	SD	N	NA	Nt
Public	su	U	su	Nt	D	Nt	su	SD	SD	NA	su

KEY:
N Not technically feasible.
Y Technically feasible; hardware modifications may be needed.
D Desirable
SD Somewhat Desirable
Nt Neutral
SU Somewhat Undesirable
U Undesirable
NA Not Applicable: potential use does not exist at this site.

Candidate Future Use

Candidate Future Use; some significant problems exist with regard to desirability.

NOTES:
1. In existing incinerators. DFS at Pine Bluff Chem. Demil. Facility may also ba used when available.
2. OB/OD costs are much lower.
3. Cost of using Explosive Waste Incinerator is much lower.
4. For range recovered and buried munitions.
5. Range recovered and buried munitions and empty TCs.
6. Miscellaneous chemically contaminated items and/or empty TCs.
7. Includes contaminated items from RMA.
8. Due to volume of material to be disposed of (e.g. contaminated building material from RMA to PUDA).
9. Note limitations on variety of feeds due to lack of DFS.
10. Includes non-agent chemical contamination.

considerations are categorized subjectively as being "desirable to undesirable" by integrating the results of tables ES-2 through ES-6. Again, footnotes are used to provide explanations and elaborations.

The basic message of table ES-8 is that while it is technically feasible to process most of the feedstocks considered in the demilitarization facilities, in a majority of cases, it is undesirable to do so. Feasible and potentially desirable future uses are indicated by the circled entries in table ES-8. Summaries of the study findings are provided below in the context of each of the facilities considered.

Aberdeen Proving Ground

At Aberdeen Proving Ground (APG) use of the CDF for thermal decontamination of chemically decontaminated ton containers is both feasible and a potentially desirable option. There are over 2,400 of the chemically decontaminated ton containers at APG. In order to release containers from storage and sell them for scrap they need to be thermally decontaminated. The CDF that will be constructed at APG is specifically designed for demilitarization of agent ton containers so that use of the facility for these additional containers would be a simple extension of its operation.

If remedial action on former burial grounds such as old "O" field is taken and involves the exhumation of buried items, an estimated 43,000 tons* of potentially agent contaminated metal might be recovered that could require thermal decontamination prior to subsequent disposal or sale as scrap. Another 6,000 tons of metal equipment from old buildings might also require thermal decontamination as scrap. The CDF could be used for both of these. However, it is estimated that it would take about 7 years and cost 119 million dollars to accomplish this task.

A small quantity of range recovered munitions are stored at APG. If burial grounds are excavated, these munitions could be disposed of in conjunction with contaminated metal and munitions recovered from the burial grounds. If the burial areas are remediated in an alternative manner, the Army will still have to address the disposal of the range recovered munitions. Use of the Aberdeen CDF for this small quantity might not be economically desirable unless no other disposal option exists.

APG also has a large inventory of potentially agent contaminated concrete and masonry building stuctures that might need to be thermally decontaminated prior to disposal. Although it is possible to use the metal

*This estimate is probably low because it includes only two small areas of a National Priorities List (NPL) site.

parts furnace of the CDF that will be constructed at APG for thermal decontamination of concrete and masonry rubble, it would require about 70 years and over 1.5 billion dollars. Other building decontamination methods currently under investigation, such as the hot gas decontamination process developed by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), might prove to be more cost effective for these structures.

Although there are potentially large volumes of contaminated soil and buried chemical munitions in burial grounds at APG that may require remedial action, it is considered neither feasible nor desirable to use the CDF that will be constructed at APG for that activity. The CDF at APG will be designed for demilitarization of bulk items only, and therefore will not have the capability to process projectiles and other munitions that may be recovered from the burial grounds. Use of the metal parts furnace for contaminated soil is not cost effective. Taking into account the feed rate of the metal parts furnace, it would require over 100 years to decontaminate the volume of potentially agent contaminated soil from old "O" field in the metal parts furnace.

Lexington-Blue Grass Army Depot

Potential future uses for the chemical demilitarization facility (CDF) that might be constructed at Lexington-Blue Grass Army Depot (LBAD) include demilitarization of conventional munitions and thermal decontamination of soil, sludges, and carbon filters contaminated with hazardous substances or explosives. However, significant local opposition exists to operation of the chemical demilitarization facility incinerators. Also the economics associated with using the chemical demilitarization facility for the potential future uses noted above do not appear to be favorable. Thus, continued use of this facility after completion of its primary mission at LBAD is not recommended. The feasibility and desirability of relocating one or more of the incinerators to a location that could make use of them should be evaluated.

Anniston Army Depot

Potential future uses for the CDF that might be constructed at Anniston Army Depot are demilitarization of conventional munitions, demilitarization of range recovered munitions and exhumed munitions from Redstone Arsenal, and thermal decontamination of soil from remedial actions at Redstone Arsenal. Use of the Anniston CDF for demilitarization of conventional munitions is, in general, not economically desirable. The condition and quantity of buried chemical munitions at Redstone Arsenal is unknown at this time. If a program is implemented to safely recover and store these items, then, depending on their condition, a decision could be made

concerning whether to transfer them to Anniston for demilitarization and disposal. Range recovered munitions currently stored at Anniston can be safely demilitarized in the Anniston CDF following its scheduled operational period.

Newport Army Ammunition Plant

A feasible and potentially desirable option for the CDF at Newport Army Ammunition Plant (NAAP) is to use it to thermally decontaminate the old VX production facility when it is dismantled. The metal parts furnace of the CDF is particularly suited for this purpose. There is a large volume of potentially agent contaminated soil at NAAP that may require remedial action. Although the metal parts furnace in the CDF that will be constructed at NAAP could be used to thermally decontaminate this soil, it is not particularly suited for this purpose. It is estimated that it will take 7 years and cost 156 million dollars to accomplish this job.

Pine Bluff Arsenal

It is feasible and relatively desirable to use the rotary kilns from the BZ plant and the CDF at Pine Bluff Arsenal (PBA) to augment the capacity of the incinerator complex there for demilitarization of smoke and riot agent munitions. PBA has the largest quantity of smoke and riot agent munitions among the locations of the CDF plants. PBA could be made a regional center for the demilitarization of smoke and riot agent munitions. If this were done, the fixed costs to demilitarizate such munitions at other locations could be avoided. The CDF at PBA can also be used to demilitarize some nonstockpile items, including Chemical Agent Identification Sets (CAIS), range recovered munitions, and chemically decontaminated ton containers located there.

There are about 10.8 tons of potentially agent contaminated soil at PBA that could be thermally decontaminated in the rotary kiln of the CDF that will be constructed at PBA. In general, decontamination of soil in the CDF is not cost effective. However, because of the special nature of agent, and its relatively small volume at PBA, use of the CDF for this purpose may be necessary.

Pueblo Depot Activity

Pueblo Depot Activity (PUDA) has chemical munitions burial grounds where mustard munitions were chemically decontaminated and burned. These areas may still be contaminated with explosives, mustard or mustard degradation products, and hazardous waste. If these areas are subjected to remedial action and excavated, the recovered munitions could be thermally decontaminated in the CDF that will be constructed at PUDA.

The PUDA CDF could also be used to thermally decontaminate chemically decontaminated ton containers and metal equipment items from Rocky Mountain Arsenal (RMA). However, intrastate transport of hazardous waste from RMA to PUDA may be restricted.

Tooele Army Depot

Nonstockpile items currently located at Tooele Army Depot (TEAD) and Dugway Proving Ground (DPG), including chemically decontaminated ton containers, range recovered munitions, contaminated chemical stockpile maintentance items, and chemical agent identification sets, can be thermally decontaminated in the CAMDS, CDF, and/or CIDP at TEAD. The storage of these items at DPG is costly and can be eliminated with transportation to CAMDS and disposal at that location. In addition, chemically decontaminated ton containers from Rocky Mountain Arsenal and range recovered chemical munitions from Dugway Proving Ground could be shipped to TEAD for thermal decontamination. CAMDS will be available for these uses in 1994.

Chemical munitions are likely to continue to be found as installation restoration activities proceed at Army installations. It is suggested that one or more national or regional chemical demilitarization facilities be maintained to properly demilitarize these items. Because such items are likely to vary in size, configuration, condition, quantity, and content, relatively small facilities capable of flexible operations are preferable for this purpose. The CAMDS and CIDP plants have these characteristics, and it is suggested that one or both of these facilities be maintained for this purpose.

The large volume of potentially agent contaminated soil at TEAD and the relatively low incineration rates and resulting high unit cost for using the chemical demilitarization plants for soil decontamination makes it undesirable to use them for that purpose.

Umatilla Depot Activity

Umatilla Depot Activity (UMDA) has spent decontamination solution and other contaminated items generated during chemical stockpile maintenance activities that could be decontaminated in the CDF that will be constructed there. There are also potentially contaminated buildings that, when dismantled, could be thermally decontaminated in the CDF in a matter of months. The estimated volume of potentially contaminated soil at UMDA could be decontaminated in the CDF rotary kiln in about 19 months.

UMDA is scheduled for realignment. Although it is believed that the CDF incinerators are too small for economic use in disposal of toxic, hazardous and nonhazardous waste (e.g., a typical commercial rotary kiln has a rating of 75-100 million Btu per hour; the CDF rotary kiln has a rating of 15 million Btu per hour), they could be offered for sale to state or commercial enterprises.

Johnston Atoll

Nonstockpile chemical items, including chemically decontaminated ton containers on Johnston Island and chemical munitions found in the islands of the South Pacific and brought to Johnston Island, can be processed in the JACADS. President Bush has recently stated that no additional chemical munitions will be sent to Johnston Atoll, excepting World War II munitions manufactured within the United States that are recovered in the Pacific area. The recent discovery of such items in the Solomon Islands is currently being addressed.

Implications of Using the Chemical Demilitarization Facilities After Their Primary Mission Is Complete

The alteration and use of the CDFs beyond their current mission will be subject to broad and comprehensive regulation arising from federal, state, and local laws and regulations. U.S. Army regulations will also affect the conduct of various future uses of the CDFs. Some current laws and regulations have an inhibitory affect on future use of the chemical demilitarization facilities. PL 99-145, for example, prohibits any subsequent use of the demilitarization plants upon completion of the Chemical Stockpile Disposal Program. Uses of the plants for other than the demilitarization of chemical stockpile items are precluded by this law.

Environmental assessments (EAs) will have to be prepared to determine the impacts of using the plants for other purposes and, based on the assessments, amendments, or supplements to existing EISs or EAs, would need to be prepared and submitted for public comment. Through this process, public acceptability/opposition would be identified. In addition, alternatives to use of the chemical demilitarization plants for specific purposes that have a low environmental impact may be identified and assessed.

If the facilities are to be used for remediation of agent burial grounds, a CERCLA-type negotiation and agreement process must be followed. The DOD must negotiate with, and obtain agreement from, the appropriate EPA region, state agencies with jurisdiction over hazardous waste cleanup, local governments, and public interest groups. A specific sequence of activities must be followed before final cleanup of a CERCLA site can

proceed. Initially, a detailed remedial investigation and feasibility study (RI/FS) must be conducted. During the RI, data is collected to characterize the site with respect to the nature and extent of contamination and to provide sufficient information to evaluate, select, and design a cost-effective remedial action. The FS involves analysis of the data from the RI to develop response objectives and alternative remedial responses. The alternatives are then evaluated in terms of their engineering feasibility, public health risks, public health protection, environmental impacts, and costs. Before commencement of the final stage of the CERCIA process--Remedial Design and Remedial Action (RD/RA)--a formal agreement called the record of decision (ROD) must be executed among all parties with jurisdiction over cleanup. These include the EPA region, state environmental regulatory and permitting agencies, local governments, and potentially responsible parties. The ROD may be complex. It may also be comprehensive and cover all sites in a multisite clean-up project, or it may be negotiated in stages on a site by site basis. The ROD can be subject to litigation and other delays.

CERCLA § 121 requires that a RCRA permit be obtained for an incinerator not immediately adjacent to a CERCLA site even if the purpose of the incinerator is to assist in the remedial action. This law may preclude use of demilitarization plants for the cleanup of waste sites at federal facilities because of the requirement for RCRA permits for "off site" remediation and the potential for state involvement in granting RCRA permits.

Cleanup of chemical weapons landfills presents a special concern. Adverse publicity from past practices, lack of funding, and fear of violating environmental regulations has inhibited the Army from initiating comprehensive actions to deal with this problem. (Congress could promote the cleanup of these landfills by passing legislation to mandate cleanup, provide funding, and not penalize the Army for very limited short-term release of agent during cleanup--provided that public health is not threatened--in the interests of cleaning up sites that pose a long-term threat to land, air, and water resources.)

State requirements under RCRA may prohibit cleanups of federal facilities or treatment of specific hazardous wastes (e.g., obsolete conventional or chemical munitions). Modifications to RCRA could result in a process similar to that which can occur under the Hazardous Materials Transportation Act, where conflicts between state and federal laws are resolved by either the Secretary of Transportation or, failing this, in federal courts. With such an amendment to RCRA, conflicts between federal and state laws that are blocking hazardous waste disposal efforts could be resolved by the EPA Administrator in cases where harm to the environment

is imminent, or where there may be other overriding national considerations (e.g., treaty compliance, public and military personnel safety). The Clean Air and Clean Water Acts similarly do not currently provide a means for resolving state-federal conflicts and expediting site cleanups.

To conclude, several existing laws can be addressed and modified in order to facilitate future use of chemical demilitarization facilities. The impacts of such modifications must be compared with the costs and benefits of developing new facilities to address disposal of the potential feedstocks identified in this report and with the costs of closing the chemical demilitarization facilities. Based on the preliminary economic analysis carried out in this report, it would appear that modification of certain chemical demilitarization facilities after completion of the Chemical Stockpile Disposal Program would be a cost effective way for the Army to dispose of some of the feedstocks identified while still complying with environmental contraints.

Summary of Findings

Potential future uses for the chemical demilitarization facilities (CDFs) include demilitarization of conventional munitions, remediation of hazardous waste disposal sites, and disposal of a variety of hazardous wastes. In general, it was found that the CDFs, while technically capable of processing these feedstock materials, are not economically attractive when compared with existing and potential alternative methods. This is due to the relatively small size of the CDF incinerators (thus limiting throughput rates) and the specialized nature of the facilities (the plants are highly compartmentalized). However, at those locations where chemical agent and/or its breakdown products are present, the use of the CDFs is usually preferable to existing alternatives and, indeed, might be the only viable option.

In particular, two future uses of the CDFs that were found to be feasible and desirable following completion of their primary mission are: thermal decontamination of materials from the old VX production facility at Newport Army Ammunition Plant after it is dismantled, and demilitarization and/or thermal destruction of non-stockpile chemical items. These items include range recovered munitions, chemically decontaminated ton containers, decontamination solutions, and dunnage items accumulated during maintenance of the stockpile. Such items are found at Aberdeen Proving Ground, Pine Bluff Arsenal, Pueblo Depot Activity, Tooele Army Depot (including items from Rocky Mountain Arsenal and Dugway Proving Ground), Umatilla Depot Activity, Johnston Atoll, Newport Army Ammunition Plant, and Anniston Army Depot (including items from Redstone Arsenal).

The chemical demilitarization plants could also be used to thermally decontaminate soil that might contain agent and/or agent breakdown products. However, at some locations, the volume of potentially contaminated soil is so great that it would take a very long period of time to decontaminate the soil, taking into account the throughput rate of the CDF incinerators.

At Pine Bluff Arsenal, the rotary kilns from the BZ plant and the CDF could be used to augment the capacity of the existing incinerator complex for demilitarization of smoke and riot agent munitions. Consideration should be given to making Pine Bluff a regional or national center for demilitarization of these items.

It was also found that the CAMDS deactivation furnace is competitive with the upgraded APE 1236 rotary kiln incinerator for demilitarization of small arms and smokes and riot agents at the Tooele Army Depot. This furnace is already equipped with pollution abatement equipment and might be available before the APE can be upgraded and permitted for this purpose. CAMDS could also be retained as a facility to test and evaluate incineration technology for remedial action activities, and to test and evaluate methods for the demilitarization of large munitions and bulk energetics. The Cryofracture/Incineration Demonstration Plant might also be useful as a research facility for size reduction and demilitarization of large munitions and bulk energetics.

DCN 5860
Executive Correspondence

SECTION 1

INTRODUCTION

1.1 BACKGROUND

Public Law 99-145, as amended, directs the Department of Defense (DOD) to develop a program to destroy the remaining U.S. stockpile of obsolete unitary chemical warfare agents and munitions. The stockpile is stored at eight Army depots in the continental United States (CONUS): Tooele Army Depot, Tooele, Utah; Anniston Army Depot, Anniston, Alabama; Umatilla Depot Activity, Umatilla, Oregon; Pine Bluff Arsenal, Pine Bluff, Arkansas; Newport Army Ammunition Plant, Newport, Indiana; Pueblo Depot Activity, Pueblo, Colorado; Aberdeen Proving Ground, Maryland; Lexington Blue Grass Army Depot, Lexington, Kentucky; and on Johnston Island in the Pacific Ocean. The U.S. Army has assigned the Office of the Program Manager for Chemical Demilitarization (PM Cml Demil) the responsibility for carrying out this effort; the Chemical Stockpile Disposal Program (CSDP).

The chemical agents to be destroyed are the nerve agents VX, GA, and GB and the blister agents mustard (H, HD, and HT) and Lewisite (L). The agents are contained in various types of munitions and are also stored as bulk agent in l-ton containers. The munitions include rockets; bombs; mines; spray tanks; 105mm, 155mm, and 8-inch projectiles; and 4.2-inch mortar rounds.

Testing and evaluation of equipment for destruction of the chemical munitions and agents has been performed at the Chemical Agent Munitions Disposal System (CAMDS) in Tooele, Utah. The process tested at CAMDS involves munition disassembly, agent draining, agent incineration, and thermal decontamination of explosive components, drained munition bodies, and bulk agent containers. The following specialized disassembly and agent draining equipment was developed for each of the different types of items in the stockpile:

- A rocket shear machine (RSM) that punches holes in the bodies of rockets, drains the agent, and shears the shipping and firing tubes, rocket body, and propellant into several sections.

- A mine machine (MIN) that punches and drains mines, and punches the booster from the mine body.

- A projectile/mortar disassembly (PMD) machine that removes fuzes and bursters from projectiles and mortar rounds.

- A multipurpose demilitarization machine (MDM) that drains agent from projectiles and mortar rounds after the explosives have been removed in the PMD machine,

- A bulk drain station (BDS) that punches bombs and ton containers and drains the agent from them.

Each of these items were tested at CAMDS and at least one of each is available for potential future use.

The following three specialized incinerator systems were developed to incinerate explosive components and agent, and decontaminate drained munition bodies and bulk containers:

- A deactivation furnace system (DFS) for rockets, mines, fuzes, and bursters.

- A liquid incinerator (LIC) for incineration of agent and spent decontamination solution (the latter is incinerated in the afterburner of the LIC).

- A metal parts furnace (MPF) for decontamination of drained projectiles, mortar rounds, bombs, and ton containers.

A dunnage incinerator (DUN) is used to destroy contaminated dunnage (protective clothing, spent activated carbon filters, and wooden pallets).

Each incinerator is equipped with an afterburner and a pollution abatement system (PAS). The DFS has a cyclone particle separator, a quench tower, a venturi scrubber, a packed tower, and a demister. The PAS of the LIC and the MPF do not have cyclones, but otherwise have the same components as the DFS. The DUN PAS consists of a high velocity scrubber.

CAMDS is equipped with one of each of the incinerator systems. The incinerators were designed for testing the incineration technology for chemical munition demilitarization and are smaller than the units that will be used in the full-scale plants. Also, the MPF and the LIC share the use of a single PAS. A more detailed description of the CAMDS facilities is provided in appendix A.

The Army has constructed a chemical agent demilitarization plant on Johnston Island, called the Johnston Atoll Chemical Agent Disposal System (JACADS), to dispose of the chemical warfare agents and munitions stored on the island. The plant contains all of the disassembly equipment and incinerators described above for CAMDS and contains three MDMs and two of each of the other demilitarization machines. Also, the incinerators at JACADS have greater capacities than the CAMDS incinerators. The equipment is laid out for efficient continuous processing of chemical munitions.

A more detailed description of the JACADS plant is provided in appendix A. JACADS is currently undergoing Operational Verification Testing (OVT) to prove out the technology on a full scale. The CSDP plan for the CONUS inventory is to destroy the stockpile on-site at each of the eight locations using the JACADS technology. The plan calls for a staggered construction schedule with the first plant currently under construction at Tooele Army Depot. Public Law 100-456 makes operation of the Tooele plant contingent on completion and analysis of the JACADS OVT. Destruction of the stockpile is currently scheduled to be completed by the end of 1998.

The Army is also continuing to test an alternative process for chemical munitions demilitarization. This process involves robotic unpacking of munitions, cryotreatment of the munitions in a liquid nitrogen bath to make them brittle so they can be readily fractured, cryofracture of the munition bodies in a hydraulic press, and simultaneous thermal destruction of agent and explosives and decontamination of metal parts in a single rotary kiln. A description of the cryofracture/incineration process is presented in appendix A.

The Army may construct a full scale Cryofracture/Incineration Demonstration Plant (CIDP) if, following completion and analysis of additional testing of the process, a determination is made that a cryofracture facility is needed. The plant could provide additional capacity for destruction of the chemical warfare munitions. It is expected that this plant will be installed at Tooele Army Depot, adjacent to the Tooele Chemical Disposal Facility.

In a separate program, the Army has completed the destruction of its stockpile of the incapacitating agent BZ at Pine Bluff Arsenal. Much of the equipment was dismantled, decontaminated, and disposed of following completion of the program. All that remains at present are a rotary kiln and four metal parts furnaces and their common pollution abatement system. This equipment is under minimal maintenance and remains potentially available for future use. The Army determined that it would not be feasible to convert the BZ facility for demilitarization of chemical munitions because of current safety and environmental regulations, capacity and life cycle cost considerations, and lack of commonality with the standard JACADS type demilitarization facility design.

The law mandating destruction of the chemical stockpile also mandated the dismantling and disposal of demilitarization equipment and buildings afterwards.* However, obligations under bilateral and multilateral

*Does not apply to CAMDS, JACADS, CIDP, or BZ.

chemical munition destruction agreements and treaties could require that one or more of the chemical disposal facilities be maintained in an operating condition after completion of the CSDP. Moreover, in November, 1989, the House and Senate Appropriations Committee of Conferees directed the Army to investigate and report on the feasibility and desirability of using chemical weapons disposal facilities for other purposes after the stockpile is destroyed.*

1.2 OBJECTIVES

The objective of this study is to assess the feasibility and desirability of using the chemical weapons disposal facilities, following completion of their primary mission, for the following purposes:

- Demilitarization of conventional munitions.
- Demilitarization and/or decontamination of nonstockpile and range recovered chemical items.
- Decontamination of buildings and equipment that are considered potentially contaminated with agent or other hazardous substances.
- Remediation of contaminated soils.
- Disposal of DOD and non-DOD industrial hazardous wastes.
- Disposal of municipal nonhazardous wastes.

1.3 APPROACH

Information for this study was obtained from interviews and meetings with Army personnel at the installations where the chemical demilitarization facilities will be operated, and at nearby installations that may have an interest in using incineration technology to dispose of their waste material. Use was also made of the technical literature for information on available technology for proposed future uses of the chemical demilitarization facilities. An initial screening analysis was performed to identify potential future uses for the chemical demilitarization plants on a site-by-site basis. Potential future uses were identified at each of the Army installations where chemical munitions and/or bulk agent are

*Title VI of the 1990 Defense Appropriations Conference (DAC) Report 101-345, entitled "Chemical Agents and Munitions Destruction, Defense."

stored. The potential future uses were then prioritized based on technical suitability of the demilitarization equipment, environmental and institutional issues, existing alternatives to the use of the chemical demilitarization facilities, and the quantity of the potential feedstock available at a site. A description of the site-specific potential future uses that were screened is provided in appendix B.

On the basis of the screening study, some of the potential future uses for the chemical demilitarization plants were selected for further evaluation with respect to feasibility and desirability as described in sections 3 and 4 of this report.

For purposes of this study, the terms feasibility and desirability were defined as follows:

Feasibility. The capability of equipment to perform a proposed task with a minimum of design or operating changes to the equipment. The feasibility of using a chemical demilitarization plant for the disposal or decontamination of a particular item is determined by evaluating the ability of the equipment to destroy or decontaminate the item within acceptable environmental parameters, taking into account the magnitude of the necessary equipment or operating changes. In this report, varying degrees of feasibility are identified. Thus some potential future uses are more or less feasible than other uses because they will require minor or major modifications, respectively, to the chemical demilitarization plant. For example, disposal, destruction, or decontamination of a potential waste material that would require additional disassembly equipment and revisions to a deactivation furnace feed system would be considered less feasible than disposal of a material that requires only minor adjustments to the operation of a pollution abatement system.

Technical features of equipment capabilities are considered in making this determination. Costs are not explicitly considered, although determining the magnitude of changes involves consideration of the relative costs of such changes.

Desirability. The advisability of using a plant for a particular purpose, taking into account the following factors:

- The necessity of the proposed activity (Army and public need).
- Competitive methods of disposal or decontamination.
- Regulatory requirements.
- Economics, including efficiency, capital costs, operating and maintenance costs, and the cost of obtaining permits.

- The amount of the potential feed material.
- Transportation issues.
- Public support or opposition.
- Uncertainties about any of these factors, especially costs and future state and local regulations or requirements.

For the most part, these factors must be evaluated on a site-specific basis, taking into account the potential uses, available competitive equipment, local requirements, and public attitudes at each of the demilitarization sites. Thus, a specific use may be desirable at one demilitarization plant site, but not at another.

Although feasibility and desirability are evaluated separately, there is, of necessity, a certain amount of overlap. For example, costs are considered primarily when evaluating desirability, but cannot be ignored when determining feasibility. Moreover, the factors affecting desirability are interrelated. For example, compliance with regulatory requirements affects costs, and the economics of using the chemical demilitarization equipment must be evaluated with respect to the economics of alternative technologies.

In consideration of the above definitions, the technical capability of the chemical demilitarization facilities and equipment for each proposed future use identified above was examined. Modifications required to accommodate the potential future use were determined and the costs for making these modifications, as well as for operating the plants were estimated.

Three management alternatives for the future uses of the chemical demilitarization plants were examined with respect to their applicability to each proposed use. These alternatives were government owned and government operated (GOGO), government owned and contractor operated (GOCO), and private ownership and operation.

The remainder of this report is organized as follows: section 2 provides a discussion of the characteristics of the potential future uses for the chemical demilitarization facilities. The technical feasibility of using the chemical demilitarization facilities for these other purposes is addressed in section 3. Section 3 also includes a discussion of alternatives to the use of the chemical demilitarization plants for each purpose. Section 4 describes the desirability of using the chemical demilitarization plants for each purpose. Three aspects of desirability are addressed: the impact of regulations, public perceptions of the potential future use, and economic considerations. Management options for

operating the chemical demilitarization facilities after the primary mission is completed are discussed in section 5. Section 6 presents conclusions about the feasibility and desirability of potential future uses of the chemical demilitarization facilities. Section 6 also includes a discussion about regulatory changes and management alternatives recommended for future use of the facilities, and concludes with a summary of the study's findings.

DCN 5860
Executive Correspondence

SECTION 2

POTENTIAL FUTURE USES FOR THE CHEMICAL DISPOSAL FACILITIES

In a 1984 report, the National Academy of Sciences suggested that the cost of disposal of the chemical warfare agent stockpile could be minimized by finding alternative uses for the disposal plants after completion of their primary mission (General Accounting Office (GAO), 1990). In a 1985 study for the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), Arthur D. Little, Inc. stated that "use of the plants for conventional ammunition demilitarization and hazardous waste treatment is considered feasible and potentially economically attractive since much of the processing involved in the subsequent use is quite similar to the initial chemical agent demilitarization plant" (A.D. Little, 1985).

In a 1990 report to Congress on the status of the chemical demilitarization program, the GAO identified two potential future uses for the planned chemical demilitarization plant at the Edgewood Area of Aberdeen Proving Ground, Maryland: thermal decontamination to the XXXXX level of empty l-ton agent containers currently in the XXX condition; and thermal decontamination of contaminated metal parts from the dismantling of a pilot-scale chemical production plant (GAO, 1990).*

Potential future uses identified in the task statement for this study were:

- Commercial hazardous waste disposal.
- Conventional commercial trash incineration.
- Destruction of old chemical agent production facilities at Newport Army Ammunition Plant and at Rocky Mountain Arsenal.
- Nonstockpile items, as defined in the Worldwide Ammunition Reporting System (WARS).

'Levels of decontamination are assigned based on definitions in AMC-R-385-131. XXX items are surface decontaminated by approved procedures and must remain under government control. With specific approval from AMC Field Safety Activity, XXX items may be buried in a landfill approved by the EPA or under an authorized state RCRA program for hazardous waste disposal. XXXXX items have been thermally decontaminated and may be released from government control without precautions.

- Miscellaneous obsolete chemical warfare stocks.
- Old chemical burial areas such as old "0" Field at the Edgewood Area of Aberdeen Proving Ground.

In response to a request for suggestions and ideas on reuse of the chemical demilitarization plants from the U.S. Army Armament, Munitions and Chemical Command (AMSMC), Rock Island, Illinois, the following additional ideas were suggested (Schardein, 1990):

- Nontoxic chemical incineration sites.
- Emergency chemical waste disposal site for local, state, and federal institutions.
- Disposal sites for pharmaceutical drugs that have expired shelf-lives.
- Storage facilities for munitions.

The Defense Reutilization and Marketing Services (DRMS) solicits competitive bids for disposal or recycle of a wide variety of waste originating from military installations. The chemical demilitarization plants could provide disposal capacity for some of these wastes. Currently, Pine Bluff Arsenal bids for nonhazardous medical waste disposal contracts from DRMS (Wright, 1990).

Six categories of potential future uses for the chemical demilitarization plants are discussed below.

2.1 CONVENTIONAL MUNITION DEMILITARIZATION

There are over 121 million individual items (almost 200,000 short tons) of conventional munitions in the U.S. demilitarization stockpile (Greenberg 1990). Additional inventory is generated at a rate of about 23,000 short tons per year. These munitions are distributed among 22 locations, as shown in figure 2-l. Some are located at the same installations as the chemical munitions and others are located at other DOD or Army installations relatively near to where the chemical munitions are located and where the chemical demilitarization plants will be built.

The munitions are categorized into 80 families and contain 78 different types of fillers. The 80 families have been consolidated into 14 groups for ease of reference (Zajicek and Ansell 1990). Appendix C provides a description of the 14 groups of munitions and the methods that are being used, or are being evaluated for use, in their demilitarization.

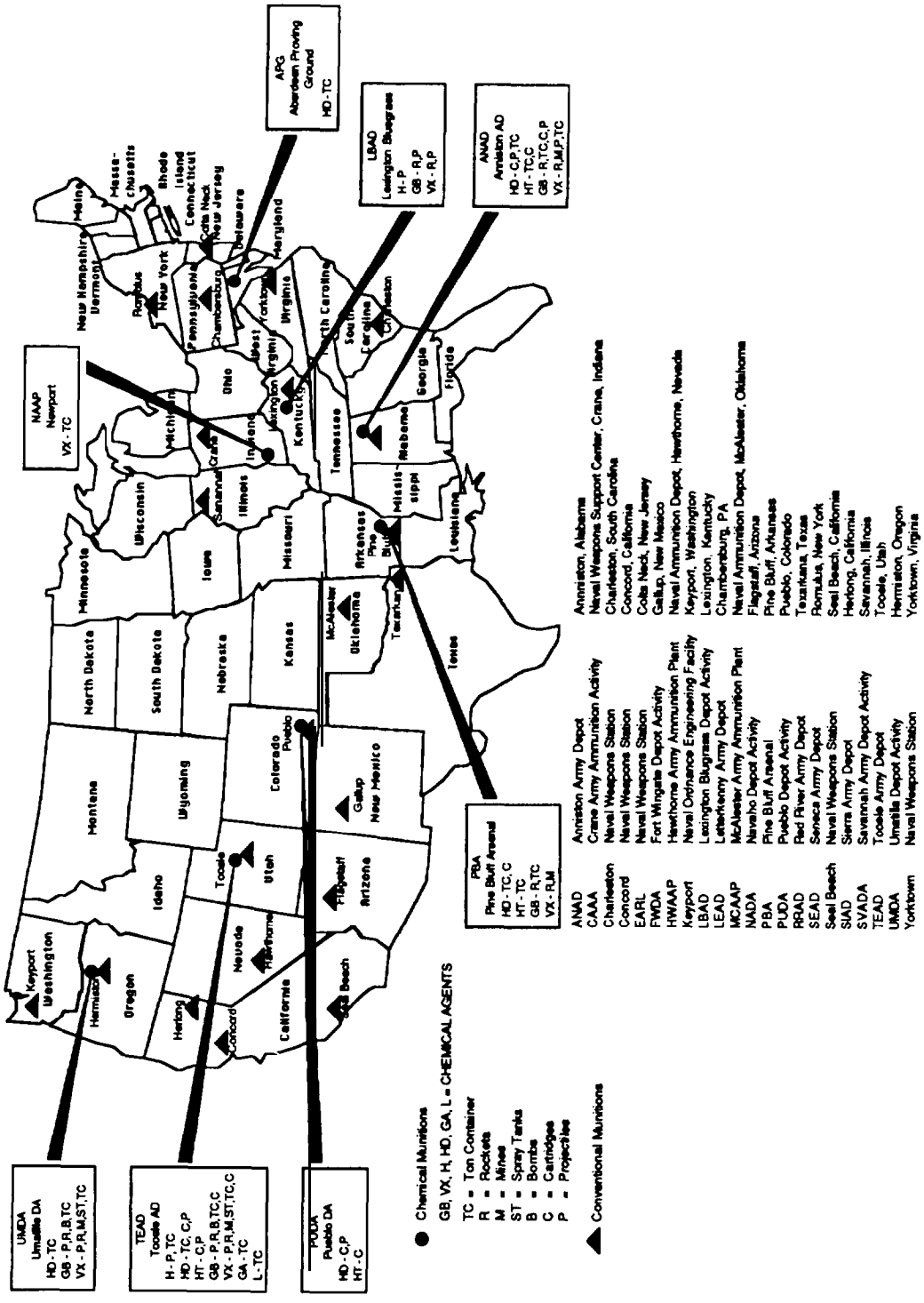


Figure 2-1. Conventional and Chemical Stockpile Locations

Demilitarization of these munitions is currently carried out by a reclamation process, a destruction process, or a combination of both. The means of destruction include open burning (OB), open detonation (OD), and incineration. Biodegradation, catalytic oxidation, electrochemical reduction, and chemical conversion processes are also being investigated.

Reclamation processes involve the disassembly of the munition and extraction of energetic materials for either recycling/reuse in the manufacture of explosives, or as a fuel supplement (Zajicek and Ansell 1990). Possible reuse of some energetic materials, e.g., ammonium perchlorate, in new munitions is being investigated.

Open burning is used to destroy waste explosives, wastes that have the potential to detonate, and bulk military propellants that cannot safely be disposed of through other modes of treatment. Open detonation is used to destroy waste that has the potential to catastrophically explode (U.S. Army 1986). Because local, state, and national environmental groups are voicing increased opposition to this form of disposal, the Army is in the process of determining the releases to the environment from OB/OD in order to obtain the data required to receive permits for continuation of these practices. In addition, the Army is actively seeking safe and effective alternatives to OB/OD--as a contingency in case the permits are denied--for items that cannot be safely disposed of by OB/OD, such as hand grenades, and for items for which OB/OD is prohibited by environmental laws, such as the smokes and dyes in some pyrotechnics (Zajicek and Ansell, 1990). Even where OB/OD is permitted, restrictions are placed on the quantity of material that can be burned or detonated daily thus inhibiting timely destruction of the stockpile. Some alternatives to OB/OD that are currently being used are described in the following paragraphs.

Small arms ammunition, primers, fuzes, boosters, detonators, grenades, shredded hardware from pyrotechnics, white phosphorous (UP), hexachloroethane (HC) and colored smoke munitions, small explosive items, and bulk energetic material are demilitarized in deactivation furnaces similar to the deactivation furnace used in the chemical weapons demilitarization process. Such furnaces are unlined because functioning small arms and tumbling munition bodies would erode or damage a refractory lining. The heat of the furnace causes the explosives to detonate and burn.

The deactivation furnaces require afterburners and high efficiency particulate removal devices, e.g., a hydro-sonic scrubbing system or cyclones followed by baghouses, in order to comply with current RCRA and other regulatory requirements. They must also be completely shrouded to eliminate fugitive emissions. Deactivation furnaces can also be used to destroy residual explosive material in 75mm through 120mm projectiles that

have had the major portion of their explosive content removed for reclamation. Larger projectiles are decontaminated in a Flashing Furnace System (Annealing Oven) (Zajicek and Ansell 1990). The Flashing Furnace System is very similar in operation to the metal parts furnace in a chemical demilitarization plant.

A demilitarization procedure for munitions containing white phosphorous whereby the white phosphorous is converted to commercially saleable phosphoric acid has been successfully developed. A plant has been constructed at Crane Army Ammunition Activity, and it is being used to eliminate all obsolete white phosphorous ammunition in the stockpile over the next 18 months (Zajicek and Ansell 1990).

Several processes are in operation that involve removal of explosives or propellant from a variety of conventional munitions. These processes include (1) use of high pressure hot or ambient water washout, (2) melting in an autoclave, (3) use of steam, and (4) incineration of the explosive or propellant and reclamation of the scrap metal (Zajicek and Ansell, 1990).

2.2 THERMAL DESTRUCTION/DECONTAMINATION OF NONSTOCKPILE CHEMICAL ITEMS

Non-stockpile chemical items include range-recovered filled or empty chemical munition items, chemical agent identification sets (CAIS), empty ton containers that have been surface decontaminated (XXX), protective clothing, rags, decontamination solutions, and tools used in maintenance of chemical surety items, and unwanted or excess chemical surety material. These items were not included in the list of chemical stockpile items existing on the date of enactment of PL 99-145, and thus are not scheduled for destruction/decontamination under the CSDP. The law, as currently written, states that "facilities constructed to carry out this section '(destruction of existing stockpile of lethal chemical agents and munitions)' may not be used for any purpose other than the destruction of lethal chemical weapons and munitions, and when no longer needed to carry out this section, such facilities shall be cleaned, dismantled, and disposed of in accordance with applicable laws and regulations." It thus appears that the law would allow use of the facility for any non-stockpile items that are "lethal chemical weapons and munitions," e.g., unwanted or excess chemical surety material and range-recovered chemical munition items. However, this would need to be clarified. Any use of the facilities for non-stockpile lethal chemical weapons and munitions would need to be specified in any applicable facility permits. In order for the chemical demilitarization facilities to be used for other non-stockpile chemical items, such as empty ton containers, the law would have to be changed.

2.2.1 Range Recovered Items

At the end of 1989 there were 6,046 items in inventory that were recovered from range clearing operations, and research and development tests. The number of recovered items is expected to increase as more are found. Items in the recovered inventory include unidentified glass bottles from World' War II (WWII), chemical agent identification sets (CAIS) that were used for training of soldiers, mortar cartridges, artillery projectiles, bombs, bomblets, levins projectiles, cluster bomb canisters, Department of Transportation (DOT) bottles, and WWII German traktor rockets. Range recovered munitions are shown in figure 2-2. Some of these items predate WWII and many are no longer identifiable with regard to agent type, fill, or weight.

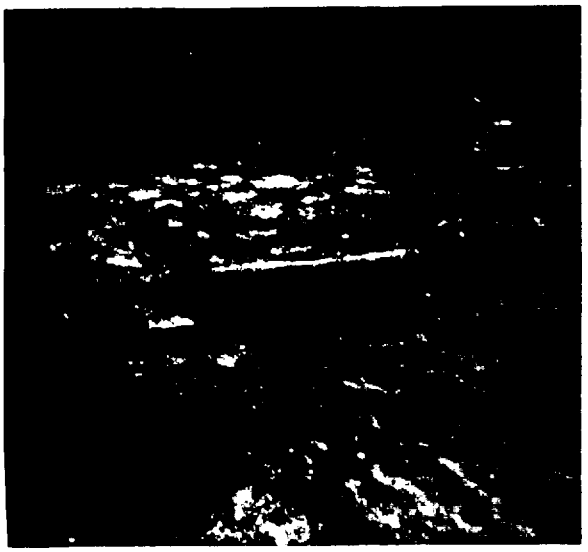
2.2.2 Unwanted Chemical Surety Material

Unwanted chemical surety material is bulk agent that is considered excess to the Army Research, Development, Test and Evaluation (RDT&E) mission, agent that has been removed from leaking chemical munitions, and agent from the Rocket Assessment Program. Approximately 4,200 pounds of unwanted chemical surety material is in inventory (Livingstone 1990).

2.2.3 Empty Ton Containers

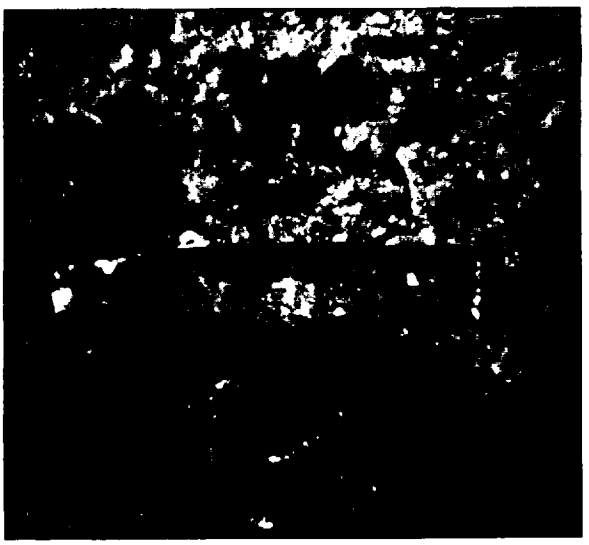
There are over 12,000 empty and decon filled ton containers similar to those shown in figure 2-3 in storage at five Army installations: Rocky Mountain Arsenal, Aberdeen Proving Ground, Pine Bluff Arsenal, Tooele Army Depot, and Johnston Atoll. These containers formerly held chemical surety material. The contamination level of the containers vary from X* to XXX. Under the U.S.-U.S.S.R. Chemical Weapons Destruction Agreement, containers from which chemical warfare agent has been removed must be destroyed (The White House, 1990). The Army considers items that have been thermally treated at 1,000°F for 15 minutes (XXXXX) to be free from agent contamination and potentially salable as scrap. Otherwise they must be buried in an EPA approved hazardous waste landfill. The disposition of the thermally decontaminated ton containers must be carried out in accordance with the provisions of DOD 4160.21-M and DOD 4160.21-M-1. The ton containers can readily be decontaminated to XXXXX in the metal parts

*"X" indicates that the level of decontamination is unknown or that an item is contaminated to the extent that agent concentrations from the bagged item or within the facility containing the item exceed a specified level (Reference AMC-R.385-131).



a) Stokes Mortar — Liquid Filled
Aberdeen Proving Ground

b) Small Caliber Projectiles — Liquid Filled
Aberdeen Proving Ground



c) 4.2 inch Mortar Liquid Filled
Aberdeen Proving Ground

Source Official US Army Photos

Figure 2-2. Typical Range Recovered Chemical Munitions

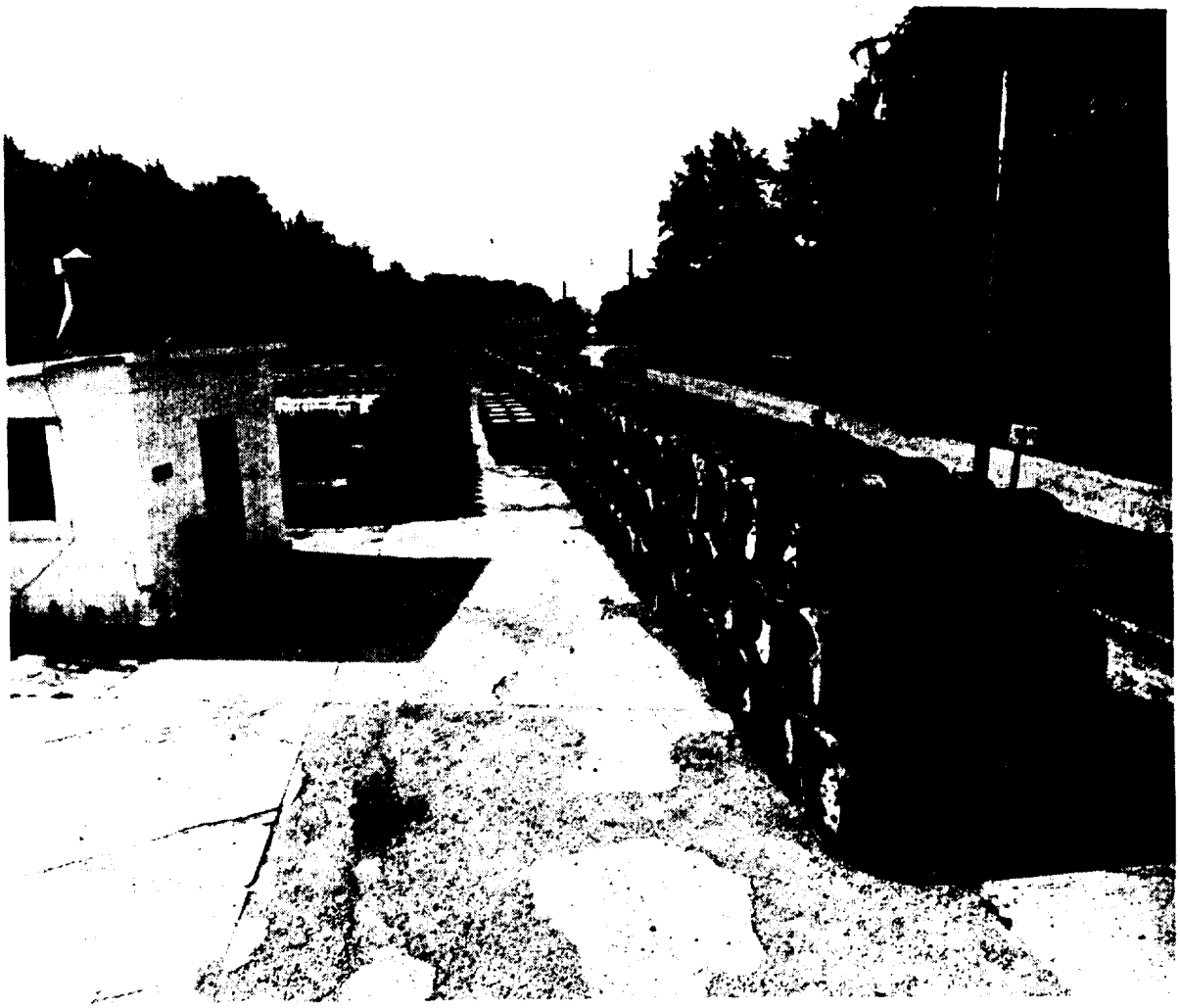
d) Levins Projectile
Aberdeen Proving Ground

e) Ml39 Bomblet — Possible GB Filled
Aberdeen Proving Ground

f) Aircraft Bomb — Liquid Filled
Aberdeen Proving Ground

Source Official US Arm, Photos

Figure 2-2. (Concluded)



Source: Official U.S. Army Photo

Figure 2-3. Empty (xxx) Ton Containers Stored — Edgewood Area, Aberdeen Proving Ground

furnace of the chemical demilitarization plants in the same manner that the ton containers in the stockpile will be decontaminated after being drained of agent. However, since they do not now contain agent, they may not be eligible for destruction in the chemical demilitarization plants under current law.

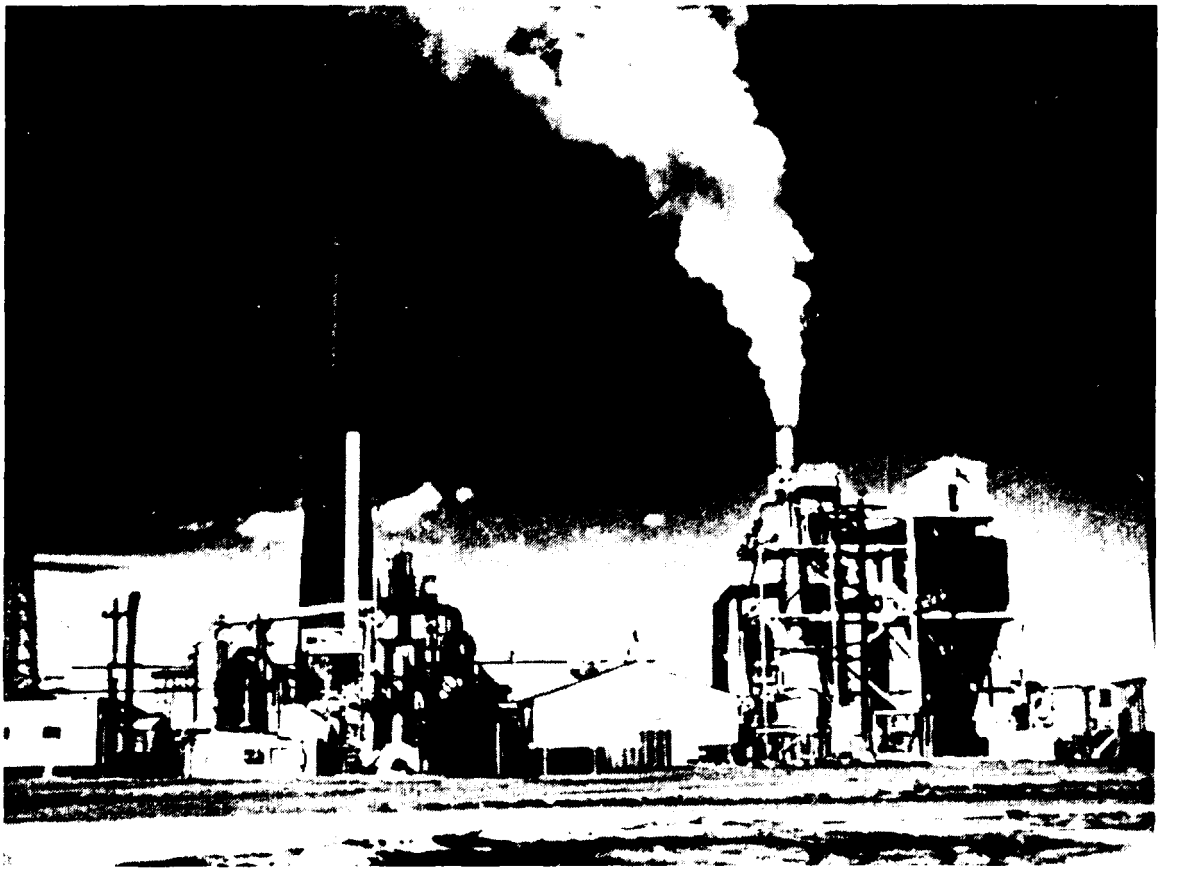
2.3 BUILDING AND EQUIPMENT DECONTAMINATION

Numerous buildings at various military installations are no longer needed and may have to be torn down or converted to other uses (see figure 2-4). As a result of previous activities, many of these buildings might be contaminated by hazardous substances, including chemical surety materials, explosives, pesticides, or other hazardous substances as defined by the EPA. In order to safely dispose of these buildings or convert them to other uses, it is necessary to decontaminate them. The internals of such buildings, consisting usually of piping, tanks, ductwork, wiring, building supports, and assorted furnishings (figure 2-5), can usually be dismantled, cut up, and subjected to thermal decontamination in a rotary kiln or metal parts-type furnace. Any metal may be sold as scrap following decontamination. A former chemical agent research and development facility at the Edgewood Area of Aberdeen Proving Ground is currently in the process of being dismantled and decontaminated in this manner. Building structures made of concrete, masonry, or metal can also be demolished and thermally decontaminated in an incineration system.

An alternative to building demolition followed by thermal decontamination, that is still in the experimental stage, is to leave the structure intact, insulate and seal the building, and heat the interior of the building sufficiently to drive off the contaminants into an afterburner equipped with a pollution abatement system. The building can then be converted for reuse, or safely demolished and buried in a sanitary landfill. Metal buildings can be converted to scrap. Disposition of the thermally decontaminated scrap metal must be carried out in accordance with the provisions of DOD 4160.21-M.

2.4 SOIL DECONTAMINATION

As a result of the Installation Restoration Program (IRP) proceeding at defense installations, many sites are being identified where toxic and hazardous wastes have been buried (figure 2-6). For example, it is estimated that there are over 1 million cubic yards of soil contaminated with explosive compounds at U.S. Army installations across the country (U.S. Army Toxic and Hazardous Materials Agency, 1989) (figure 2-7). Contaminated soil has also accumulated from construction activities



Source: Official US Army Photo

Figure 2-4. Agent Contaminated Buildings and Structures Scheduled for Dismantling and Decontamination — Rocky Mountain Arsenal

Source: Official US Army Photo

Figure 2-5. Agent Equipment Packaged and Ready for Thermal Decontamination — Newport Army Ammunition Plant

Source: Official US Army Photo

Figure 2.6. Decontaminated Waste Burial Ground — Newport Army Ammunition Plant

at military installations. At Aberdeen Proving Ground, Maryland, construction of the Wheeled Vehicle Training Facility resulted in the accumulation of 15,000 cubic yards of contaminated soil for which Aberdeen has no cost effective means of disposal (Stachiw, 1990).

In some instances, the wastes are migrating and either are contaminating or have the potential to contaminate nearby surface or groundwaters. One solution to the problem is to dig up the contamination, which in many instances is adsorbed onto the soil at the site, and either dispose of it in a hazardous waste landfill or decontaminate it on site. Contaminated soil is readily thermally decontaminated in a rotary kiln. Successful thermal decontamination of soil contaminated with explosives has been demonstrated at several Army Installations (Turkeltaub and Wiehl 1989; Noland, Marks, and Marks, 1984). PCB and dioxin contaminated soils have been successfully incinerated at the Twin City Army Ammunition Plant, Minnesota, and at Fort A. P. Hill, Virginia, respectively (Parker, 1990). Lined rotary kilns were used in all these cases. The advantage of a rotary kiln for soil decontamination is that as the kiln rotates, the soil is constantly agitated and fresh soil surface is continually exposed to the heat. Thus, efficient volatilization and incineration of contaminants from the surface of the soil occurs (Parker, William H., 1990).

2.5 TOXIC, HAZARDOUS, AND NONHAZARDOUS WASTE DISPOSAL

A waste is characterized as toxic or hazardous if it possesses certain characteristics and it has been so defined or listed by the EPA in their regulations (40 CFR 260). Some states may'also regulate additional wastes as hazardous even though the EPA did not list them as hazardous. Included in the list of hazardous wastes are synthetic organic chemicals, heavy and toxic metals, inorganic sludges, solvents, and dilute aqueous waste streams of hazardous or toxic substances. These hazardous wastes are generated during routine daily activities of industrial and commercial operations, laboratories, and the military. In addition, remedial action at former hazardous waste landfills is adding to the volume of hazardous wastes requiring disposal.

Routine activities at Army installations generate a variety of toxic, hazardous and non-hazardous wastes. These include petroleum, oils, lubricants, hydrocarbon solvents, chlorinated solvents, grease and paint from maintenance activities, chemically treated wooden pallets, and medical wastes from on-post hospitals and medical laboratories. The GAO recently published a report (GAO 1990b) recommending that DOD discontinue the purchase and use of the decontamination solution DS2, which consists of a mixture of sodium hydroxide, an amine, and a glycol. As a result of this, the existing inventory of DS2 may have to be disposed of. The DRMS

currently solicits contracts for disposal of DS2 from waste recovery and disposal firms who separate useful products from the DS2 by a distillation/solvent recovery process. Non-hazardous wastes include conventional wood and paper trash. Sewage sludge from on-post wastewater treatment plants is also generated at some installations.

Methods for managing wastes include waste reduction/minimization efforts, treatment, destruction, containment, and land disposal. Thermal destruction by incineration is effective for many toxic, hazardous and non-hazardous wastes. The Army's non-agent type hazardous and non-hazardous wastes remaining after on-site efforts at treatment, recycle/reuse, or disposal have been exhausted are generally disposed of through the DRMS. DRMS solicits competitive bids for disposal of the wastes. Pine Bluff Arsenal currently bids for contracts from the DRMS to dispose of non-hazardous medical wastes using the spare capacity in their incinerators. One or more of the chemical demilitarization plants could provide additional disposal capacity for those hazardous wastes currently disposed of through DRMS that are routinely incinerated. If the demilitarization plants are not used by the Army after the chemical demilitarization program is completed, private hazardous waste disposal companies may be interested in purchasing the incinerators to provide additional disposal capacity to their business.

2.6 OTHER POTENTIAL USES

The chemical demilitarization plants will include a variety of support activities with specialized facilities and equipment. These facilities and specialized equipment will likely continue to be used if the demilitarization plants continue to be used for other purposes. However, if the demilitarization equipment is dismantled, the support facilities could be turned over to the host installation to fulfill their requirements for new or replacement equivalent facilities. For example, the buildings could be used to add needed warehouse space, the laboratory could be used to replace an old outdated facility or to provide additional capability, and the maintenance facility could replace or augment existing maintenance facilities. In cases where the host installation is scheduled for closure, the structures may be attractive to the private sector for commercial or industrial use.

Since the potential for future use of these specialized facilities and equipment is site-specific and dependent upon the needs of the installation or commercial interests at the time they become available, an assessment of the feasibility and desirability of using them should be made at that time.

SECTION 3

FEASIBILITY OF POTENTIAL FUTURE USES OF CHEMICAL DISPOSAL FACILITY SYSTEMS

In order to evaluate the feasibility of using all or part of the chemical demilitarization plants for other purposes, the demilitarization plants were considered to be composed of eight subsystems or building blocks. The applicability of each of the building blocks to a potential future use was then determined. Descriptions of the chemical demilitarization plants are provided in appendix A. The eight building blocks are described below.

- Pre-Incineration. This building block includes the machines in a chemical demilitarization plant that are used to disassemble, punch, drain, shear, or crush munitions. The CSDP and the CAMDS demilitarization plants contain one or more of the following demilitarization machines: the rocket shear machine (RSM), the mine machine (MIN), the bulk drain station (BDS), the projectile/mortar disassembly machine (PMD), and the multipurpose demilitarization machine (MDM). The CIDP contains cryo-pretreatment, a material transfer robot, a cryofracture press system and a large rotary kiln.

- Deactivation Furnace System (DFS). This building block includes a munitions feed chute, a rotary kiln, a heated discharge conveyor, a hot cyclone, and an afterburner. Also included is a pollution abatement system (PAS) that consists of a quench tower (QT), a venturi scrubber (VS), a packed bed scrubber, a demister vessel, brine feed/recycle pumps, and a variable speed induced draft fan. This building block is used to incinerate explosives, propellant, and explosive components, and to thermally decontaminate munition bodies with residual agent and sheared rockets. The PAS is used to cool and clean exhaust gases.

- Metal Parts Furnace (MPF). This building block includes a munitions feed mechanism, a primary volatilization/burnout chamber, and an afterburner. The associated PAS is similar to the one mentioned above. This building block is used to decontaminate munition bodies and bulk agent containers containing residual agent (but no explosives) by volatilizing and thermally destroying the agent.

- Liquid Incinerator (LIC). This building block consists of a two-chamber liquid injection incinerator with the chambers connected by a crossover duct. The associated PAS is similar to the one mentioned above. This building block is used to incinerate the liquid chemical agent and decontamination solutions.

- Dunnage Incinerator (DUN), This building block consists of a . primary combustion chamber and an afterburner. Also included is a PAS consisting of a quench tower, a baghouse, and an induced draft fan. This building block is used to incinerate nonmetallic wastes including protective garments, wooden pallets, packaging material, and charcoal filters.

- Toxic Cubicle Area - Brine Reduction Area (TOX-BRA). This building block covers a toxic cubicle that consists of storage tanks and pumps, and a brine reduction area that consists of holding tanks, pumps, evaporators, and dryers. This building block is used to store and process a variety of brines generated in the building and in the PAS. It is also used to dewater and dry brines.

- Other Operational Facilities. This building block covers the munitions holding area (MHA), the unpack area (UPA), the environmental monitoring laboratory (LAB), and the central decontamination system (CDS).

- Support Facilities. This building block includes facilities not handling chemical agent or munitions, such as general chemical storage, fuel storage, control room, and utilities, among others.

The TOX-BRA, other operational facilities, and support facilities building blocks will be generally useful in combination with the other building blocks for most potential future uses of the chemical demilitarization facilities. For example, the tanks and the pumps associated with the toxic cubicle area, and the tanks and pumps associated with the brine reduction area would be used to collect and treat brines from the pollution abatement system. The unpack area would be used to inspect munitions and remove their shipping and storage containers. The environmental monitoring laboratory would provide analytical chemistry services and would support the monitoring programs that are necessary to ensure compliance with occupational exposure criteria and with process emission criteria. The utilities, such as plant air, instrumentation air, process water, steam, fuel oil, gas, and electrical power, among others, are an integral part of the operation of the plants, regardless of the feedstock that would be processed.

For purposes of this report, it will therefore be assumed that these building blocks will be an integral part of any future use of the demilitarization facility. If the demilitarization facilities are dismantled, however, some of the facilities may find a future use independent of the demilitarization facility. For example, the host installation may find a use for the laboratory, buildings, or storage tanks to replace or augment existing facilities. Consideration of these potential future uses is beyond the scope of this report.

3.1 CONVENTIONAL MUNITION DEMILITARIZATION

As discussed in section 2, conventional munitions have been categorized into 80 families. These families were consolidated by Zajicek and Ansell (1990) into 14 groups. These munition groups are described in appendix C. For purposes of this report, the 14 groups were further consolidated into four groups based on similarities with respect to size of munitions and methods of demilitarization. These groups are:

- Small conventional munitions.
- Smokes and riot agents.
- Large conventional munitions.
- Bulk energetics.

The Army has equipment called Ammunition Peculiar Equipment (APE) that is designed and built to accomplish a specific task such as breakdown, disassembly, defuzing and incineration associated with demilitarization of conventional munitions, A list of some of this equipment is contained in appendix D. Information about the technology and equipment currently used by the Army to demilitarize conventional munitions provided a basis for assessing the technical feasibility of using the chemical demilitarization facilities for this purpose.

The feasibility of using the chemical demilitarization facilities for demilitarization of each of the four groups of conventional munitions is discussed in the following subsections.

3.1.1 Small Conventional Munitions

Small conventional munitions include small arms, fuzes, primers, grenades and mines. These munitions are commonly demilitarized by incineration in an unlined rotary kiln. One such kiln commonly used by the Army is an APE 1236 furnace that has been upgraded by the addition of pollution control devices to comply with current environmental laws.

Generally, these munitions do not require disassembly before incineration. However, the APE 2196 shear machine for small items is used to punch holes in explosive items to facilitate better control of demilitarization in an upgraded APE 1236. Some grenades and mines require that their fuzes be removed prior to incineration. Also, larger mines that contain about 20 pounds of explosives are usually processed through a washout/meltout facility to remove the explosive for reuse or for incineration in an Explosive Waste Incinerator (EWI). The EWI is similar in design and operation to the APE 1236, the difference being the addition of a positive feed mechanism. This feed mechanism consists of a conveyor that carries an open container (8" by 20" long) through a concrete wall to a ram. The ram allows the pan to slide into the furnace. Munitions containing thermite, an incendiary material, are not amenable to incineration because this material burns at too high a temperature (5,400°F) and may destroy the incinerator.

The chemical demilitarization facility building blocks that are potentially usable for demilitarization of small conventional munitions include the mine machine (MIN), the deactivation furnace system, and the dunnage incinerator system. In addition, in order to accommodate the larger mines, a washout/meltout facility would need to be installed.

The deactivation furnace is similar to the APE 1236 and could be used to incinerate some small munitions without any modifications. The dunnage incinerator would be used to incinerate packaging material associated with the small munitions, e.g., wooden boxes. The mine machine would be used to remove fuzes and boosters from high explosive mines.

3.1.2 Smokes, Riot Agents

Most munitions containing smokes and dyes require disassembly to remove explosive components and fillers. For example, the APE 2099 disassembly machine is used to remotely disassemble 3.5-inch white phosphorus rockets with an automatic or emergency dump chute. Smoke devices containing FS are also disassembled by an APE and the acidic filler is neutralized with a brine slurry. If neutralization is not available, FS smokes could be processed in an upgraded APE 1236. Smoke devices containing colored dyes or petroleum products can also be processed in an upgraded APE 1236.

The disassembly of some pyrotechnic items could be difficult. Once disassembly is achieved, then these items can be processed in an upgraded APE 1236. However, those munitions filled with an aluminum and magnesium mixture are not amenable to incineration because they burn at too high a temperature (about 5,400°F).

Munitions containing riot control agents do not require disassembly and can be incinerated in an upgraded APE 1236. A fluidized bed incinerator (FBI) can be used to incinerate combustibles from disassembled munitions. The bed media used in the FBI is approximately 8 feet, expanded height, of silica sand.

While the deactivation furnace system is potentially usable for demilitarization of smokes, dyes, and the riot control agent DM, the PAS may need to be modified to remove organic carcinogens and arsenic oxide. The deactivation furnace is amenable to the incineration of most other riot control agents without further modification, The MPF/PAS subsystem of the chemical demilitarization facility could be used to thermally decontaminate metal components, and the DUN/PAS subsystem could be used to burn dunnage associated with the feedstock. The bulk drain station would be used to punch and disassemble smoke and riot agent items.

Modifications to the existing deactivation furnace pollution abatement system (PAS) would include the installation of a baghouse or an electrostatic precipitator to remove fine particles.

3.1.3 Large Conventional Munitions

Large conventional munitions include High Explosive (HE) loaded projectiles, rockets, missiles, bombs, torpedos, depth charges, cluster bomb units (CBUs), navy gun ammunition (explosive D), special function projectiles, and inert rounds. Generally, these items are disposed of by OB/OD or are disassembled using an APE, contour drilling, or size reduction machines. For example, the APE 2175 projectile saw machine is used to saw high explosive loaded projectiles for demilitarization of munitions ranging in size from 75mm to 120mm. After disassembly, explosives are removed by a washout/meltout facility and are incinerated in an EWI or are recovered for reuse. Metals are thermally detoxified and fuzes are deactivated in an upgraded APE 1236. Most of these items would require disassembly.

The disassembly equipment in the chemical demilitarization facilities could be used to remove the plugs and fuzes from munitions. Washout/meltout facilities are needed to remove explosives and propellants from the disassembled munitions. The cryopretreatment and cryofracture equipment of the CIDP could also be used for size reduction of the large munitions assuming that explosive limits for the cryopress are not exceeded. The DFS/PAS subsystem could be used to incinerate propellants and explosives. The MPF/PAS subsystem could be used to thermally detoxify metals to remove residual explosives, while the DUN/PAS subsystem could be used to burn dunnage associated with the feedstocks.

3.1.4 Bulk Energetics

Bulk energetics are bulk explosives (TNT, Composition B, Explosive D, dynamite, and Composition A) and propellant charges. Generally, bulk explosives do not require disassembly, however, bulk dynamite needs to be size reduced and exposed. Also, some propellant-filled items do not require disassembly, and a few propellant charges may require the use of an APE for disassembly.

Once bulk energetics are disassembled, selected items might require the use of a washout/meltout facility to remove explosives and propellants. The recovered explosives could be reused or incinerated in an EWI, and the propellants can also be incinerated in an EWI.

The rocket shear machine in the CSDP and/or the cryofracture equipment of the CIDP may be used to size-reduce bulk energetics. Also, the DFS/PAS subsystem could be used to thermally decontaminate metals, and incinerate the propellants and explosives within the constraints of the explosive limit of the incinerator. The MPF/PAS subsystem could be used, if necessary, to thermally detoxify the limited amount of metal parts, while the DUN/PAS could be used to burn any dunnage associated with the feedstock.

3.2 NONSTOCKPILE CHEMICAL ITEMS

Nonstockpile chemical items include range recovered chemical munition items, CAIS, empty or decontamination solution filled ton containers that require thermal decontamination, dunnage (protective clothing, rags, and tools), decontamination solution from maintenance of chemical surety items, and unwanted or excess chemical surety material not considered part of the chemical stockpile scheduled for disposal in the chemical demilitarization plants. Many of these items are similar to items that are scheduled for destruction in the chemical demilitarization plants and therefore are natural candidates for future use of the plants. These would include identifiable range recovered chemical munitions, the empty or decontamination solution filled ton containers, dunnage items contaminated by chemical surety material during maintenance of the stockpile, and excess chemical surety material. Disposal of such items should not require any modifications to the chemical demilitarization facilities. The range recovered items may be more difficult to handle than the normal stockpile because they are likely to be in a deteriorated condition and thus more difficult to disassemble or even to identify as to their contents. Additional specialized equipment may, therefore, be needed to accomplish the disassembly (such as the reject disposal system developed by the Ammunition Equipment Directorate in Tooele, Utah) and processing may need to be carried out in a slower, more deliberate manner, than processing of the normal stockpile.

3.3 DISPOSAL OF HAZARDOUS WASTES

Routine activities at Army installations generate a variety of hazardous wastes. These include waste petroleum oils and lubricants (POL), grease, solvents, chlorinated solvents, painting wastes, spent activated carbon, sludges, chemically treated wooden pallets, and wastes contaminated with heavy metals. Such wastes are treated in an industrial wastewater treatment plant or disposed of through DRMS or on-call contractors, or are transported off-site for disposal by a variety of methods including incineration in a rotary kiln, a liquid injection combustor, or a hearth type furnace.

Also, there is a wide range of non-DOD hazardous waste that can be incinerated. Of particular interest are combustible or partially combustible liquid wastes such as pesticides, oils, solvents, such as trichloroethylene (TCE), and solid or semi-solid wastes, such as sludges and lubricants. Rotary kilns and liquid incinerators are commonly used to destroy these wastes.

The DFS/PAS subsystem of the chemical demilitarization facility could, with suitable modification, be used to incinerate and/or volume reduce a variety of hazardous wastes. Among the modifications that would be required are the addition of appropriate mechanisms for feeding the waste to the kiln, e.g., piping for liquid wastes and/or a bucket elevator for solids and sludges, and assorted control systems. Additional storage tanks may be required to hold the waste until it can be processed. The existing mist eliminators may be inadequate to remove the types and amounts of acid gases produced when incinerating hazardous wastes. Therefore, the PAS might need upgraded mist eliminators. The MPF/PAS subsystem could also be used, if necessary, to detoxify some hazardous materials, such as painting wastes, provided that the feed and discharge mechanism is modified and the PAS is upgraded to provide capability for removal of the combustion products of paint wastes, such as heavy metals and metal oxides. The LIC/PAS subsystem can be used to incinerate liquid hazardous wastes, such as solvents (xylene, DS_2, TCE) and waste oils. Some changes to the feed mechanism would be necessary.

3.4 REMEDIATION OF CONTAMINATED SOILS AT DOD SITES

Industrial operations at DOD sites, such as the maintenance of combat vehicles, generate wastes containing heavy metals, grease, oils, solvents, acids, and caustics. In the past, these wastes were often disposed of by burial in nearby unlined or poorly lined landfills. Also, open burning, open detonation, and other activities might have contaminated some land areas with explosive material. It is estimated that there are over 1 million cubic yards of soil potentially contaminated with explosive

compounds at U.S. Army installations across the country (U.S. Army Toxic and Hazardous Material Agency, 1989). Contaminated soil has also resulted from oil spills and from burial of conventional and chemical munitions. In some instances, the pollutants are migrating and are contaminating nearby surface and groundwaters. Methods for decontaminating soil include removal and deposit in an approved landfill, soil washing, in situ stripping with air and/or heat, biodegradation, and dewatering and incineration in a refractory lined rotary kiln.

Where incineration of contaminated soil is determined to be the preferred method of decontamination, the DFS/PAS subsystem of the chemical demilitarization facility could be used. However, such use would require modification, including the addition of a refractory lining (for the purpose of improving thermal efficiency), and appropriate feed and discharge mechanisms, such as bucket conveyors, screw conveyors, and ram feeders. The MPF/PAS subsystem could be used to decontaminate soil at sites without a DFS/PAS subsystem. The drawback to the MPF/PAS subsystem for this application is that the throughput rates should be very low to ensure complete decontamination. Feed and discharge modifications would be required to process soil through the MPF/PAS subsystem. The DUN/PAS subsystem could also incinerate any dunnage material used in transporting contaminated soils to the furnace area.

3.5 AGENT CONTAMINATED BUILDINGS/EQUIPMENT

Numerous buildings at various military installations are no longer needed and will have to be torn down. Many of these buildings might be contaminated by hazardous substances, including chemical surety material, explosives, pesticides, or other hazardous substances. A demonstrated technology for decontamination of these buildings is to demolish the concrete and masonry sections of the building, dismantle and cut-up the pipes/metals/equipment, and subject these materials to thermal decontamination in a rotary kiln or a metal parts furnace. A former chemical agent research and development facility at the Edgewood Area of Aberdeen Proving Ground is currently in the process of being dismantled and decontaminated in this manner.

The DFS/PAS and the MPF/PAS subsystems of the chemical demilitarization facilities could be used to decontaminate rubble, pipes, tanks, and structural steel. The feed/discharge mechanism of the furnaces may have to be modified to handle larger pieces of metal or rubble. Alternatively, rubble and pieces of metal could be cut to smaller sizes so they can be fed to the metal parts furnace or to the deactivation furnace. As with soil, the throughput rate for rubble treated in the MPF/PAS subsystem may

be much lower than that for rubble treated in the DFS/PAS subsystem to ensure complete decontamination. The DUN/PAS subsystem is capable of incinerating any dunnage material used in packaging and transporting contaminated rubble and metal.

3.6 DISPOSAL OF NONHAZARDOUS WASTE

A variety of nonhazardous waste, such as scrap wood and paper, is being generated daily at Army installations. Such refuse is commonly disposed of in a sanitary landfill or incinerated in single chamber, multiple chamber, or large municipal type incinerators that are refractory lined.

Nonradioactive medical waste is also generated at some military installations. These wastes include blood, surgical equipment, needles, and human and animal tissues. Regulations are getting very stringent for handling these wastes because of the fear of exposure to the Acquired Immune Deficiency Syndrome (AIDS) virus, hepatitis B, toxic metals and organics. Hospital wastes are normally incinerated in a multiple chamber incinerator or occasionally in a rotary kiln.

The DFS/PAS, MPF/PAS, and DUN/PAS subsystems of the chemical demilitarization facility could be used to destroy nonhazardous solid waste. The DFS/PAS can also be used to incinerate nonradioactive medical waste provided that a feed hopper and an auger feed system are added.

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SECTION 4

DESIRABILITY OF FUTURE USES OF CHEMICAL DISPOSAL FACILITIES

In this section, the desirability of using chemical disposal facilities for alternative future uses is discussed. Three major aspects of desirability are considered: the impact of regulations on future use, public perceptions of the costs and benefits associated with such use, and economic aspects of alternative uses of the plants, taking into consideration the existence of technological alternatives to these plants.

In section 4.1, an overview is provided of current federal and Army regulations that will have an impact on decisions concerning potential future uses. While a corresponding review of state regulations is premature since such regulations are rapidly and independently evolving, the roles of states in regulating demilitarization plant future use is discussed and examples of existing state regulations that could affect such use are provided.

Section 4.2 contains a summary of current public perceptions concerning use of the plants for their prime mission: chemical munitions demilitarization, using material obtained from public hearings in the communities involved. To the extent that future use has been discussed to date, expressions of support or opposition to future uses of the plants are also presented and specific proposals for such uses are noted.

In section 4.3, the economic desirability of using the plants for applications other than the destruction of chemical munitions is discussed. In this section, alternatives to the use of the plants, (e.g., other Army incinerators, use of commercial facilities) are described and the costs of such alternatives are summarized. These costs are compared with those to be expected when using the demilitarization plants for the feedstocks considered.

4.1 REGULATORY ASPECTS OF POTENTIAL FUTURE USES

The alteration and use of the chemical demilitarization plants beyond their current mission to destroy the U.S. stockpile of obsolete chemical munitions will be subject to broad and comprehensive regulation, arising from federal, state, and local laws. U.S. Army regulations will also affect the conduct of various future demilitarization plant uses. In many instances, the various laws and regulations originating at these jurisdictions overlap and create uncertainties concerning how future plant uses will take place.

The following subsections summarize the major laws and regulations that have general application to the demilitarization plants future uses, and identify the potential impacts these regulations may have. It should be noted here that the following discussion is not a detailed legal review of future use options. Rather, due to the uncertainties involved, this analysis provides a general basis for identifying how various regulations will apply to generic concepts of demilitarization plant future use and possible areas where legislative action may need to be considered to allow future uses to take place (as discussed in section 6.2). Uncertainties affecting this analysis arise principally from the time frame involved for most of the facilities under consideration (8-10 years in the future) and the fact that laws and regulations, and particularly environmental laws, continue to evolve at all levels of government. Also, an increasing amount of the burden of environmental regulation is being delegated by the federal government to states, which, in turn, are developing and enforcing their own additional regulations. The impact of regulations on future use alternatives will therefore be highly site-specific.

In sections 4.1.1 and 4.1.2, federal and Army regulations affecting demilitarization plant future uses are discussed. Section 4.1.3 is a summary of the impacts that states are having on the process of permitting and regulating the demilitarization facilities.

4.1.1 Federal Regulations

Federal laws represent the most comprehensive body of regulation affecting the future use of demilitarization plants. These laws, and the regulations derived from them, range from general policies for environmental protection to extensive and prescriptive requirements covering all aspects of plant operations and alternative uses.

Table 4-1 summarizes the applicable federal laws according to three generic future use categories: incineration of conventional munitions in the demilitarization inventory; incineration of hazardous wastes recovered from previous, uncontrolled waste disposal practices; and incineration of hazardous wastes from current operations. The second category--hazardous wastes site remediation--includes all hazardous wastes recovered from IRP cleanup actions at military facilities. Also included is incineration of range-recovered chemical and conventional munitions, contaminated building debris and hazardous building materials, and all other wastes from hazardous waste site cleanup. The third category includes disposal and incineration of hazardous wastes resulting from current operations and sources. In all cases, incineration is considered to be the only treatment or disposal operation undertaken in demilitarization plants.

Table 4-1. Applicablity of Major Federal Environmental Laws and Regulations to Demilitarization Plant Future Uses

Law/Regulations	Conventional Munition Destruction	Hazardous Waste Site Remediation	Other Solid/Hazardous waste
National Environmental Policy Act of 1969 (NEPA)	Applies to all Federal actions with potential to affect the environment • Legislative changes • Demil plant mission changes All proposed changes require environmental analysis (EAs, EISs)		
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended under the Superfund Amendments and Reauthorization Act of 1986 (SARA)	Not applicable except for range-recovered items and items excavated during remediation of landfills	Defines overall procedures for implementation of waste site cleanup at federal facilities Incorporates other federal, environmental requirements and regulations as applicable or relevant and appropriate (ARAR)	Not applicable
Resource Conservation and Recovery Act of 1976 (RCRA), as amended under the Hazardous and Solid Waste Amendements of 1964 (HSWA)	• Applies to obsolete munitions at the time they are designated as waste for destruction or disposal (Army Reg. 200-l) Overall regulatory framework for all hazardous waste treatment and disposal activities	• Technical standards for on-site remediation • Technical standards applied through permits for off-site treatment, disposal Applies to CERCLA actions as an ARAR	Applies to all aspects of hazardous waste management • Technical environmental standards, regulations • Permits

Table 4-l. Applicablity of Major Federal Environmental Laws and Regulations to Demilitarization Plant Future Uses (Concluded)

Law/Regulations	Conventional Munition Destruction	Hazardous Waste Site Remediation	Other Solid/Hazardous Waste
Clean Water Act of (CWA), as amended in 1987 (Water Quality Act) (Replaces Federal Water Pollution Control Act of 1972)	NPDES permits required for all "Point Source" discharges to surface waters • Treatment requirements are technology related and determined on a pollutant and site-specific basis • Newly enacted NPDES storm water requirements		
Clean Air Act of 1955 (CAA), as amended	NSPS, PSD, and NESHAP enforced through permitting process • Removal requirements are technology related and determined on a pollutant and site-specific basis		
Toxic Substances Control Act of 1976 (TSCA), as amended	Not applicable unless PCBs are discovered in soil, dunnage or other items associated with munitions	CERCLA actions involving PCBs and asbestos must comply with TSCA as an ARAR • Incineration standards • Residue disposal	Applies to handling, disposal of PCBs and asbestos • Incineration standards • Residue disposal
Federal Insecticide, Fungicide. and Rodenticide Act of 1972 (FIFRA), as amended	Not applicable	CERCLA actions involving pesticides subject to FIFRA as an ARAR • Incineration guidelines	Applies to storage and disposal of pesticides and containers • Incineration guidelines

Key :

NPDES = National Pollution Discharge Elimination System
NSPS = New Source Performance Standards
NESHAP = National Emission Standards for Hazardous Air Pollutants
PCB = Polychlorinated Biphenyls
ARAR = Applicable, or Relevant and Appropriate Regulation
PSD = Prevention of Significant Deterioration

4.1.1.1 The National Environmental Policy Act of 1969 (NEPA)

NEPA is the basic federal policy concerning protection of all aspects of environmental quality. It is a policy, rather than a set of prescriptive regulations, which requires that all significant actions of the federal government with the potential for impacts on the human environment be subjected to a comprehensive, systematic, documented environmental analysis.

Regulations developed to support NEPA (40 CFR 1500-1508) establish requirements for this environmental analysis process, and outline the steps to be followed: (1) preparation of an environmental assessment (EA) to determine the need for an environmental impact statement (EIS), and (2) preparation of the EIS, if results of step 1 so indicate. Program officials may opt to skip preparation of an EA and proceed directly to preparation of an EIS.

An environmental impact statement is a public document containing the results of the environmental analysis, and is part of a process entailing both public and intergovernmental review and comment. Comments received must be responded to in writing and may result in limitations on the proposed action. Preparation of an EIS may also involve public hearings to address public comments or allow debate on the proposed action and alternatives.

The Army has prepared a programmatic EIS for conduct of the CSDP at the eight CONUS stockpile locations, and either has prepared, or will prepare, a site-specific EIS at each of the eight stockpile locations for construction and operation of eight CSDP plants and the Cryofracture Incineration Disposal Plant (CIDP). An EIS has also been prepared for construction and operation of the JACADS facility at Johnston Island. Operation of the BZ destruction facility at Pine Bluff Arsenal is covered under an EA, and the CAMDS facility at Tooele Army Depot operates under an EIS.

Some options for demilitarization plant use (e.g., dismantling and relocation of various plant equipment) may result in no significant impacts, while other use options have the potential for environmental impacts. Pending the outcome of environmental assessments for conversion of these plants to other uses, amendments or supplements to the existing EISs or EA would be prepared, reviewed, and finalized in an amended record of decision. The potential exists for public controversy over continued use of these facilities, and this could impact the schedule and technical requirements for facility operation.

4.1.1.2 The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

CERCIA is the overall federal enabling legislation for the "Superfund" program to identify, cleanup, and assess liabilities for releases from abandoned or uncontrolled hazardous waste sites. Prior to 1986, CERCLA primarily addressed releases from industrial' or privately-owned hazardous waste sites and did not contain specific requirements for on-site CERCLA actions to comply with other federal laws. With the passage of the Superfund Amendments and Reauthorization Act of 1986 (SARA), Congress undertook sweeping amendments to CERCLA to (1) bring Superfund site remediation into compliance with other environmental regulations, and (2) bring various programs for cleanup of hazardous waste sites on federal facilities into compliance with **CERCLA** procedures and processes for selecting remedial actions and determining liabilities.

CERCLA § 121 requires that remedial actions comply with other laws and environmental regulations that are determined to be either **applicable**, or **relevent** and **appropriate** regulations **(ARARs)**. This process can encompass the entire body of federal environmental regulation as well as state laws governing cleanup of hazardous waste, and incorporates by reference all such requirements into CERCLA actions. Therefore, with few exceptions, CERCLA actions must comply with **ARARs** from RCRA, the Clean Air and Clean Water Acts, the Toxic Substances Control Act, other federal laws, and state laws at each cleanup site.

The specific impacts of CERCLA § 121 on future uses of demilitarization plants stem from the CERCLA use of "on-site" versus "off-site" remediation. CERCLA § 121(d)(3) states that off-site transfer of CERCLA wastes shall only be to facilities that are in compliance with applicable federal laws, and CERCLA § 121(c)(3)(B) requires off-site storage, destruction, treatment, or secure disposition of hazardous substances from Superfund sites to be carried out only at hazardous waste disposal facilities that are in compliance with Subtitle C of RCRA (see RCRA discussion below). CERCLA § 121(e), on the other hand, provides that no federal, state, or local permit shall be required "for the portion of any removal or remedial action conducted entirely on-site" when the action is selected and carried out in compliance with the cleanup standards requirements of § 121. EPA has subsequently interpreted "on-site" to include the "areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (U.S. EPA, 1988). Presumably, the demilitarization plants would be considered as "off-site" treatment and destruction facilities, thereby requiring all necessary permits, as well as compliance with operating requirements of other federal and state laws. There is precedence, however, for grouping multiple hazardous waste sites at a

single installation, thereby designating the entire installation as "on-site". Thus, operation of a demilitarization plant within overall installation boundaries for destruction of CERCIA hazardous wastes could be considered an "on-site" action, and therefore exempt from the RCRA permitting process. This issue is, however, subject to interpretation, controversy, and potential litigation from states seeking to increase control over CERCLA actions at DOD installations.

The second major impact of SARA on potential future uses of demilitarization plants is the restructuring of the IRP to conform with CERCLA procedures. The use of demilitarization plants for treatment and destruction of hazardous waste recovered from past disposal activities on military installations can only occur as the end result of a CERCLA-type negotiation and agreement process as documented in a Record of Decision. Under SARA, the Department of Defense must negotiate with, and obtain agreement from, the appropriate EPA region, state agencies with jurisdiction over hazardous waste cleanup, local governments, and public interest groups on the final Record of Decision. This will certainly have the effect of introducing delays and potential restrictions (or possibly complete foreclosure) on the potential future use of demilitarization plants at some locations.

In addition to these two major effects of SARA, Title III of SARA, known as the Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA), created broad new requirements for development of community hazardous materials emergency response capabilities and dissemination to the public of information on chemical hazards in their communities and workplaces. EPCRA established a chain-of-command structure extending from state government emergency response commissions to local emergency response committees. The law specifies membership composition of these organizations (e.g., local emergency response personnel, owners and operators of facilities with hazardous chemicals), defines roles for members (planning, training, detection, response, recovery) and specifies conditions under which owners and operators of facilities with hazardous substances must comply with the law (e.g., designation of "threshold planning quantities" of hazardous substances). The law mandates close coordination of hazardous substance emergency capability development with the Federal Emergency Management Agency (FEMA) emergency management programs, and appropriate funds to strengthen FEMA's role in developing and expanding hazardous substance incident response. Of particular importance to owners and operators of facilities covered under EPCRA are requirements for documentation of emergency response plans and the provision of information to government officials and the public on chemical hazards and accidents in their facilities. Included are preparations of Materials Safety Data Sheets for all hazardous substances, Emergency and Hazardous Chemical Inventory Forms, and Toxic Chemical

Release Forms. Facility owners and operators must also provide extension programs for training and protection of employees, including protective equipment, medical surveillance, engineering controls (to reduce exposure), and informational programs on specific workplace hazards. Emergency Preparedness programs have been set up at all chemical demilitarization sites.

As with other federal regulatory programs, states may develop additional or more stringent requirements under EPCRA as long as the federal ones are met.

4.1.1.3 The Resource Conservation and Recovery Act of 1976 (RCRA)

Of all environmental laws and regulations, RCRA has the largest potential to shape the demilitarization future use options. RCRA is an omnibus, "cradle-to-grave" body of federal regulation that is both comprehensive in scope and prescriptive in terms of requirements to be met. It addresses all aspects of hazardous waste generation, storage, transfer, treatment and disposal. Its scope includes current hazardous waste generation and management, as well as the cleanup of previous disposal sites (through its incorporation by reference into CERCLA as an ARAR), and it both incorporates and strengthens the role of states in hazardous waste regulation through delegation of the permitting and enforcement functions. Implications of RCRA on the demilitarization plants are summarized below.

Permits. The permitting process mandates detailed procedures and information requirements. These include specific designations, analyses, and characterizations of hazardous waste streams; development of management, security and emergency response plans; detailed documentation of plant/facility design and operation; exposure assessments; closure plans; and financial reports. For incinerators, conduct of a trial burn (see below) program is also required.

RCRA § 1003(a)(7) establishes a federal-state partnership to assist states in developing permitting and enforcement programs that, ultimately, are intended to supercede the federal RCRA role in approved states (states must comply with RCRA program requirements, 40 CFR 271.13). State requirements for RCRA permits may also be more stringent or comprehensive than federal ones (40 CFR 271.1(i)(1) and (2); 40 CFR 271.14). Full authority for permit issuance and enforcement of permit conditions therefore rests with those individual states participating in the EPA-state programs.

Permits for RCRA-regulated activities are detailed and prescriptive, and are developed for very specific waste compositions and management practices. As a result, any modifications to waste composition and

management practice in a permitted facility necessitate modifications to the permit. EPA has recently adopted a three-tiered approach to permit modifications, based on the nature and degree of modification requested. Procedures to be followed are summarized below:

- Class One Modification - involves administrative changes or replacement of equipment with other functionally equivalent equipment. Does not entail changes to facility operating conditions and/or environmental interaction. Minimal public notification and action from permitting authority required.

- Class Two Modification - includes changes in operating practices to manage wastes that are similar to those for which the facility is permitted, or changes that would enhance capabilities to meet current permit requirements. Procedures require permitting agency approval, full public notice (local media), a 60-day comment period, and an informal public meeting (not a hearing) during the comment period. The public must also be informed by the permitting agency of the facility's compliance history.

- Class Three Modification - includes changes that substantially alter a facility and its operations, such as new waste streams and new treatment practices or technologies. Procedures involve public notification and a comment period for the proposed changes, an informal meeting, public review and comment on the draft proposed permit or permit modifications, and a formal public hearing, if requested.

Adoption of these new permit modifications practices is not binding on state permitting agencies with federally-approved RCRA permitting and enforcement programs.

Incinerator Operating. Standards. RCRA-derived regulations (40 CFR 264, Subpart 0) apply to all facilities that incinerate hazardous wastes. Requirements of this Subpart include preparation of a waste analysis to bound the physical and chemical characteristics of incinerator feed, identification of Principal Organic Hazardous Constituents (POHCs) in the waste feed, and conduct of a successful trial burn. Any modifications to waste feed or incinerator operation requires a new or amended incinerator permit (40 CFR 264.344), with specific modification procedures determined by either the new, three-tiered EPA approach or else in accordance with individual state permitting requirements.

For hazardous waste incinerators to be RCRA-permitted, a trial burn program must be successfully completed. During the trial burn, facility operating parameters are verified, and compliance with applicable RCRA standards for hazardous waste incinerators is verified under the

anticipated range of facility operating conditions. General performance standards (40 CFR 264.343) to be demonstrated in the RCRA trial burn are:

1. 99.99 percent destruction removal efficiency (DRE) of all principal organic hazardous constituents of the input waste streams (higher DREs are required for chemical agents, dioxin and dibenzofuran-containing wastes: 99.9999 percent).*

2. 0.08 grains/dry standard cubic foot (gr/DSCF) particulate emissions corrected to 7 percent oxygen.**

3. 4 pounds/hour hydrogen chloride (HCl) gaseous emissions or a 99 percent removal efficiency.***

The trial burn program must be carefully planned and executed since the results will (1) determine whether or not a permit will be granted, and (2) become the explicit permitting conditions for incinerator operation. The trial burn should therefore be based on combustion of wastes (or simulated waste streams), which both qualitatively (i.e., physical state) and quantitatively (i.e., composition) bound the anticipated waste feed characteristics for incinerator operation. Of particular importance is designation of the POHCs in the waste feed. These are chemical compounds or substances listed in 40 CFR 261 Appendix VIII, that have either been determined by analysis to be contained in the proposed waste streams, or that have been designated as anticipated waste feed constituents. The POHCs must be selected on a "worst case" basis to bound waste feed

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*EPA has proposed extension of RCRA Subpart 0 incinerator emissions standards to include products of incomplete combustion (PICs) as well as POHCs. Regulatory approaches proposed by EPA are twofold: (1) a risk-based standard for hydrocarbon emissions using established methods to demonstrate that PIC emission rates would not pose unacceptable levels of health risk, or (2) a technology-based demonstration that hydrocarbon emissions are below required levels as assured by combustion efficiency, which is indicated by stack gas carbon monoxide (CO) levels (55 FR 17864 [April 27, 1990]).

**EPA has proposed to expand regulation of particulate emissions to include risk-based limits for metals listed in 40 CFR 261, Appendix VIII (ibid., p. 17863).

***EPA has proposed that the present standard for HCl emissions of 4 pounds/hour be revised to a risk-based methodology to be applied on a case-by-case basis (ibid., p. 17864).

quantity (the POHC of highest concentration) and combustibility (the POHC with the lowest heat of combustion). In many cases, these two bounds will be met by different POHCs, so more than one may be specified in the trial burn (and permit) conditions. The trial burn plan is submitted to the EPA Regional Director for review and approval, or to the appropriate state regulatory agencies in states with approved RCRA permitting programs.

Modifications to waste feed will require new amended RCRA permits. A Class Three Modification, in which one or more POHCs are to be changed, would require a trial burn if the new POHC is either higher in concentration or more difficult to burn than those specified in the existing permit.

Corrective Actions. RCRA Sections 3004(u) and (v) allow EPA (or states) to require cleanup of hazardous waste releases from previous or ongoing hazardous waste management operations at a facility, and RCRA Section 3008(h) authorizes imposition of a corrective action as a condition for issuing a RCRA permit. Thus, RCRA establishes potential linkages between issuance (or amendment) of a demilitarization plant RCRA incinerator permit and corrective actions at the same installation, even though the incinerator may not be part of the corrective action. Also, corrective actions do not require the documentation of the decision process as occurs under CERCLA cleanups. Part B RCRA applications for each of the CSDP sites, except APG, addressed corrective actions for these installations. APG corrective actions had been addressed in a previous Part B submission.

Transoortation. While the detailed requirements for transportation of hazardous wastes under RCRA have no direct bearing on future uses of demilitarization plants, language in 40 CFR 271 helps to assure that wastes from other DOD installations can be transported interstate to demilitarization plants for treatment and disposal. This potential use option can therefore remain open both under RCRA and under provisions of Hazardous Materials Transportation Act (see 4.1.1.8 below). (States may take regulatory action to restrict fntrastate hazardous waste shipments as described in section 4.1.3 below.)

Storage. Storage of hazardous wastes without a RCRA storage facility permit is limited to 90 days or less (40 CFR 262.34(a)). Future use activities involving recovery of hazardous materials (e.g., CERCLA-type cleanups of burial sites) or interim storage of other hazardous wastes must, therefore, not exceed the 90-day period, or otherwise must be carried out in conjunction with fully-permitted hazardous waste storage facilities.

Closure. Closure refers to those actions necessary to terminate hazardous waste treatment and disposal operations in such a manner as to eliminate threats to human health and the environment. For a treatment facility

(incinerator), closure under RCRA would be a "clean closure" in which all remaining hazardous wastes and residues are certifiably removed from the incinerator site, thereby effectively eliminating any subsequent "post-closure" requirements (e.g., extended groundwater monitoring). Incinerator operators must be able to demonstrate that any residue removed from the incinerator facility during operations or at closure is not a hazardous waste, or else certify that the hazardous waste is disposed of according to applicable RCRA regulations (e.g., at a permitted landfill or impoundment) (40 CFR 264.351).

4.1.1.4 The Clean Air Act of 1955 (GM)

The Clean Air Act and its various amendments incorporate state and local regulatory involvement to a greater degree than any other body of environmental regulation affecting the future uses of demilitarization plants. Although federal standards and regulations have been developed, these are considered only as the national regulatory framework for use by states and local or regional governments in developing and enforcing their own air quality regulatory programs. Although states therefore have extensive roles in air quality regulation, the Federal Government, through EPA, does have a significant role in developing standards, providing guidelines, and assuring minimum compliance with state programs. In section 4.1.3, the state role in environmental regulation is discussed; the subsections below provide a review of the principal federal role in air quality regulation.

National Ambient Air Quality Standards (NAAQS). The Clean Air Act Amendments of 1970 established national ambient air quality standards (NAAQS) for certain pollutants. These standards concern ambient air quality and, therefore, indirectly apply to permitting of specific activities in a given area, or air quality control region (AQCR). For installations in areas that are in attainment for criteria pollutants, a prevention of significant deterioration (PSD) permit is required. The PSD permit is issued on the basis of a facility's demonstrated ability to not result in any violation of AAQSs through the application of Best Available Control Technology (BACT). For areas that are in nonattainment for one or more criteria pollutants, major new stationary sources, or a major modification to an existing source, must pass a New Source Review prior to obtaining a permit. Principal federal requirements are technology-based accomplishment of the lowest achievable emission rate (LAER), the most stringent level of technical control; certification that all other DOD emission sources on an installation or within the state are in compliance; and obtaining emission reductions from other existing sources in the AQCR to more than offset the effects of the proposed facility (the so-called "Offset Rule").

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National Emission Standards for Hazardous Air Pollutants (NESHAPs). NESHAPS are source-specific emission standards for identified hazardous chemical air pollutants. EPA lists pollutants for NESHAPs based on risk assessment and health effects methodology. States play an important role in this area of air quality regulation. Upon EPA approval, states may implement their own Air Toxics Programs with varying requirements and enforcement approaches (as long as they comply with overall federal program requirements). Many states are developing more extensive regulations concerning specific pollutants. Wide variability therefore exists between state-level Air Toxics programs.

New Source Performance Standards (NSPS). The New Source Performance Standards are source emission standards established by EPA for all new, modified, or reconstructed stationary sources. Because of plant size, the NSPS are most likely to be the major CM requirement for demilitarization plants. Specific incinerator standards are in 40 CFR 60.50-53. Determination of major source status is dependent on specific pollutant emission rates and state definitions of major sources. As with other elements of CAA regulation, the states may administer the permitting and enforcement of NSPS, and may elect to apply more stringent standards than those of the federal regulations.

4.1.1.5 The Clean Water Act of 1977 (CWA)

The Clean Water Act would have limited application to future uses of demilitarization plants unless design or operations are changed such that wastewater is discharged from the plant to the surface water environment. If this is the case, the plants would be subject to the requirements of a National Pollutant Discharge Elimination System (NPDES) permitting process and enforcement of regulations and permit conditions.

Discharge requirements (pollutant concentrations) from point sources are determined on a case-by-case basis, and pollutant removal requirements are technology-based; conventional pollutants require best conventional technology (BCT), and toxic and nonconventional pollutants require best available economically achievable technology (BAT). Water quality standards are determined by individual states in cases where states have EPA-approved water quality programs. States may also develop more stringent standards of their own.

4.1.1.6 The Toxic Substances Control Act of 1976 (TSCA)

The Toxic Substances Control Act, or TSCA, provides federal regulation over specific chemicals or mixtures that pose an imminent hazard. Of significance to potential uses of demilitarization plants are TSCA regulation of polychlorinated biphenyls (PCBs) and asbestos--both of which could be contained in potential feed to demilitarization plants.

TSCA sets specific handling, storage, and disposal requirements for PCB liquids and PCB-contaminated equipment. Disposal (including thermal destruction of PCBs in containers or equipment) is to be in a TSCA-compliance incinerator that meets the operating requirements of 40 CFR 761.70 as approved by the appropriate EPA Regional Administrator. CSDP plants will require design and operating capabilities for PCBs since some M55 rocket shipping and firing tubes are contaminated with PCBs from the fiberglass manufacturing process. Therefore, the DFS/PAS subsystem meets the regulations for disposal of liquid PCB.

Asbestos contaminated building materials resulting from demolition of structures that are candidate feedstocks for future plant use must be handled in accordance with 40 CFR 61.152. Incinerator requirements under 40 CFR 61.152 include operation with no visible emissions and proper disposal of friable asbestos residues.

4.1.1.7 The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA)

The Federal Insecticide, Fungicide, and Rodenticide Act regulates the sale, distribution, and use of pesticides. This includes the storage and disposal of pesticides and pesticide containers. Amendments to FIFRA made in 1988 expanded the scope of FIFRA to include enforcement authority and more detailed regulation. At present, FIFRA requirements are recommendations since publication of detailed regulations are pending. Current FIFRA guidelines for disposal include incineration of organic pesticides, and chemical and physical treatment of organometallic pesticides prior to incineration to remove metals. Thus, use of a demilitarization plant for pesticide disposal may require pretreatment or processing of pesticides to remove metals before incineration. Current recommendations for disposal of pesticide containers are in 40 CFR 165.9.

4.1.1.8 Other Federal Regulations

Public Law 99-145, which is the enabling legislation for the DOD effort to destroy the remaining U.S. stockpile of unitary chemical weapons, also directs the Army to dismantle the demilitarization plants upon completion of their mission at each location. Obviously, this requirement has the most direct regulatory impact on future use of the demilitarization plants. The feasibility and desirability of using these plants is the focus of this study.

A Congressional initiative would be necessary to change PL 99-145 (as opposed to one that originates in a federal agency). Consequently, a legislative EIS would not be included in the initial congressional recommendation although the Congress could request that the implementing agency for future use of the demilitarization plants, the Army, prepare

one. A more likely approach would be an amendment or supplement to the already-existent site-specific EIS for stockpile disposal to cover the various identified future use options after changing PL 99-145. The process of reopening, draft EIS amendment review, and public hearings would then take place at each demilitarization plant site and for each intended future use.

Other federal statutes impacting the future operation of demilitarization plants include various OSHA (Occupational Safety and Health Act) requirements for workers who handle hazardous materials. Title 29 of the Code of Federal Regulations details regulations concerning handling and exposure protection levels for numerous hazardous and toxic materials.

Public Law 91-121, as amended by Public Law 91-441, places restrictions on the transportation and disposal by the Department of Defense of any lethal chemical or any biological warfare agent in the United States. Specifically, the law includes requirements that the Secretary of Defense determine that such transport and disposal is necessary to national security; that the Public Health Service review the transport and/or disposal to identify potential hazards to public health and safety and recommend precautionary measures; and that these precautionary measures be verifiably implemented before transportation and/or disposal takes place. This law would most directly impact future uses where chemical munitions or other chemical warfare items recovered from burial or storage sites at one installation are proposed for transport to a demilitarization plant for disposal at another site. In cases where the Public Health Service (i.e., the Surgeon General of the United States) determines that the shipment poses unacceptable hazards to public health and safety, the shipment or disposal operation could be blocked, pending a review by the President to override the Surgeon General's determination (Public Law 91-121, § 409 (a) (3)). However, §506 (b) (4) allows shipment and disposal of chemical agent ". ..in emergency situations" to take place without the previously described restrictions if compliance "...would clearly endanger the health or safety of any person." Thus, removal of range-recovered munitions to safe areas for storage and disposal could take place, and has been done in instances where buried items have been uncovered and are endangering public safety. Public Law 91-441 additionally requires that all chemical or biological warfare agents be "...detoxified or made harmless to man and his environment..." before disposal (Public Law 91-441, § 506 (d)).

One additional federal statute that has particular impact on future use options is Public Law 98-407 (§ 2692) that prohibits the Department of Defense from using any DOD installation for the storage or disposal of any hazardous or toxic materials ". ..not owned by the Department of Defense." This law, therefore, effectively forecloses the option of utilizing a demilitarization plant owned by DOD on a DOD installation for treatment

and disposal of non-DOD municipal or commercial hazardous wastes. For this usage to occur without changing P.L. 98-407, the demilitarization plant and property would either have to be excessed or the plant dismantled and removed, and custody of the equipment transferred to others.

The transportation of all hazardous materials in the United States is regulated under the Hazardous Materials Transportation Act of 1975 (P.L. 93-633). As with major federal environmental laws, regulatory responsibility for the HMTA is delegated to individual states, and this results in considerable variation in requirements between states. Unlike environmental regulations, however, the HMTA places some limitations on states developing more comprehensive or stringent regulations if they are determined by the Secretary of Transportation as being "inconsistent" with federal law. State laws must not "unreasonably burden commerce" (§ 112 (b)), and the Secretary of Transportation may, therefore, preempt state laws on this basis. Nevertheless, within their framework, states may and do implement additional requirements, such as routing restrictions, curfews, notification, and public right-to-know requirements (Office of Technology Assessment, 1986).

4.1.2 U.S. Army Regulations Affecting Future Uses

Two major Army regulations affect the selection of future use options and the operation of demilitarization plants. They are AR 200-1, Environmental Protection and Enhancement; and AR 200-2, Environmental Effects of Army Actions. Of these, AR 200-l is most significant at the operations level as it sets forth the detailed environmental operating and management requirements for all Army activities. AR 200-2 is the Army's NEPA compliance document that details the procedures and requirements for analyzing all environmental consequences of Army actions.

4.1.2.1 AR 200-1, Environmental Protection and Enhancement

AR 200-l codifies the procedures, policies, and responsibilities of the U.S. Army to protect and preserve the quality of the environment, This includes compliance with all applicable federal environmental regulations: NEPA (Chapter 1, paragraph 1-39 (1)); RCRA (Chapter 6, 6-l); CERCLA and SARA (Chapter 9, 9-l); CM (Chapter 4, 4-land 2); CWA (Chapter 3, 3-2); TSCA (Chapter 5, 5-1 (b) (2)); and FIFRA (Chapter 5, 5-l (b) (1)). In addition, the individual chapters of AR 200-l concerning hazardous waste management, air quality, and water quality state that it is the Army's policy to comply with all applicable local and state regulations and permitting requirements under these basic environmental headings.

Beyond these basic compliance requirements, AR 200-L also contains additional regulations that may affect the selection and implementation of demilitarization plant future uses. These are highlighted below.

Non-DOD Wastes. As stated in section 4.1.1.8 above, Public Law 98-407 prohibits treatment and disposal of non-DOD hazardous wastes at DOD installations and facilities. This is incorporated into AR 200-l through reference and quotation at 5-4(a)(l): "...the Secretary of Defense may not permit the use of an installation of the Department of Defense for the storage or disposal of any material that is a toxic or hazardous material and that is not owned by the Department of Defense". AR 200-L (l-35 (a)(6)) extends this same restriction to government-owned contractor-operated (GOCO) facilities.

Offsite and Coonerative Programs. Two regulations in AR 200-l concern Army participation in offsite hazardous waste disposal programs. Chapter 6, 6-2(3) "[e]ncourage[s] the use of joint or regional resource recovery or waste treatment facilities with federal and nonfederal agencies (including commercial waste treatment facilities) when advantageous, cost-effective, or more efficient to the Army". Similarly, 6-4(f)(2) authorizes installation commanders to "...enter into agreements with local, State or Federal agencies to participate in construction of regional treatment and disposal facilities on other than Army-owned property." Both regulations suggest that demilitarization facilities could either be excessed or dismantled and plant components transferred to a regional cooperative or multi-use hazardous and solid waste disposal facility.

erial al of Conventional Ordnane and Related Mat Chapter 6 (6-7) establishes Army policies for application of hazardous waste management requirements *to* the demilitarization of conventional munitions and ordnance, including propellant, explosive, and pyrotechnic materials (PEP). Section 6-7(d) defines the point at which munitions and ordnance become waste to be when it is so designated by Army officials. At this point in the life cycle, all such materials become subject to RCRA hazardous *waste* management requirements, and this is formalized when the ammunition transfer record is signed, indicating the receipt of the munitions or ordnance at a demilitarization facility (e.g., an incinerator) (6-7(e)). Section 6-7(h) further requires that RCRA apply to disposal operations and that any remaining residue (ash or sludge) is subject to regulation and must be handled as a RCRA solid waste if it is listed in RCRA or exhibits RCRA hazardous waste characteristics. Section 6-7(k) excludes small arms ammunition (DOT class C or type 1.4) from RCRA disposal requirements.

4.1.2.2 AR 200-2, Environmental Effects of Army Actions

AR 200-2 is the Army's basic policy statement on compliance of its activities with the National Environmental Policy Act, or NEPA. It sets forth procedures, processes, and decision criteria for the conduct and documentation of environmental analyses of Army actions, programs,

projects, and activities of the Army, and it establishes criteria for determining categorical exclusion from requirements to prepare environmental impact statements.

Alternative uses of demilitarization plants would require environmental evaluations as documented in an environmental assessment or, if required, an environmental impact statement (or supplement to an existing one).

4.1.2.3 AMC-R 385-131, Safety Regulation for Chemical Agents H, HD, HT, CB, and VX

This is the basic regulation covering all safety aspects of the handling, storage, disposal and personnel protection from chemical warfare agents. Any future use of the demilitarization plants involving disposal of chemical warfare stocks and items (i.e., range-recovered chemical munitions, contaminated equipment, building rubble, etc.) are to be fully in compliance with AMC-R 385-131. This regulation reiterates Army compliance with applicable local, state, and federal RCRA requirements and regulations (AMC-R 385-131, 5-2).

4.1.3 Overview of State Regulatory Roles

It is a well-established policy of the federal government to encourage, develop, and support the delegation and the implementation of environmental regulations to individual states. In so doing, federal environmental protection initiatives have been and are continuing to be developed as national standards for minimum compliance by the states. States may apply for full or partial delegation of authority and, upon federal agency (EPA) approval, may undertake responsibility for their own environmental regulation.

In addition to delegation of federal regulations, states may also develop their own environmental regulation and enforcement programs. Federal statutes, in many cases, allow individual states to develop more stringent requirements than those provided under federal regulations. States may also develop additional regulations and requirements that do not have federal counterparts. As a general rule, state regulations that parallel federal regulation must be equivalent to or more stringent than their federal counterparts; state regulations without federal counterparts require no federal authorization and may be applied independently.

The impacts of such regulations on the demilitarization plants--during the CSDP, as well as any future use--can be major. For example, the State of Kentucky has proposed an incinerator emissions standard for dioxin and furans that will require a minimum two-second afterburner residence time. This has doubled the present design residence time for the demilitarization plant afterburners and has necessitated significant design changes.

Kentucky has also delegated jurisdiction for issuance of incinerator permits to individual counties, thereby introducing an additional level of regulatory uncertainty. Other examples of more stringent or additional state laws are Utah's requirement for 0.02 grains per dry standard cubic foot particulate emissions rate, which is one quarter of the federal requirement, and Maryland's regulation requiring zero opacity (no visible particulates) in the stack emissions.

Table 4-2 summarizes the relationship of federal laws to regulation at the state level for those areas of federal regulation with greatest potential significance to the various future use options. As is evident in the table, both the scope and potential impact of state regulation on future use initiatives are extensive. Indeed, state regulations may become the limiting factor in determining future uses at some locations. Also, the continuing evolution of both federal and state regulations, and the variations in requirements and regulatory approaches from state to state, combine to introduce considerable uncertainty into the project planning cycle. Inevitably, each plant and, in turn, each application at each plant, must proceed on a case by case basis with the exact regulatory outcome largely unknown in advance. As a minimum, projected future use strategies should be added to the agenda of the programmatic and site-specific intergovernmental consultation and coordination boards to help address state, local, and public concerns, and relationships between the Army and each community.

4.2 ACCEPTABILITY TO THE PUBLIC OF FUTURE USES OF THE CHEMICAL DISPOSAL FACILITIES

Public acceptability of future use of the chemical disposal facilities varies among the nine plant sites, and also according to the generic types of uses considered. In general, patterns of public opinion about future use parallel those for the CSDP although the basic concept of future use has not yet received widespread consideration in the communities involved due to limited publicity and the longer time frames involved (post-CSDP operations).

Among communities that are supportive of future use of the demilitarization plants, some concern has been raised over the uses of the plants for treatment of hazardous wastes brought from outside the specific community or region. Citizens have stated that they do not want their communities to become disposal sites for others' hazardous wastes. In areas where there is general support for the demilitarization program and for future use of the plants, the primary benefit is perceived as being economic (jobs, revenues) although use of the plants to solve environmental problems is

Table 4-2. Overview of State Roles in Environmental Regulation

Federal Law	State Role(s)	Relationship of State Regulations to Federal Laws	Provisions for Broader, More Stringent Regulation5
National Environmental Policy Act (NEPA)	Moderate: ● Review Draft, Final EIS, comments to federal agencies	● Comply with NEPA process	Not Applicable
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Potentially major: ● Party to Record of Decision (ROD) at all federal facilities • Regulation of cleanups through ARARs . Issue permits if RCRA applies (off-site remediation)	● Must comply with federal rules, procedures to decide cleanup (RODs) • Must meet federal standards 55 a minimum for RCRA-regulated cleanups	• ARARs on RCRA-regulated cleanups may include all additional state regulations (more comprehensive or stringent
Resource Conservation and Recovery Act (RCRA)	Major: • Issue permits and enforce regulations for 511 treatment and disposal facilities	• Must be federally authorized program • Equivalent to and consistent with federal programs as a minimum • ♦♦⊗♦ℳ• ○♦•♦ ■□♦ □ℳ•♦□⊀ℳ♦ interstate hazardous waste transport ● State regulations must be "consistent with federal laws"	. Additional stat. regulations may be more stringent and comprehensive

Table 4-2. Overview of State Roles in Environmental Regulation (Continued)

Federal Law	State Role(s)	Relationship of State Regulations to Federal Laws	Provisions for Broader, More Stringent Regulations
Clean Air Act (CM)	Major: • Develop air quality state Implementation Plans to enforce National Ambient Air Quality Standards • Issue permits and enforce regulations - NSPS - NESHAPS	• Federal Government retains authority to develop new national standards • States must meet all requirements for National Air Duality Standards	• May adopt more stringent regulations or control strategies than necessary to meet federal requirements - Toxic Air Pollutants (TAP) Program
Clean Water Act (CWA)	Major: • Issue NPDES permits and enforce all provisions in accordance with national effluent limitations guidelines	• Federal government retains authority for national affluent guidelines • States must meet all federal requirements	• May adopt more stringent regulations
Toxic Substances Control Act	Insignificant: • States may receive federal funding for independent programs to address chemical hazards - Complement, but not replace federal regulation	• Federal Government retains most regulatory authority	• No state regulatory authority

Table 4-2. Overview of State Roles in Environmental Regulation (Concluded)

Federal Law	State Role(s)	Relationship of State Regulations to Federal Laws	Provisions for Broader, More Stringent Regulations
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	None	None	Not applicable
Hazardous Materials Transportation Act (HMTA)	Limited: • Some enforcement of federal regulations • States may develop some regulations over intrastate shipments	• Federal government retains primary authority for regulations • State regulations must not be inconsistent: - Preempted by federal standards - Subject to DOT review. judicial process	• [illegible]

NSPS = New Source Performance Standards
NESHAPS = National Emission Standards for Hazardous Air Pollutants
NPDES = National Pollution Discharge Elimination System
EIS = Environmental Impact Statement
ROD = Record of Decision

also viewed as a positive attribute. In at least four communities, the concept of alternative future uses has received some preliminary discussion although, as of late 1990, no official inquiries concerning these proposals had been received by the Army.

In almost all areas, the central concern beyond use of the facility for wastes brought from outside, is public safety and environmental protection. Even in areas that are supportive of the demilitarization program, public attention is focused on the need to assure safe and environmentally sound plant operation. In most instances, environmental concerns have been advanced by national environmental interest groups and their local affiliates although in at least two instances, citizens have organized locally to oppose construction of the CSDP plants in their communities. In cases where community opinion is negative, opposition is not directed specifically toward the program approach chosen by the Army for the CSDP plants, as much as toward the concept of hazardous waste incineration in general. Residents seem to be as concerned about incineration as a remediation process as they are about the potential risks of continued storage of hazardous wastes.

This is reflective of a broader trend concerning the perception of risk versus actual, quantifiable risk levels. Recent studies (e.g., Slovic, 1987) analyzing reaction to risk indicate that for certain kinds of issues the public relies more on intuitive and subjective judgement about risks and less on any objective or quantifiable measures of risk, such as those used by experts in the field. These perceptions of risk, in turn, appear to be shaped by certain common, perceived characteristics about the nature of a given risk. For instance, the public perceives the risks of nuclear power, nuclear waste, or chemicals in the environment as being uncontrollable, potentially catastrophic in at least long-term effects (e.g., induced cancers), and involuntary (people feel that they are being subjected to risks against their will). On the other hand, risks associated with driving, recreational sports, or smoking are perceived as controllable (at least to some extent), less catastrophic in consequence, and more voluntary in nature. Previous experience and familiarity with a given risk seem to make that risk more acceptable. Thus, although driving a car and smoking cigarettes result in far more casualties per year than nuclear power plants, chemical process plants, or accidents involving chemical weapons, the public is far more tolerant of the former class of hazards than the latter. Hazardous waste incinerators, and the perceived possibility for harmful emissions from them, belong in the public's mind to the class of risks regarded as uncontrollable and possibly harmful to large numbers of people, even though rigorous evidence of any such effects is lacking. This perception, more than any objective measure of risk, may result in public concern about the CSDP and potential future uses of the chemical disposal plants.

The law also needs to be clarified with respect to using the plants for disposal of non-stockpile chemical surety material. These items are not included in the list of chemical stockpile items existing on the date of enactment of PL 99-145. However, the law states that "facilities constructed to carry out this section '(destruction of existing stockpile of lethal chemical agents and munitions)' may not be used for any purpose other than the destruction of lethal chemical weapons and munitions, and when no longer needed to carry out this section, such facilities shall be cleaned, dismantled, and disposed of in accordance with applicable laws and regulation." This could be interpreted as allowing the use of the plants to dispose of range-recovered munitions containing or suspected of containing agent, as well as for disposal of any unwanted neat agent. Any use of the facilities for such purpose would need to be specified in any applicable facility permits in any case.

Public Law 98-407. This law, and its corresponding Army regulation (AR 200-1, 1-35 [a][6]), prohibit the use of any DOD facility for the storage or disposal of any non-DOD toxic or hazardous wastes. Thus, PL-98-407 will have to be changed to permit any future uses involving disposal of non-DOD wastes in any facility that remains in DOD custody, should such uses be considered desirable.

CERCLA. With the enactment of SARA, cleanup actions at DOD installations previously exempted from CERCLA requirements became subject to CERCLA procedures and subject to other environmental laws and regulations as a result of their being determined applicable, relevant, and appropriate (ARAR). As a result, RCRA, the Clean Air Act, the Toxic Substances Control Act and all other federal, state and local regulations and permitting requirements are potentially applicable to CERCLA actions at federal facilities. CERCLA § (2) (e), however, exempts CERCLA actions from RCRA permits if the remedial action is "on site", and meets the technical requirements of applicable laws and regulations (see section 4.1.1.2). The EPA has interpreted "on site" as including only the area1 extent of contamination and any contiguous area required for implementation of the response actions. Therefore, a demilitarization plant at an installation would require a RCRA incinerator permit or modifications to allow use in the remedial action, even though it is within the same installation boundaries. CERCLA § 121 could be amended to allow use of demilitarization plants (as well as other installation treatment and disposal facilities) for CERCLA-type remedial actions on DOD installations without the need for a RCRA permit, as long as applicable or relevant and appropriate standards are met, as is presently the case with the EPA-defined "on site" remediations. A clarification or amendment of this type could facilitate use of demilitarization plants for the cleanup of waste sites at federal facilities if their use for this purpose is otherwise feasible or desirable.

Table 4-3. Summary of Public Perceptions Concerning the CSDP and the Proposed Future Use of Demilitarization Plants

Plant	Use Category: CSDP in General?	Other Installation Wastes?	Local or Municipal Hazardous Wastes?	Military or Civilian Hazardous Wastes from Outside Areas?
Aberdeen Proving Ground, MD	-1	-1	-1	-2
Lexington/Bluegrass Army Depot, KY	-2	-2	-2	-2
Newport Army Ammunition Plant, IN	-1	-1	-1	-2
Anniston Army Depot, AL	2	2	0	-1
Pine Bluff Arsenal, AR	2	2	2	1
Pueblo Depot Activity, al	0	0	0	-1
Tooele Army Depot, UT	1	1	-1	-1
Umatilla Depot Activity, OR	1	1	1	1
Johnston Atoll Chemical Agent Disposal System	-1	-2	NA	-2

Key: 2 = Strongly Supportive, 1 = Supportive, 0 = Neutral, -1 = Opposed, -2 = Strongly Opposed.

At present, no community groups or private concerns are proponents of any future use of the plant.

4.2.2 Lexington-Blue Grass Army Depot, Kentucky

The Blue Grass Activity (area) of Lexington-Blue Grass Army Depot (LBAD) is located in central Kentucky, about 30 miles southeast of Lexington (population 204,000) near the city of Richmond, Kentucky (21,000). There is widespread and well organized opposition to the construction and operation of the demilitarization plant at the Blue Grass area of the depot, and presumably to any future use of the plant (Mead, 1990). Residents have objected to the presence of incinerators on environmental and safety grounds, and have successfully pressured the Kentucky legislature into passing laws that impose stringent standards on incinerators and that delegate incinerator permitting authority to county governments. Use of the facility at Blue Grass after completion of the CSDP is expected to draw considerable local opposition.

4.2.3 Newport Army Ammunition Plant, Indiana

Newport Army Ammunition Plant is an inactive production facility (a portion is currently maintained in a "standby" condition for TNT manufacture) located in western Indiana, about 25 miles north of Terre Haute (population 61,000). A group of area residents has mounted a campaign against the CSDP plant at Newport on the grounds that it could become a "permanent fixture" used for disposal of toxic wastes from outside the area. Several thousand area residents have signed a petition opposing construction of the incinerator at NAAP (Crittenden, 1990).

The mayor of Terre Haute has publicly expressed an interest in investigating use of the NAAP incinerator as a regional municipal solid waste disposal facility, but no formal study of this suggestion has yet been undertaken (Pastore, 1990).

4.2.4 Anniston Army Depot, Alabama

Anniston Army Depot (ANAD) is located in northeast Alabama, about 10 miles west of Anniston (population 29,000). The Depot, along with Fort McLellan, are the region's major employers.

Citizens and communities around ANAD are supportive of both the CSDP and future use of the ANAD demilitarization plant. During public hearings on the CSDP Environmental Impact Statement, the wisdom of closing and dismantling the plant after its initial mission is completed was questioned.

Use of the ANAD facility to dispose of waste streams at ANAD, and possibly from the community itself, is considered acceptable by the local population, but transportation of hazardous wastes to ANAD from other installations or from out of state would be widely opposed. This parallels public sentiments and recent state government attempts to restrict out-of; state waste shipments to a large commercial hazardous waste landfill located elsewhere in the state.

At least one proposal for future use of the CSDP has been informally discussed with the Army, and this is use of the plant as a local/regional facility for hospital waste. In 1987 correspondence, the Stringfellow Memorial Hospital administrator discussed the need for a regional multiuse hazardous waste facility at Anniston with the Installation Commander for Fort McClellan, with one use being destruction of hospital and medical waste- -a need also facing Fort McClellan. No formal analysis of this proposal has yet been conducted by the Army or by the interested parties.

4.2.5 Pine Bluff Arsenal, Arkansas

Pine Bluff Arsenal (PBA) is located near Pine Bluff, Arkansas (population 56,000). PBA has received broad-based community support for future use of the CSDP plant to be built at PBA, as well as interest in use of the now inactive BZ destruction facility. The local news media have also raised the issue of allowing future use of the PBA facilities. Specifically, the Mayor of Whitehall, Arkansas, a nearby community, expressed an interest in exploring use of the BZ incinerator facility although no specific proposal has been put forth. Also, local news media suggested possible use of the CSDP plant to destroy dioxin-contaminated wastes currently stored at the Vertac, Inc. chemical plant in Jacksonville, Arkansas, about 60 miles north of PBA. No other specific proposals for use of the PBA plants have been publicly disclosed at this time.

4.2.6 Pueblo Depot Activity, Colorado

The Pueblo Depot Activity (PUDA) is located in southeast Colorado, about 15 miles east of Pueblo (population 101,000). PUDA has been scheduled for realignment after the completion of the CSDP, so future use of the plant may be favorably received due to its potential to retain jobs in the community. An ad-hoc group of local residents and governments is studying alternatives for development of the entire PUDA property after realignment and included among these is the use of the CSDP plant for hazardous waste disposal. At present, however, no specific proposals for use of the plant have been publicly discussed. There is, at present, no significant local opposition to the CSDP plant at PUDA, although conservation and environmental groups in Colorado have expressed concerns over operation of the plant and transportation of hazardous wastes from outside locations (including Rocky Mountain Arsenal) to the plant site.

4.2.7 Tooele Army Depot, Utah

The CSDP operations are located in the South Area of Tooele Army Depot (TEAD), which is 25 miles south of Tooele (population 26,000) and 50 miles southwest of Salt Lake City, Utah.

To date, there has been little public opposition to the CSDP or to the notion of using the demilitarization plant for disposal of other installation waste streams. However, expanding the plant's function to include disposal of wastes from off the installation or from any non-DOD sources would likely encounter opposition and most especially if wastes are to be brought from out of state. Local business concerns engaged in hazardous waste treatment and disposal (including incineration facilities in the West Desert Hazardous Industry Area) have expressed strong opposition to allowing non-military use of the TEAD demilitarization plant on the grounds that it would compete with their capabilities (Bern, 1990). Local media have echoed these concerns, stating that the area does not need another (commercial) hazardous waste incinerator (Tooele Transcript-Bulletin, 1990).

4.2.8 Umatilla Depot Activity, Oregon

Umatilla Depot Activity (UMDA) is located in northwest Oregon, near the town of Hermiston (population 9,400) and along the Washington state border. UMDA has been scheduled for realignment after the completion of the stockpile destruction program. There is considerable community interest in developing the entire facility, including the CSDP plant, for alternative uses. A local concern, the Hermiston Economic Development Company, is presently exploring potential commercial (private sector) uses for the Depot, and the CSDP plant is being considered for use as a regional hazardous waste facility (Cockle, 1990). Specific proposals for its use have not yet been developed.

In general, the community around UMDA is supportive of the CSDP and future use of the demilitarization plant. There has been some opposition to the plant on environmental grounds from groups elsewhere in the state, however.

4.2.9 Johnston Atoll Chemical Agent Disposal System

Located on a remote atoll in the Central Pacific, about 720 miles southwest of Hawaii, the Johnston Atoll Chemical Agent Disposal System (JACADS) is in an unincorporated territory of the United States. As such, there is no indigenous community or proximate regional population base, but the construction and operation of JACADS has drawn increasing international public opposition. This opposition was focused by a 1990 U.S. government decision to transport chemical munitions from the Federal Republic of Germany to Johnston Atoll for storage and eventual destruction in the

JACADS plant. Hawaii's state legislature has adopted a resolution opposing shipment of the European munitions to Johnston Island, and the Federated States of Micronesia have registered a formal protest with the U.S. Department of State. Fears motivating this opposition are (1) a transportation accident releasing agent to the ocean environment, and (2) prolonged effects of incineration emissions on the Pacific Ocean ecology. Much of the controversy has centered on objections by the "Greenpeace' organization, which has stated its opposition to incinerating chemical agents at Johnston Atoll, but has offered no alternative except continued storage. Their allegations were refuted in a recent report of the Australian Peace Research Center (Findlay, 1990).

President Bush has recently stated that no additional chemical munitions will be sent to Johnston Atoll excepting WWII munitions of U.S. manufacture recovered in the Pacific area. Recent discovery of such items in the Solomon Islands is currently being addressed.

4.3 ALTERNATIVE PROCESSES AND TECHNOLOGIES FOR DISPOSING OF PROPOSED FUTURE USE FEEDSTOCKS

This section discusses the desirability of future use of the chemical demilitarization plants on the basis of economics. The economics of future use depends, in part, on the availability and cost of alternatives (generally conventionally used methods) to the use of the chemical demilitarization plants for a particular purpose. In this section, alternative methods to the use of the chemical demilitarization plants for each of the following purposes are discussed:

- Demilitarization of conventional munitions.
- Demilitarization and/or decontamination of nonstockpile items including range-recovered chemical munitions and empty XXX agent ton containers.
- Decontamination of buildings and equipment that are considered potentially contaminated with agent or other hazardous substances.
- Remediation of contaminated soils.
- Disposal of industrial hazardous waste (DOD and non-DOD).
- Disposal of conventional trash.

Cost estimates are provided and compared for using the chemical demilitarization facilities and the alternative methods for each of the above uses. Assumptions used to develop the costs are provided in

appendix E. The cost numbers have high uncertainties and are only useful for comparative purposes. Actual costs based on detailed engineering calculations are likely to be significantly different. However, we would not expect more accurate cost figures to change the conclusions derived from the cost numbers used in this study.

Note that the cost estimates include only those costs that are in addition to the primary mission costs. Therefore, the sunk capital costs for chemical demilitarization facility construction are not included in the estimates. The only capital costs included are those for facility modifications required to allow incineration of other feedstocks.

In comparing the chemical demilitarization facilities with alternate disposal methods, it was generally assumed that the alternate disposal facilities currently exist. Therefore, capital costs for alternate disposal methods were not included. In a few cases, use of the chemical demilitarization facility appears prohibitively expensive or slow and yet no promising disposal alternative exists. In these cases, it was recommended that an alternative disposal method be developed. It is acknowledged that capital costs (and possibly research and development costs) will be incurred to dispose of these wastes.

Note also that the costs are based on the most current information available. No attempt was made to escalate the costs into the future because it is unknown which costs will escalate faster than inflation. If all costs escalate at the same rate, the conclusions drawn from the escalated costs will be the same as those drawn from the current costs.

4.3.1 Conventional Munitions Demilitarization

There are almost 200,000 short tons of conventional munitions stockpiled in the U.S. and scheduled for disposal (Greenberg, 1990). Additional inventory is generated at a rate of about 23,000 short tons per year. Four groups of conventional munitions have been defined (See section 3).

Alternative technologies to the chemical demilitarization plants that are available to demilitarize each of the four categories of conventional munitions are discussed below.

4.3.1.1 Small Conventional Munitions

Generally, demilitarization of small conventional munitions does not involve disassembly. It is normally carried out in an APE 1236 deactivation furnace. This furnace has four major components, which are the feed system section, the retort assembly section, the discharge section, and the pollution abatement system.

Currently the Army has fourteen APE 1236 furnaces that are being upgraded (Zajicek, p.3-29, 1990) to comply with RCRA requirements. Some of these are located at TEAD, PBA, ANAD, and LBAD. The upgrade involves the addition of an automatic waste feed subsystem, an afterburner, a high/low temperature heat exchanger, a centrifugal dust collector (cyclone), a baghouse, an induced draft fan and an exhaust stack, as well as completely shrouding the furnace to minimize fugitive emissions.

The total amount of small conventional munitions requiring demilitarization at all U.S. locations is about 28,231 short tons (Greenberg, 1990). Assuming that the throughput rate of an upgraded APE 1236 is 1000 pounds per hour, then 53,500 furnace hours would be required to demilitarize the current inventory of small munitions. If we assume that small conventional munitions continue to be generated at a rate proportional to the amount in the current inventory, 6,440 furnace operating hours would be required to destroy the amount available annually.

Assuming that all 14 furnaces become operational, then each furnace would have to operate for 4,040 hours to complete the destruction of the small munitions stockpile (an APE 1236 normally runs about 1000 hours per year on a single shift basis) (Hill, 1990). Therefore, on a national basis, the upgraded APE 1236 furnaces appear to have adequate capacity to complete the demilitarization of small arms.

In table 4-4, the various O&M costs for demilitarization of small arms by conventional means in the APE 1236 are compared with the cost for using the chemical demilitarization system for the same purpose. Explanations of these cost estimates can be found in appendix E. It appears that the APE 1236 is substantially less expensive to operate than the chemical demilitarization facilities (except for CAMDS) for destruction of small conventional munitions. The costs for the APE 1236 might have been somewhat understated and those for the demilitarizations facilities somewhat overstated. Even so, it appears that the CSDP and CIDP plants are not economically competitive with the APE 1236 for the destruction of small arms. The APE 1236 has lower labor requirements because of the plant's configuration. The configurations of the CSDP and CIDP plants require more remote operators and maintenance personnel. The CAMDS facility's O&M cost is competitive with the APE 1236 O&M cost because the configuration and incinerator capabilities are similar.

A more detailed cost estimate, including estimates of modification costs and permitting costs at selected sites, is shown in table 4-5. As before, these cost estimates are suitable for comparisons only. The assumptions and calculations for all values shown in table 4-5 are given in appendix E.

Table 4-4. Small Arms Disposal O&M Cost Estimates

	APE 1236	CSDP	CAMDS	CIDP
O&M Disposal Cost Thousands of dollars/Ton	2.0	5.5	1.4	4.8

Table 4-5. Estimated Total Costs and Times for Small Arms Disposal

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted)							
	TEAD	CAMDS	LEAD		ANAD	PBA	PUDA	UMDA
Mod. Costs								
Washout/ Meltout[a]	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4
Permitting	0.45	0.45	0.45	0.65	0.225	0.225	0.45'	0.45
Trial Burn	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Total O&M[b]	6.8	1.7	6	2	7	30	1.7	9.4
Total Cost	10-12	5-7	9-11	5-7	8-10	33-35	5-7	12-14
Time (months)	3	4	3	1	3	13	1	4
O&M($000/ton)	5.5	1.4	4.8	5.5	5.5	5.5	5.5	5.5
Quantity(ton)	1245	1245	1245	360	1270	5450	300	1700

[a]Large mines of the small conventional munitions may require a washout/meltout facility.
[b]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.

The cost and time for disposing of the small arms at Tooele are calculated three ways: (1) using the CSDP facility only, (2) using the CAMDS facility only, or (3) using the CIDP facility only. It may be better to use a combination of these facilities to dispose of small arms. The cost and time required for doing so depends on the particular combination selected.

There appears to be very little economic advantage to disposing of all small arms at a central location because the fixed, costs such as the modification, permitting and trial burn costs, are a small portion of the total cost. The operating costs are a far greater portion of the total cost. The time calculations are based on the feed rates given in appendix E and the assumption that the plant operates 6,240 hours per year with an operating factor of 85 percent. Since there appears to be adequate existing capacity for demilitarization of small arms and the cost of using the chemical demilitarization facilities for this purpose appears to be significantly higher than for using existing facilities (except for CAMDS), it does not appear to be economically desirable to use the chemical demilitarzation facilities for demilitarization of conventional small arms munitions.

4.3.1.2 Smokes, Riot Agents

The steps involved in the demilitarization of the non-lethal agent munitions include disassembly, neutralization, recovery, incineration, and pollution abatement of incinerator flue gases. Items containing plasticized white phosphorous (PWP) are disassembled to remove explosive components and the munition bodies can be decontaminated in an upgraded APE 1236 that has been further modified by the addition of mist eliminators. The phosphorous pentoxide (P_2O_5) resulting from combustion of the white phosphorous can be collected and converted to phosphoric acid (H_3PO_4) in a WP plant. Smoke devices containing unplasticized WP can be incinerated or can be processed to recover the WP without incineration and convert it to H_3PO_4. Smoke devices containing colored dyes can be processed in an upgraded APE 1236. Smoke devices containing FS are disassembled to remove the acidic filler, which can be neutralized with a lime slurry to produce disposable salts. Currently, the U.S. Army does not have the capability of using the neutralization process (Zajicek, 1990). Smoke devices containing petroleum products can be processed in an upgraded APE 1236. The USATHAMA is pursuing a research program, which appears to show some promise of success, to dispose of such wastes, mixed with fuel oil in an industrial-type boiler. Items containing a pyrotechnic mix can be processed in an upgraded APE 1236; riot control agents such as CS- and CN-filled hand grenades must first be punched to expose the agent and then they can be incinerated in an upgraded APE 1236. Riot agents such as bulk CN and CS do not require disassembly. They can be incinerated in a fluidized bed incinerator (FBI) equipped with an appropriate PAS.

The total amount of smokes, dyes, pyrotechnics, and riot control agents in the demilitarization and disposal inventory is about 11,342 short tons (Greenberg, 1990). The fourteen APE 1236 furnaces at various Army installations and the FBI incinerator at PBA can be used, after being upgraded to comply with RCRA, to demilitarize the smokes, dyes, and riot control agents. Assuming a throughput rate of 1,000 pounds per hour for each incinerator, about 22,700 furnace hours would be required to demilitarize the inventory of smokes, dyes, pyrotechnics, and riot control agents. This estimate does not include the additional inventory that is being generated each year. Such additional inventory would require about 2,760 furnace hours annually.

If all 15 existing furnaces become operational, each furnace would have to operate for 1,510 hours to complete the destruction of the smoke stockpile. It should be noted that the 14 APE 1236 furnaces are the same as those that were considered for the destruction of the small munitions stockpile.

Table 4-6 gives a comparison of the O&M costs for demilitarization of smokes and riot agents in the existing demilitarization equipment with the same costs if the chemical demilitarization plants were used.

Explanations of these costs can be found in appendix E. It appears that the CSDP plants are competitive with the APE 1236 for the destruction of smokes and riot agents. Further, it appears that CARDS and the CIDP plant may be substantially less expensive to operate than the APE 1236 for the destruction of smokes and riot agents. The CSDP plants are competitive with the APE 1236 because offsetting factors cancel each other out. The hourly labor costs for the CSDP plants are much higher than for the APE 1236 because of the configuration of the CSDP plants. This tends to increase the CSDP O&M cost. However, the throughput rate is also much higher for the CSDP plants, which tends to reduce the CSDP O&M cost. The result is that the CSDP and APE 1236 O&M costs are nearly equivalent for smokes and riot agents on a per ton basis.

The CARDS hourly labor costs are similar to those for the APE 1236. However, since the CAMDS throughput rate is somewhat higher for smokes and riot agents, the total O&M cost per ton is significantly lower for CARDS than for the APE 1236. The hourly labor cost for the CIDP is higher than for the APE 1236. This tends to increase the O&M cost for the CIDP. However, the throughput rate for the CIDP is much higher than for the APE 1236, which tends to reduce the CIDP O&M cost. The result is that the CIDP O&M costs are substantially lower than the APE 1236 O&M costs for smokes and riot agents on a per ton basis.

A more detailed cost estimate, including estimates of modification costs and permitting costs, is shown in table 4-7. As stated above, these cost estimates are suitable for comparative purposes only. The actual costs may vary significantly from these estimates. The assumptions and calculations for all values shown in table 4-7 are given in appendix E.

The cost and time for disposing of the smokes and riot agents at Tooele are calculated three ways: (1) using the CSDP facility only, e.g., the Tooele Chemical Disposal Facility (TOCDF); (2) using the CAMDS facility only; or (3) using the CIDP facility only. It may be better to use a combination of these facilities to dispose of smokes and riot agents. The cost and time required for doing so depends on the particular combination selected. There may be some economic advantage to disposing of all smokes and riot agents at a central location (probably PBA since it has the largest inventory of smokes and riot agents). The calculations of the time required to complete disposal of items in the inventory are based on the feed rates given in appendix E, and the assumption that the plant operates 6,240 hours per year with an operating factor of 85 percent.

At all the locations, except PBA, listed in table 4-7, the fixed costs for use of the chemical demilitarization plants to demilitarize smokes and riot agents (addition of disassembly facilities, upgrade of the pollution abatement system with a baghouse, obtaining a permit, and conducting a trial burn) is greater than the operating cost for disposing of the inventory at the site.

The fixed costs could be avoided by disposing of the smoke and riot agents in an existing on-site upgraded incinerator suitable for this service (rotary kiln or FBI). Pine Bluff Arsenal has the largest quantity of smokes and riot agents when compared to other sites and is equipped with an upgraded rotary kiln incinerator and an FBI that are permitted to dispose of smoke and riot agent items. The incremental cost of disposing of these items from other sites at Pine Bluff would be relatively small since Pine Bluff has already incurred the major fixed costs. Therefore, consideration should be given to transferring smokes and riot agents from locations without approved facilities for disposal of such items to Pine Bluff for disposal.* Since existing facilities appear to have adequate capacity for disposal of smokes and riot agents, there does not appear to be a need to consider using the chemical demilitarization facilities for

*Permit restrictions at PBA, and costs associated with transport and storage of designated hazardous materials may add some cost to this action; however, this still appears to be desirable.

the motors). Removed explosives can either be reused or incinerated in an upgraded EWI, and the munition bodies can be processed in an upgraded EWI or an upgraded APE 1236.

OB/OD capabilities exist at about 12 U.S. Army installations. If OB/OD is allowed to continue, the inventory of large conventional munitions can be demilitarized in a few years. If OB/OD is disallowed, then washout/meltout coupled with incineration would be used. There are 14 hot water (APE 1300) washout facilities. Two are currently operational and 12 require upgrading. Also, a high pressure (water jet) washout system exists at the Western Area Demilitarization Facility (WADF), and one steamout facility exists at Crane Army Ammunition Depot, Crane, Indiana. The upgrade involves replacement of rusted equipment and the installation of a charcoal filter system to remove the explosive from the waste water prior to discharge. The average processing rate of the explosive removal facilities ranges between 500 and 1,400 pounds of explosives removed per hour.

Assuming that the weight of energetic material in large munitions is about 10 percent of the total weight or 13,540 short tons and the average removal rate of explosives is 900 pounds per hour, about 30,100 hours would be required to remove energetic material from large munitions in the current demilitarization and disposal inventory. About 3,530 furnace hours would be required annually to destroy the energetic material in the large munitions that are added to the demilitarization and disposal stockpile each year. Thus, there are an insufficient number of operational washout/meltout facilities to remove the energetic material from large munitions in a timely manner, and either the ones that are in layaway have to be upgraded or new ones have to be built. In addition, the recovered energetic material has to be dealt with.

Currently, the Army has six EWIs that require upgrading. An EWI has a capacity of about 300 pounds of bulk energetics per hour. Therefore, if the six EWIs become operational, each furnace would have to operate for 15,000 hours to incinerate the energetic material in the large conventional munitions inventory.

The quantity of metal parts and fuzes from the large munitions will be about 121,800 short tons. In order to feed the metal parts from these munitions, the metal parts would need to be reduced in size, as previously stated. This could, perhaps, be achieved by the use of a cryogenic press-type system or other mechanical size reducing equipment. Assuming that the throughput rate of an upgraded APE 1236 is 1000 pounds per hour, then an average of 243,600 furnace hours would be required to demilitarize the metal parts and fuzes from large munitions. The annual addition to the

inventory would require about 28,600 furnace hours for demilitarization. It is apparent that there is insufficient APE 1236 furnace capacity for demilitarizing large munitions. The DFS and the HPF of the chemical demilitarization facilities could be used to provide additional capacity for this purpose.

In table 4-8 a comparison is given of the various O&M costs for demilitarization of large conventional munitions by open burning/open detonation (OB/OD) and by controlled incineration in the chemical demilitarization plants. In these cost estimates, it is assumed that the fuzes and explosives would be demilitarized in the deactivation furnace, and the munition bodies would be demilitarized in the metal parts furnace. Explanations of these cost estimates can be found in appendix E. Demilitarization of large munitions by OB/OD is significantly less expensive than disposal in the chemical demilitarization facilities. However, the OB/OD cost may be somewhat understated, especially as permitting restrictions increase the OB/OD costs. Even so, it seems clear that the CSDP or CIDP plants are not economically competitive with the OB/OD for the destruction of large conventional munitions.

A more detailed cost estimate, including estimates of modification costs and permitting costs, is shown in table 4-9. As stated above, these cost estimates are suitable for comparative purposes only. The actual costs may vary significantly from these estimates. The assumptions and calculations for values shown in table 4-9 are given in appendix E.

The cost and time for disposing of the large munitions at Tooele are calculated three ways: (1) using the CSDP facility only, (2) using the CAMDS facility only, or (3) using the CIDP facility only. It may be better to use a combination of these facilities to dispose of large munitions. The cost and time required for doing so depends on the particular combination selected. Note also that there is no economic advantage to disposing of all large munitions at a central location because the fixed costs such as the modification, permitting, and trial burn costs are a very small portion of the total cost at each site. The operating costs are the major portion of the total cost. Also note that the time calculations indicate that at some sites such as Tooele the length of time to dispose only of the large munitions is so long (over 10 years) that use of the demilitarization facility alone for this purpose may not be desirable. However, it may be desirable to use the demilitarization facility in conjunction with other disposal methods to reduce the stockpile of large conventional munitions. The time calculations are based on the feed rates given in appendix E and the assumption that the plant operates 6,240 hours per year with an operating factor of 85 percent.

Table 4-8. Large Conventional Munition Disposal Cost Estimates

O&M Disposal Cost	OB/OD	CSDP	CAMDS	CIDP
Thousanda of dollars/Ton				
Range	..	3.6 - 22.2	1.7 - 10.7	3.3 - 20.9
Beat Estimate	0.8	8.9	4.3	8.4

Table 4-9. Estimated Total Costs and Times for Large Conventional Munition Disposal

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted)							
	TEAD	CAMDS	CIDP	LBAD	ANAD	PBA	PUDA	UMDA
Hod. Costs								
Washout/ Heltout	1-2	1-2	0[a]	l-2	l-2	l-2	1-2	1-2
Permitting	0.45	0.45	0.45	0.65	0.225	0.225	0.45	0.45
Trial Burn	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Total O&M[b]	301	146	285	30	49	79	114	121
Total Cost	304	149	286	33-34	51-52	81-82	117	124
Time (months)	128	163	99	13	21	34	49	52
O&M($000/ton)	8.9	4.3	8.4	8.9	8.9	8.9	8.9	8.9
Quantity(ton)	33,800	33,800	33,800	3300	5500	8800	12,800	13,600

[a]The Cryopress can be used to size reduce the large munitions so no washout/meltout facility is needed.
[b]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.

4.3.1.4 Bulk Energetic8

Bulk energetics include bulk explosives and propellant charges. There are over 13,500 short tons of bulk energetics in the demilitarization inventory. Most of the bulk explosives do not require disassembly and are either reused or are incinerated in an upgraded EWI. Some propellant charges require disassembly, and the propellant is incinerated in an upgraded EWI while the metal propellant containers are thermally decontaminated in an upgraded APE 1236.

OB/OD of bulk energetics is practiced at about twelve U.S. Army installations. If OB/OD is allowed to continue, the inventory of bulk energetics can be disposed of in a few years. Alternatively, the Army's six EWIs could be upgraded to meet pollution regulations and used to thermally destroy the bulk energetics. It should be noted that these are the same EWIs that were considered for use in destruction of the energetics removed from the large munitions. Assuming that the throughput rate of an upgraded EWI is 300 pounds of bulk energetics per hour, about 90,000 furnace hours would be required to demilitarize the bulk energetics in the current demilitarization and disposal inventory. This estimate does not include the additional inventory that is being generated each year. This additional inventory would require about 10,800 additional hours annually.

If the six EWIs become operational, each furnace would have to operate for about 15,000 hours to complete the destruction of bulk energetics. The CSDP, CAMDS, and CIDP chemical demilitarization facilities could provide additional capacity for the disposal of bulk energetics.

Table 4-10 provides a comparison the O&M costs for disposal of bulk energetics by controlled incineration in the EWI and in the chemical demilitarization facilities. Bulk propellant is shown separately from bulk explosive because the O&M costs are very different for propellant and explosive.

Table 4-10. Bulk Energetic Disposal Cost Estimates

	EWI	CSDP	CAMDS	CIDP
O&M Disposal Cost Thousands of dollars/Ton				
Bulk Propellant	0.8	11	2.7	9.6
Bulk Explosive	6.6	57.9	21.5	83.8

Explanations of these cost estimates can be found in appendix E. It appears that the EWI is substantially less expensive to operate than the chemical demilitarization facilities for destruction of bulk energetics. It may well be that the costs for the EWI have been somewhat understated and those for the demilitarization facilities somewhat overstated. Even so, it seems clear that the chemical demilitarization facilities are not economically competitive with the EWI for the destruction of bulk' energetics. The EWI has lower labor requirements than the chemical demilitarization facilities because of the plant's configuration. Also, the EWI is specifically designed to incinerate bulk energetics and therefore has a higher throughput rate than the chemical demilitarization facilities.

More detailed cost estimates including estimates of modification costs and permitting costs, are shown in tables 4-11 and 4-12. As stated before, these cost estimates are suitable for comparisons only. The actual costs may vary significantly from these estimates. The assumptions and calculations for all values shown in tables 4-11 and 4-12 are given in appendix E.

The cost and time for disposing of the bulk energetics at Tooele are calculated three ways: using the CSDP facility only, using the CARDS facility only, or using the CIDP facility only. It may be better to use a combination of these facilities to dispose of bulk energetics. The cost and time required for doing so depends on the particular combination selected. There may be some economic advantage to disposing of all bulk energetics at one or more regional locations because the fixed costs such as the modification, permitting and trial burn costs are considerable at sites with very little bulk energetics. The time calculations are based on the feed rates given in appendix E and the assumption that the plant operates 6,240 hours per year with an operating factor of 85 percent.

4.3.2 Nonstockpile Chemical Items

Nonstockpile chemical items include the following:

- Range recovered munitions.
- Unwanted chemical surety material.
- Chemical agent identification sets.
- Empty ton containers that have been decontaminated to the XXX level.

Table 4-11. Estimated Total Costs and Times for Bulk Propellant Disposal

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted)							
	TEAD	CAMDS	CIDP	LBAD	ANAD	PBA	PUDA	UMDA
Mod. Costs								
Washout/ Meltout[b]	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2
Permitting	0.45	0.45	0.45	0.65	0.225	0.225	0.45	0.45
Trial Burn	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Total O&M[c]	8	2.0	7.0	7.3	5.6	22.7	21.5	10.1
Total Cost	10-11	4-5	9-10	10-11	7-8	25-26	24-25	12-13
Time (months)	3.5	5	2.5	3.2	2.5	9.9	9.4	4.4
O&M($000/ton)	11	2.7	9.6	11	11	11	11	11
Quantity(ton)	730	730	730	665	505	2065	1955[a]	920[a]

[a]The quantity of bulk propellant was assumed to be 90% of the total bulk energetic quantity.
[b]Selected items only may require the use of a washout/meltout facility.
[c]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.

Table 4-12. Estimated Total Costs and Times for Bulk Explosive Disposal

Type of Cost	Costs at Sites (Millions of Dollars Exceptas Noted)							
	TEAD	CAMDS	CIDP	LBAD	ANAD	PBA	PUDA	UMDA
Mod. Costs								
Washout/ Meltout	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2
Permitting	0.45	0.45	0.45	0.65	0.225	0.225	0.45	0.45
Trial Burn	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Total O&M[b]	16.2	6	23.5	9	0.1	8.7	12.7	5.8
Total Cost	15-16	8-9	26-27	12-13	2-3	11-12	15-16	8-9
Time (months)	11	14	8.3	5.8	0.1	5.7	8.3	3.8
O&M($000/ton)	57.9	21.5	83.8	57.9	57.9	57.9	57.9	57.9
Quantity(ton)	279	279	279	155	1	150	220a	100[a]

[a]The quantity of bulk explosive was assumed to be 10 percent of the total bulk energetic quantity.
[b]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.

There are two potential disposal methods for non-stockpile chemical items: (1) chemical decontamination followed by disposal in a RCRA approved hazardous waste landfill and (2) thermal destruction or decontamination. The latter method is preferred since it eliminates a potential hazard and, in the case of contaminated metal items, might allow their eventual sale as scrap. Disposition of the decontaminated chemical items must be carried out in accordance with the provisions of DOD 4160.21-H.

Since the chemical demilitarization plants are specifically designed to destroy and/or decontaminate chemical warfare agent contaminated items, it would be prudent to use the facilities for the non-stockpile chemical items in lieu of constructing new facilities specifically for this purpose.

The largest number of items in this inventory is 12,000 empty XXX ton containers. The CAMDS facility and the chemical demilitarization facilities that will be built can handle the inventory in this category in the same manner as the ton containers in the stockpile will be handled. The extension of CSDP, CAMDS and CIDP plant operations to decontaminate these materials appears to be an obviously desirable future use for these facilities.

Since there are no alternative processes for these items, no cost comparison between the demilitarization facilities and an alternative method can be given. Tables 4-13 through 4-16 present cost estimates for disposing of the non-stockpile chemical items at each site. These costs are based on the O&M costs, fixed costs, and quantities of items developed in appendix E. These cost estimates have high uncertainties and are based on many assumptions, and are suitable for comparison purposes only. The actual costs may vary significantly from these estimates. Note that the incineration costs for buried chemical items do not include the excavation of these items. Also, the cost for building and process equipment disposal includes incineration costs only and not the cost of dismantlement. Note that all the processing time calculations in the following tables assume the plant operates 6,240 hours per year with an operating factor of 85 percent.

Table 4-13, Estimated Total Costs and Times for Range Recovered Items, gives costs and times for disposing of the range recovered items at Tooele and PBA. Note that the cost and time for disposing of range recovered items at Tooele are calculated three ways: using the CSDP facility only, using the CARDS facility only, or using the CIDP facility only. Note also that the permitting and trial burn costs shown may be overestimates. Depending on the type and contents of the range recovered items, these costs may be lower than estimated since the requirements of the permits and trial burns for the chemical stockpile may apply. The total O&M costs and the times shown may be underestimates because the calculations assume

Table 4-13. Estimated Total Costs and Times for Range Recovered Items

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted) TEAD	CAMDS	CIDP	PBA
Mod. Costs	0	0	0	0
Permitting	0.45	0.45	0.45	0.225
Trial Burn	0.53	0.53	0.53	0.53
Total O&M[a]	0.3	0.0-3	0.1	2.9
Total Cost	1.3	1.0	1.1	3.7
Time (months)	0.1	0.1	0.02	0.7
O&M ($000/munition)	2.4	0.2	0.4	2.4
Quantity (munitions)	145	145	145	1209

[a]Total O&M = O&M ($000/munition) x Quantity (munitions)/1000.

steady state processing. In short processing runs such as these, set-up times and start-up inefficiencies may increase the O&M costs and the processing times noticeably, perhaps by as much as a factor or 2 or 3.

Table 4-14, Estimated Total Costs and Times for Empty XXX Ton Containers, gives costs and times for disposing of the empty ton containers at APG, PBA, NAAP, Tooele, and JACADS. It is assumed that of the 4,259 tons at Tooele, 3,440 tons (4,300 ton containers) are received from Rocky Mountain Arsenal.

The permitting and trial burn costs shown may be overestimates. Depending on the former contents of the ton containers, the permitting and trial burn costs may be lower than estimated since the permits and trial burns for the chemical stockpile may apply. As is the case with range recovered items, the total O&M costs and the times shown may be underestimates because the calculations assume steady state processing. The CSDP O&M and feed rates for metal in appendix E were used for the JACADS calculation. This may result in a slight underestimation of the O&M cost because the labor cost at JACADS is higher than at the other sites.

Table 4-15, Estimated Total Costs and Times for Full Ton Containers, gives the costs and times for disposing of the 4 VX filled ton containers at APG. In this case, the permitting and trial burn costs are not likely to be overestimates because the APG chemical demilitarization facility will be permitted only for mustard, not VX. Therefore, substantial permitting and trial burn costs are expected if the VX filled ton containers are incinerated in the chemical demilitarization facility at APG. An alternative disposal method for the excess VX at Aberdeen should be considered.

This alternative is chemical neutralization of the VX and incineration of the resulting solution in the existing permitted Decon/Detox facility (see appendix B). The Decon/Detox facility could also decontaminate the resulting empty ton containers to XXXXX. Using this alternative would eliminate the VX well before the chemical demilitarization facility became available.

Table 4-16, Estimated Total Costs and Times for Agent Contaminated Metals, gives the costs and times for decontaminating metal at APG, PUDA (including material from RMA), UMDA and NAAP. This metal comes from a variety of sources: buried equipment, metal buildings, and process equipment inside buildings. At all sites except UMDA, the O&M costs represent a large majority of the total costs. UMDA has such a small quantity of metal that the fixed costs drive the total costs. The permitting and trial burn costs may be overestimates because the permits and trial burns for the chemical stockpile may apply. Another option for UMDA might be to chemically decontaminate the metal to a XXX level, and

Table 4-14. Estimated Total Costs and Times for Empty XXX Ton Containers

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted)					
	APG	PBA	NAAP	TEAD[a]	CAMDS[a]	JACADS
Mod. Costs	0	0	0	0	0	0
Permitting	0.65	0.225	0.25	0.45	0.45	0.45
Trial Burn	0.53	0.53	0.53	0.53	0.53	0.53
Total O&M[b]	4.7	9.9	0.05	13.2	6.0	0.74
Total Cost	5.9	10.7	0.8	14.2	7.0	1.7
Time (months)	3	5	0.03	7.0	13.8	0.3
O&M ($000/ton)	2.4	3.1	2.4	3.1	1.4	3.5
Quantity (ton)	1962	3200	20.8	4259	4259	211

[a]Includes empty XXX ton containers moved from RMA.
[b]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.

Table 4-15. Estimated Total Costs and Times for Full Ton Containers

Type of Cost	Costs at APG (Millions of Dollars Except as Noted)
Mod. Costs	0
Permitting	0.65
Trial Burn	0.53
Total O&M[a]	0.01
Total Cost	1.2
Time (hours)[b]	5
O&M ($000/ton)	4.7
Quantity (ton)	3

[a]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.
[b]Based on a processing rate of 0.88 ton containers per hour. A ton container is assumed to weigh 1400 pounds.

Table 4-16. Estimated Total Costs and Times for Agent Contaminated Metals

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted) APG	PUDA[a]	UMDA	NAAP
Mod. Costs	0	0	0	0
Permitting	0.65	0.45	0.45	0.225
Trial Burn	0.53	0.53	0.53	0.53
Total O&M[b]	118	8	0.002	85
Total Cost	119	9	1	86
Time (months)	81	4	<1	58
O&M ($000/ton)	2.4	3.1	3.1	2.4
Quantity (ton)	49,039[c]	2,472	0.7	35,445

[a]Includes metals from Rocky Mountain Arsenal.
[b]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.
[c]This estimate may be low because it only includes items from two locations of an NPL site

then transport it to another site for decontamination to the XXXXX level. The processing times for APG and NAAP may prove to be too long to be practical. Most of the metal at APG comes from items projected to be recovered from old "O" field. Clean-up of other sites at APG known to be similarly contaminated could add to the quantity. Due to the unknown types and conditions of these items, the O&M costs and processing times are likely to be underestimates. The long processing time is one indication that cleanup of old "O" field will require additional cleanup capacity. It is recommended that the old "O" field problem be analyzed in detail in a separate study. The majority of metal at NAAP comes from the old VX processing plant building and equipment. The amount and condition of this material is well known. Therefore, the O&M cost and processing time for clean-up of the contaminated metal at NAAP have less uncertainty.

4.3.3 Disposal of Hazardous Waste

Hazardous wastes are being generated at many DOD facilities. The U.S. EPA has compiled and proposed a list of hazardous waste substances (40 CFR 261). In addition to the published list, EPA has defined four characteristics by which waste can be classed as hazardous. These characteristics are ignitability, corrosivity, reactivity, and toxicity. Also, TSCA regulates the disposal of some toxic substances, such as PCB and asbestos.

DOD hazardous wastes are the same as the hazardous waste from industry and include petroleum oils, lubricants, solvents, grease, chemically treated pallets, paint waste, stripping waste, spent activated carbon, sludges, and wastes contaminated with heavy metals.

Industry usually employs pretreatment technologies prior to ultimate disposal. Such pretreatment technologies include cementation, filtration, thickening, and vacuum filtration. The final disposal of hazardous waste is by incineration, biological degradation, chemical degredation, or landfilling.

Incineration technology is used to convert a waste to a less bulky, less toxic, or less noxious material. Several basic types of incineration units are being used by industry. These are:

- Rotary kiln incinerators.
- Liquid injection combustors.
- Fluidized bed incinerators.
- Multiple hearth incinerators.

The rotary kiln incinerator used by industry is applicable for incineration of both liquid and solid hazardous wastes and slurries. This incinerator is a refractory-lined shell that is mounted on a slight incline. Rotation of the shell provides for transportation of the waste through the kiln as well as for enhanced mixing of the waste with the combustion air. A typical kiln is 16 feet long and 10 feet in diameter. Typical feed capacities for solids range from 1,300 pounds/hour to 4,400 pounds/hour (Bonner, et al., Nov., 1990).

Liquid injection combustors are used to dispose of virtually any combustible liquid waste (e.g., phenols, plating wastes, paints, thinners, solvents, detergent/digester sludges, pesticides, polymers, and still bottoms). The liquid is atomized and mixed with air into a suspension. Combustion takes place in a refractory lined combustion chamber and atomization is usually achieved using pressure systems. Typical combustion chamber residence time and temperature ranges are 0.5 to 2 seconds and 1,300°F to 3,000°F, respectively. Typical liquid feed rates are as high as 200 cubic feet per hour or 25 gallons per minute (Bonner, et al., 1990).

The fluidized bed incinerator consists of a refractory-lined vessel containing inert granular material. Industrial waste feed, which can be solids, liquids, or gas, enter the incinerator either above or within the bed. The FBI has primarily been used for industrial waste incineration, and it has some potential for treating hazardous waste. A typical reactor has an inside diameter of 26 feet and an elevation of 33 feet. Silica beds are commonly used and have a depth of 3 feet at rest and extend up to 6.5 feet in height when fluidized by air passing through the bed. A typical residence time for liquid hazardous waste is 12 to 14 seconds at a combustion temperature of 1,500°F to 1,800°F (Bonner, et al., 1990). Liquid wastes are pumped directly from a tank truck into the reactor by a recirculating pump system. Liquid feed rates range between 6 gallons per minute and 35 gallons per minute.

The multiple hearth furnace includes a refractory-lined steel shell, a central shaft that rotates, and a series of solid flat hearths. Sludge and/or granulated solid combustible waste is fed through the furnace roof by a screw feeder. The rotating central shaft with arms and teeth plows the waste material across the top hearth to drop holes. The waste falls to successively lower hearths until discharged as ash at the bottom. When this type of furnace is used to dispose of hazardous waste such as still bottoms, oil refinery sludges and pharmaceutical wastes, a secondary combustion chamber is necessary in most cases. Multiple hearth furnaces range from 6 feet to 25 feet in diameter and from 12 feet to 75 feet in height (Bonner, et al., 1990). Normal incineration usually requires a minimum of six hearths. Liquid combustible wastes may be injected into the unit through auxilliary burner nozzles. In general, maintenance costs are high because of the number of moving parts subjected to combustion conditions. An average wet waste feed rate is about 136 tons per day.

The inventory of hazardous waste generated at Army installations is large. However, hazardous waste minimization practices coupled with the building of advanced waste treatment plants will reduce the amount of hazardous waste that is generated. Commercial hazardous waste operators could handle the disposal of waste more economically because they operate facilities that are sized and designed specifically for hazardous waste disposal. As can be seen from the above discussion, the throughput rate of the commercial incinerators is much larger than the incinerators of the chemical demilitarization facilities in order to take advantage of the economies of scale. Therefore it would not be economically desirable to use the chemical demilitarization furnaces to process hazardous waste except possibly on a case by case basis and for specific wastes.

The operating and maintenance (O&M) costs for disposing of hazardous waste by commercially available methods and by use of the chemical demilitarization plants is presented in table 4-17. Explanations of these costs can be found in appendix E.

Table 4-17. Hazardous Waste Disposal O&M Cost Estimates

O&M Disposal Cost Thousands of dollars/Ton	Incinerator	Landfill	CSDP	CAMDS	CIDP
Hazardous Soil	0.2-1.5	0.2-0.3	3.3	2.0	0.7
Hazardous Sludge	3	0.2-0.3	9.3	5.6	2.3
Solvents					
General	0.2-0.5	N/A	2-13	3-13	N/A
DS2	1.0	N/A	10.5	10.4	

It appears from the table that commercially available methods for hazardous waste disposal are substantially less expensive than the chemical demilitarization facilities. A major reason for the high O&M costs for the chemical demilitarization facility relative to the commercially available methods is that the chemical demilitarization incinerators are much smaller than the commercially available ones. This means that the throughput rates for the chemical demilitarization incinerators are much lower, and the corresponding operating costs per ton are much higher. However, the CIDP incinerator is closer in size to the commercially available ones, so its O&M cost may be competitive with commercial incinerators. Another reason for the high O&M costs of the chemical demilitarization facilities is that the plant configuration requires more operations and maintenance personnel. Because of the high cost differential, it does not appear to be desirable from an economic standpoint to use the chemical demilitarization facilities for disposal of hazardous wastes, One exception to this may be disposal of herbicide Orange contaminated soil on Johnston Island since the cost of shipping the

coral to an off-site disposal location may negate any cost advantage of the off-site disposal method.

A detailed cost estimate for disposing of this material at JACADS, including estimates of modification costs and permitting costs, is shown in table 4-18. This cost estimate is suitable for comparison only. The actual costs may vary significantly from this estimate. It was assumed that both the MPF and DFS would be used simultaneously for this effort. Therefore, the costs of modifications, permitting, and trial burns for both furnaces were included in the calculations. The assumptions and calculations for all values shown in table 4-18 are given in appendix E.

4.3.4 Remediation of Potentially Agent or Explosive Contaminated Soil

Decontamination of soil is normally carried out by removal and deposition in a RCRA permitted landfill, soil washing, in situ stripping with air and/or heat, biodegradation, or dewatering and incineration in a refractory-lined rotary kiln.

Contaminated soils are incinerated either in off-site rotary kilns or by on-site mobile or transportable incinerators. Mobile units are truck-mounted and can be rapidly connected and assembled in the field often without removal from the truck beds. Transportable units consist of a set of compatible modules that can be readily assembled on a concrete pad and used for any period of time for site clean up.

For soil decontamination, the combustion chamber temperature is 1,500°F to 2,700°F and the residence time varies from several minutes to half an hour.

Soil characteristics affect the method of pretreatment and the selection of the incineration technology. Soils with a high moisture and clay content can agglomerate into balls or clumps and, can affect the waste handling system. Wet soil can stick and jam numerous types of conveying, screening, and feeding equipment. Gravel and rocks in the soil can cause problems with material handling equipment. Screw and belt conveyors are affected by the abrasive and sharp rock edges, as well as by gravel size. Pretreatment of soils includes screening, shredding, metal separation, size separation, and dewatering.

Several problems have been identified with soil waste feed system. For example:

- Soil has been fed into rotary kilns by means of screw conveyors. Screw conveyors work well for uniform sandy soils, but they have experienced problems with conveying gravel-bearing soil and soil mixed with scrap. Excessive wear of the screws can require weekly shutdown for replacement.

Table 4-18. Estimated Total Costs and Times for Decontamination of Hazardous Waste Contaminated Soil

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted) JACADS
Mod. Costs	
DFS Feed System	0.1
MPF Feed System	0.1
DFS Refractory	0.1
Permitting[a]	0.9
Trial Burn[a]	1.06
Total O&M[d]	26-79
Total Cost	29-82
Time[c] (months)	8-24
O&M ($000/ton)[b]	4.3
Quantity (ton)	6,000-18,000

[a]Cost of permitting two furnaces (MPF and DFS).
[b]Cost of operating two furnaces (MPF and DFS).
[c]Using combined feedrate.
[d]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.

- Soils have sometimes been fed into an incinerator by means of a ram feeder. The fines in some soils can spill around the ram.

It is estimated that there are over one million cubic yards of soil contaminated with explosive compounds alone at U.S. Army installations across the country. Contaminated soils would require excavation, pretreatment, on-site or off-site thermal decontamination, and perhaps redeposit in their original location.

Off-site rotary kiln incinerators with feed rates greater than 10 tons per hour, or specially designed on-site mobile or transportable units with feed rates less than 10 tons per hour are normally used to remediate contaminated soils. The throughput rates of the DFS incinerators of the chemical demilitarization facilities vary from about 0.5 tons per hour in the CAMDS DFS to 5 tons per hour in the CIDP kiln. Additional factors that discourage the use of the chemical demilitarization plant incinerators for soil decontamination are that they require modifications, and could be far from the location of the soil.

In table 4-19, Estimated Total Costs and Times for Potentially Agent Contaminated Soil, cost estimates and times are given for decontaminating soil in the chemical demilitarization facilities. Most sites have potentially agent contaminated soil. Decontamination of Tooele soil is calculated three ways: using the CSDP facility only, using the CAMDS facility only, and using the CIDP facility only. If a combination of facilities is selected to decontaminate soil, the cost and time for doing so will depend on the particular combination selected. Note that the quantities of soil at each site were generally reported in a rather vague manner such as "burial ground", "pit", or "field". Assumptions were made to convert these terms into tons of soil for calculation purposes. These assumptions are listed in appendix E. For this and other reasons, these costs are valid for comparisons only, and the actual cost may vary significantly from these estimates.

In the O&M costs for those sites that have a DFS, it was assumed that the DFS (rather than the MPF) was used for the soil decontamination. It was further assumed that the DFS had 9 inch thick refractory added to it for processing soil. Adding refractory improves fuel efficiency and raises the maximum temperature, but also reduces the throughput rate. It may be that the reduction in throughput outweighs the improvement in fuel efficiency, and when optimized, a smaller amount of refractory would be needed.* At best, this would double the throughput rate and reduce the O&M cost by half. Therefore, the O&M costs and processing time may be overestimated by as much as a factor of two.

*Another possibility may be to provide external insulation for the incinerator. The feasibility of this option has not yet been determined.

Table 4-19. Estimated Total Costs and Times for Potentially Agent Contaminated Soil

Type of cost	Costa at Sites (Millions of Dollars Except as Noted)									
	TEAD*	CAMDS*	CIDP*	APG	LBAD	ANAD**	PBA	PUDA	UMDA	NAAP
Mod. Costa										
DFS Feed System	0.1	0.1	0.15	N/A	0.1	0.1	0.1	0.1	0.1	N/A
MPF Feed System	--	--	--	0.1	--	--	--	--	--	0.1
DFS Refractory	0.1	0.1	0.4	N/A	0.1	0.1	0.1	0.1	0.1	N/A
Permitting	0.45	0.45	0.45	0.65	0.65	0.225	0.225	0.45	0.45	0.25
Trial Born	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
O&M ($000/ton)	3.6	2.0	0.7	10.5	3.6	3.6	3.6	3.6	3.6	10.5
Quantity (ton)[a]	2,299,970	2,299,970	2,299,970	110,000***	3,227	3,227	10.6	6,454	9,681	14,750
Total O&M	8,740	4,600	1,610	1.155	12	12	0.04	25	37	155
Total Cost	6,741	4.601	1,612	1.156	13	13	1	26	36	156
Time (months)	4,525	10,407	1,001	1,223	6	6	<1	13	19	64

not.: Dashes indicate no coat incurred; MPF will not be used.

● Includ.. Dugway.
**Includes Redstone.
***This is probably • la ● stimM.e because it includes only 2 areas of • much larger Rational Priorities List site.

[a]See tables E-16 through E-24.

For Tooele and APG, the times are in the thousands of months and the costs are in billions of dollars. These are clearly not desirable, even if they are overestimated by a factor of two. For these sites, an alternate method of decontaminating the soil is needed. Examples are larger, properly sized incinerators with appropriate pollution abatement systems and the use of a technology for soil remediation that is better suited for large quantities of soil. The soil from old "0" field is part of the large amount at APG projected to be excavated. As stated previously, it is recommended that a separate, detailed study of the old "0" field problem be performed. While the chemical demilitarization facility may be able to provide a portion of the cleanup capacity for this site, it is not adequate to be used for old "O" field cleanup by itself.

The costs and times for the other sites are more reasonable. Except for PBA, the majority of costs are for O&M. At PBA, the amount of soil is quite small, and the fixed costs for processing soil may not be justified. It may be better to consider shipping this soil to another site or using a mobile soil incinerator for processing the PBA soil.

In table 4-20, Estimated Total Costs and Times for Potentially Agent Contaminated Sludge, cost estimates and processing times for sludge at Tooele and NAAP are given. The cost estimate and processing time for Tooele was calculated for three assumptions: using the CSDP facility only, using the CAMDS facility only, and using the CIDP facility only. If a combination of these facilities is used, the cost and time estimates would change, depending on the combination selected. The O&M costs and feed rates used from appendix E are the ones developed for hazardous contaminated sludge. Therefore, the O&M costs may be slightly underestimated because the labor costs for agent contaminated sludge may be somewhat higher. However, the driving factor is the low throughput rate for sludge whether contaminated with agent or hazardous material. The permitting and trial burn costs may be overestimated since the facilities may have applicable permits from processing the chemical stockpile.

4.3.5 Decontamination of Agent Contaminated Buildings and Equipment

Agent contaminated buildings and equipment consists of concrete buildings, metal buildings and metal equipment. A demonstrated technology for decontamination of agent contaminated buildings and equipment is to chemically decontaminate them to the XXX level, demolish the concrete and masonry sections of the building, dismantle and size reduce the pipes/metals/equipment, and subject these materials to thermal decontamination in a rotary kiln or a metal parts furnace. A former chemical agent research and development facility at the Edgewood Area of

Table 4-20. Estimated Total Costs and Times for Potentially Agent Contaminated Sludge

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted) TEAD	CAMDS	CIDP	NAAP
Mod. Costs				
DFS Feed System	0.1	0.1	0.15	N/A*
MPF Feed System	--	--	N/A	0.1
DFS Refractory	0.1	0.1	0.4	N/A
Permitting	0.45	0.45	0.45	0.25
Trial Burn	0.53	0.53	0.53	0.53
Total O&M[a]	4.8	3	1	1
Total Cost	6	4	3	2
Time (months)	3	7	1	2
O&M ($000/ton)[b]	9.3	5.6	2.3	19.0
Quantity (ton)[c]	519	519	519	45

Note: Dashes indicate no cost incurred; MPF will not be used.

*N/A = not applicable.

[a]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.
[b]Assume same O&M cost as for hazardous contaminated sludge.
[c]See tables E-16 through E-24.

APG is currently in the process of being dismantled and decontaminated in this manner. Disposal of the XXX material in a government controlled hazardous waste landfill is an alternative to thermal decontamination of material in a DFS or an MPF.

The costs of decontaminating metal buildings and equipment in the chemical demilitarization facilities have already been addressed in section 4.3.2. In general, the O&M cost per ton of metal in the chemical demilitarization facility ranges from $2,500 to $3,500. The cost to date for decontaminating the old Pilot Plant at Edgewood in the Decon/Detox Incinerator is about $2,000/ton.

Cost and processing time estimates for decontaminating concrete buildings that are agent contaminated are presented in table 4-21, Estimated Total Costs and Times for Agent Contaminated Concrete. Four sites might have agent contaminated concrete: APG, PUDA (including RMA), UMDA and NAAP. The O&M costs and feed rates were assumed to be the same as for the agent contaminated soil given in appendix E. In all cases, the vast majority of the total costs consist of the O&M costs. For APG and PUDA, the time estimate for decontamination is between 50 and 100 years and the cost is over a billion dollars. Clearly, it is not desirable to process agent contaminated concrete in this manner. Other methods for decontaminating concrete are needed. The hot gas method, which is still under development, may ultimately be useful, depending on the results of testing of this method. The time and cost estimates for UMDA and NAAP are much more reasonable. For these sites, it may be desirable to use the chemical demilitarization facility to decontaminate concrete.

4.3.6 Disposal of Municipal and Other Nonhazardous Waste

Currently the U.S. burns about 10 percent of the municipal refuse that is generated, and the other 90 percent is largely landfilled (House of Representatives, 1987). Most of the 10 to 15 thousand tons of ash produced daily from the incinerated refuse is also landfilled.

Three different technologies are used for municipal refuse incineration: starved air modular, rotary kiln, and excess air grate. Refuse incineration may simply involve feeding mixed wastes to an incinerator followed by landfilling the noncombustible residue, or it may consist of fairly sophisticated separation of glass, and ferrous and nonferrous metals followed by incineration of the remaining combustibles, possibly involving heat recovery by steam generation. Emissions from existing facilities are generally controlled with electrostatic precipitators. Other emission control methods that could be used include fabric filters, wet scrubbers, or dry scrubbers combined with fabric filters.

Table 4-21. Estimated Total Costs and Times for Potentially Agent Contaminated Concrete

Type of Cost	Costs at Sites (Millions of Dollars Except as Noted) APG	PUDA*	UMDA	NAAP
Mod. Costs				
DFS Feed System	N/A**	0.1	0.1	N/A
MPF Feed System	0.1	--	--	0.1
DFS Refractory	N/A	0.1	0.1	N/A
Permitting	0.65	0.45	0.45	0.25
Trial Burn	0.53	0.53	0.53	0.53
Total O&M[a]	1,575	1,283	19	42
Total Cost	1,576	1,284	20	43
Time (months)	849	664	10	23
O&M ($000/ton)[b]	10.5	3.8	3.8	10.5
Quantity (ton)	150,000	337,500	5,000	4,025

Note: Dashes indicate no cost incurred; MPF will not be used.

*Includes Rocky Mountain Arsenal buildings.
**N/A • not applicable.

[a]Total O&M = O&M ($000/ton) x Quantity (ton)/1000.
[b]Assume same O&M cost as for agent contaminated soil.

There are about 150 municipal waste incinerators in the country with capacities ranging from 25 tons per day to 3,000 tons per day. The majority of these are in the 100 to 300 tons per day range (House of Representatives, 1987).

Hospital wastes are normally decontaminated in a refractory-lined multiple chamber incinerator or occasionally in a refractory-lined rotary kiln incinerator. Incineration temperature ranges from 1,000°F to 1,800°F in the primary chamber and from 1,800°F to 2,200°F in the secondary chamber. Based on the size of the incinerator, the throughput rate could vary from 1,300 to 4,400 pounds per hour (Neulicht, 1989). The pollution abatement system connected to hospital incinerators include quench towers, wet scrubbers, dry scrubbers, and fabric filters (baghouse).

The operating and maintenance (O&M) costs for disposal of municipal and other nonhazardous waste by commercially available methods and by use of the chemical demilitarization plants is presented in table 4-22. Detailed explanations of these costs can be found in appendix E.

Table 4-22. Municipal and Other Nonhazardous Waste Disposal O&M Cost Estimates

	Incinerator	CSDP	CAMDS	CIDP
O&M Disposal Cost Thousands of dollars/Ton				
Municipal Waste	0.025	3.3[a]	2.0[a]	0.7[a]
Medical Waste	0.50	3.3[a]	2.0[a]	0.7[a]

[a]O&M costs for hazardous waste were used to approximate municipal and other non-hazardous waste costs.

It appears from the table that the commercially available methods for disposal of municipal waste are less expensive than using the chemical demilitarization facilities. There are two major reasons for this. First, the chemical demilitarization facilities are much smaller than the commercially available incinerators, resulting in a lower throughput and higher cost per ton. Secondly, the compartmentalized configuration of the chemical demilitarization plant is designed to ensure worker safety when conducting chemical surety operations. This configuration is very inefficient when such precautions are unnecessary.

In general, it does not appear to be economical to incinerate medical wastes in the chemical demilitarization facilities. Hospital incinerators are usually much smaller and simpler than the chemical demilitarization incinerators. Sixty percent of the hospital incinerators have throughput

rates of less than 200 pounds per hour (EPA, 1988) while the chemical demilitarization throughput rates are estimated at over 1,000 pounds per hour. A throughput rate disparity of this magnitude implies that the larger incinerator is inefficient to run because of fixed staffing and overhead costs, even though the quantity of waste to be incinerated is small. Also, it is important to minimize the handling of medical waste to reduce risk of exposure to disease. Thus, on-site incinerators are preferable to off-site ones. For these reasons, medical waste does not appear to be a good candidate for future use of the chemical demilitarization facilities. If the quantity and characteristics of medical wastes at a particular site change during the primary mission, further evaluation of medical waste incineration in the chemical demilitarization facility may be warranted.

SECTION 5

MANAGEMENT OPTIONS FOR FUTURE USES OF THE CHEMICAL DISPOSAL FACILITIES

Management options for the chemical disposal facilities are alternative approaches for their ownership and operation following the completion of their initial missions of supporting and carrying out the Chemical Stockpile Disposal Program. Management options fall into three basic categories:

1. Government ownership and operation
2. Government ownership and contractor operation
3. Transfer to nongovernment ownership and operation

The following subsections discuss and compare the three basic categories and some minor variations (e.g., government leasing to a private concern), and table 5-1 summarizes this discussion.

5.1 GOVERNMENT OWNERSHIP AND OPERATION

Under this basic approach, the government retains ownership of plants and facilities, and they are fully staffed by government employees (although title to the facility could be transferred to another government entity).

In the entire Chemical Stockpile Disposal Program, only a single facility is currently both owned and operated by the government: the CAMDS pilot plant at Tooele Army Depot, Utah. CAMDS has played a unique and vital role as both technology test bed and limited-scale chemical weapons destruction facility in this program. Its primary contribution to the CSDP has been engineering scale component development and integrated systems testing for the reverse assembly demilitarization process, currently undergoing full-scale Operational Verification Testing at JACADS. In addition, CAMDS may also be used for testing of some components and subsystems for cryofracture process development. CAMDS also has been utilized to destroy unserviceable chemical warfare stocks stored at TEAD. CAMDS is, therefore, a paradigm of an instance where government ownership and operation have been beneficial. It is a one-of-a kind facility with a high degree of adaptability and flexibility to assume multiple and changing roles. This same flexibility also limits the practicability of contractor operation. Evolving roles, especially in technology development, make contracting for specific operating services difficult since both operational and management needs will change in ways that cannot always be specified in advance. Retaining a government owned and operated facility also provides a resource where the government can

Table 5-l. Summary of Management Options for Future Uses of the Chemical Disposal Facilities

Option/Variant	Advantages	Disadvantages	Comments/Issues
1. Government owned, government operated ("GOGO") - Includes transfer to othu government organizations	. Remains under full government control and is available for additional future uses/missions	• Need to maintain permanent government personnel slots for operation	• Optimum situation for small, versatile facilities (e.g., CAMDS) for future R&D or other small-scale • pmia1ir.d uses
2. Government-owned, contractor-operated ("GOCO") - Includes leasing to private firma	• Remains under government control and is • vailabl* for additional future uses/missions	• Liability controversy over worker safety and • virommatal concerns - Poor DOE, DOD GOCO performance and public perception (e.g., DOD arsenals and plants, DOE weapons production complex)	• Regulatory compliance requirements and indemnity concerns must be worked out in advance and specified in contract8
	• Staffing not constrained by government ceilings		• Cm leased facilities be used for non-DOD purposes as well? (Change P.L. 98-407?)
	• Flexibility in hiring md compensation to obtain required personnel skills	• Current DOD policy is divestiture of GOCOs	
	• Access to unique corporate capabilities not found or difficult to duplicate in government	• Process DOD wastes only	
	• ⊞⊡⊠♦ • ffoctivo - pay only for services needed over the time required	• Still requires core of government technical and management personnel (QA, auditors, • ⊠⊞⊠♦⊡⊥⊿⊿⊞⊠⊡	
	• Leasing could provide revenues		

Table 5-1. Summary of Management Options for Future Uses of the Chemical Disposal Facilities (Concluded)

Option/Variant	Advantages	Disadvantages	Comments/Issues
3. Transfer to non-government ownership - Excessing of plant and lands - Demolition, salvage of plant and equipment	• Ownership (operation, maintenance) costs eliminated after CSDP • Revenues from sale of facility • PL 99-145 would not have to be changed in cases where plant is decommissioned and salvaged • Create new enterprise □□□□□♦♦■※♦⊠ for private sector investment • Could process non-defense wastes	• Plant/Land must undergo Army and RCRA clean closure before sale or transfer - All facility equipment "5X" tantamount to destroying much of the plant's value - Excessing of plant. property not practicalable if installation not being realigned	• Only option for realigning installations

develop and maintain a core of technical and management expertise to support other program needs, including management and oversight of other similar government-owned, contractor-operated facilities.

Disadvantages of government ownership and operation are that the government must maintain permanent staffing and incur all related cost burdens for the indefinite future. Adding and subtracting permanent government personnel are also complex. The government also assumes full liability for employee and public health and safety as well as environmental compliance. Finally, the facility could not be used to treat or dispose of non-DOD wastes as long as it remains under ownership of the DOD (Public Law 98-407).

5.2 GOVERNMENT OWNERSHIP AND CONTRACTOR OPERATION

In this basic approach, the federal government retains title to the facility, but contracts for (or otherwise transfers responsibility for) its operation to a nongovernment entity. This option also includes leasing of a government facility to another organization for both government and/or private uses. This approach, commonly known as "GOCO" for government-owned, contractor-operated, has been the primary means by which both the Departments of Defense and Energy have provided for operation of the nation's major military production facilities (ammunition plants, arsenals, and nuclear weapons production plants). It also is the approach selected by the Army for operation of the BZ destruction plant at Pine Bluff Arsenal, the JACADS plant, and the eight CSDP plants to be built in the continental United States.

The GOCO approach has some significant advantages for accomplishment of missions or activities requiring resources not available from within the government in a timely fashion. Contracting for plant operation provides flexibility in staffing and compensation not available under federal government personnel management practices, thereby allowing the government to access the special skills and expertise of both individuals and corporations. This flexibility is especially valuable in technical efforts taking place in remote locations where federal civil service compensation limitations might not be adequate to attract skilled employees from elsewhere in the federal government. Also, capabilities can be obtained, on an as-needed basis, for the duration of the specific project or mission, thereby eliminating the administrative and cost burdens associated with reassigning permanent government personnel upon mission completion. The government pays only for the specific capabilities it needs over the time needed. This is an especially beneficial aspect of the GOCO approach for the CSDP since operations at each stockpile site are planned to range from one to five years only.

A further advantage in retaining government ownership is government control over alternative uses and, therefore, assurance of availability for future demilitarization efforts on an as-required plant basis.

In spite of these advantages, the basic concept of GOCOs has come under increasing criticism and scrutiny in recent years because of the poor record of performance in employee health and safety and environmental compliance at DOD and DOE facilities. Congressional hearings have dealt at length with GOCO problems, and Congress has broadly criticized the system for a breakdown in management controls over environment, health, and safety matters, and for the need for restructuring the government-contractor relationship in the GOCO system (e.g., House of Representatives Committee on Armed Services, Environmental Restoration Panel, May 2, 1989; H-201-7). The intent of DOD, as described in the opening remarks at the above-cited hearing, is "... to limit the government's environmental liability at GOCO operations, including vigorous efforts to divest itself of as many GOCO's as is possible" (ibid, p. 255). Issues in the government-contractor relationship concern assignment of liability and indemnity for environmental cleanup, and responsibility for RCRA permit compliance. DOD's present interpretation is that if "...the government provides the facility, we [the government] can be responsible for environmental noncompliance due to facility limitations...." (statement of William H. Parker, Deputy Assistant Secretary of Defense-Environment, op. cit., p. 256). Also, DOD presently interprets the contractor's role in environmental liability as operational compliance with laws and regulations and as signatory parties on applicable (e.g., RCRA) permits.

The regulators' approach toward this controversy, as represented by the EPA, is to "...take enforcement actions against other private parties," (op. cit., p. 355), and "...contractors are in fact responsible for complying with the law and for full compliance with our [EPA's] regulations" (ibid., p. 356).

Resolution of the issues of liability and regulatory compliance continues to evolve with various legislative and regulatory agency initiatives to clarify owner and contractor responsibilities, establish limits on liability and indemnification, and define interagency regulatory enforcement policies.

5.3 TRANSFER TO NONGOVERNMENT OWNERSHIP

Under this option, title to the facilities could be excessed to nongovernment entities in two different ways.

First, the entire plant or facility, including buildings and land, could be transferred by sale or donation. This approach is subject to

limitations. Army regulations and RCRA requirements both stipulate "clean closure" of the facility prior to transfer to any nongovernment entity. For the Army, this means that all previously agent-contaminated (including surface or XXX decontaminated) equipment, materials, and structures be subject to thermal, or XXXXX, decontamination at 1,000°F, for 15 minutes [AMC--R 385-131, 5-l a.(3)]. In addition, permit requirements also stipulate certifiable decontamination, removal, and disposal of any hazardous by-product materials or incinerator residues as conditions for clean closure of a permitted incinerator facility. These requirements would, therefore, result in de facto demolition and destruction of significant portions of plant equipment and property, thereby substantially reducing a facility's overall potential usefulness and value (as in the case of the remaining portions of the BZ destruction facility at Pine Bluff Arsenal). Also, in instances where the land on which a facility or plant is constructed also is planned for excessing, this would have to be implemented in such a fashion that future use of the land (and remaining parts of the facility) would not introduce conflicts with the surrounding installation's future missions and land uses. That is, this approach is best suited to cases where a demilitarization facility is to be excessed as part of a host installation realignment.

The second approach is to proceed with dismantling and XXXXX decontamination of the plant, and sale and removal of salvaged equipment and material while the land itself remains under government custody. Again, Army and EPA (or state) requirements for decontamination and clean closure would apply. Salvageable equipment (furnace parts, some pollution abatement system components, and other "downstream" equipment) could be broken out and sold, and the remaining buildings and structures removed or released along with the land for other DOD use.

Under both of the above options, government liability for continuing use would be eliminated after decommissioning and clean closure. Also, since the facility itself must be decontaminated in such a fashion as to render it no longer useful (without major rehabilitation and reconstruction), Public Law 99-145 would effectively be complied with. A small amount of revenue would also be realized from the sale of released assets.

SECTION 6

CONCLUSIONS

A wide variety of DOD and non-DOD wastes and contaminated materials exist that are amenable to disposal or decontamination by incineration. These items consist of:

- Conventional munitions in the demilitarization and disposal inventory
- Items containing or contaminated with chemical warfare agent but not in the stockpile scheduled for destruction in the chemical demilitarization plants (e.g., range recovered chemical munitions, chemical agent identification sets, empty or decontamination solution-filled one-ton containers, excess chemical surety material, and items contaminated during maintenance of the chemical warfare stockpile)
- Buildings and equipment contaminated with chemical warfare agent and/or other hazardous or toxic substances
- Soils contaminated with chemical warfare agent, agent breakdown products, explosives, and/or other hazardous substances, such as PCBs, oil, and solvents
- Hazardous wastes from routine daily activities (medical wastes from military hospitals and clinics)
- Conventional trash, including packaging materials, wooden pallets, and paper. Non-DOD wastes include hazardous and nonhazardous wastes from commercial and industrial activities, civilian hospitals and clinics, and municipal nonhazardous wastes

In this section the findings of this study are summarized with respect to using the chemical demilitarization plants, after the completion of their primary mission for disposal and decontamination of these items.

In section 6.1 the findings of this report are discussed with respect to the feasibility and desirability of using the chemical demilitarization plants for other purposes. In section 6.2 regulatory changes are identified that would be required to permit or facilitate other uses of the chemical demilitarization plants. In section 6.3 recommendations are provided with respect to managing the chemical demilitarization plants if and when they are used for other purposes.

6.1 FEASIBILITY AND DESIRABILITY OF FUTURE USES OF THE CHEMICAL DISPOSAL FACILITIES

6.1.1 Demilitarization of Conventional Munitions

The chemical disposal facilities use several different types of incinerators: a rotary kiln, a liquid injection incinerator, a hearth type metal parts (flashing) furnace, and a hearth type dunnage (trash) incinerator. The incinerators are equipped with afterburners, to assure complete combustion of residual organic compounds, and with pollution abatement systems for efficient capture of acid gases and particulates to comply with stringent environmental protection regulations.

A rotary kiln type incinerator, the APE 1236, is commonly used by the Army to demilitarize conventional munitions including small arms, smokes and riot agents, and the fuzes and plugs from large conventional munitions. Another rotary kiln, the EWI, is used by the Army to incinerate bulk explosives and propellant charges. The EWI is similar to the APE 1236, but has a positive feed mechanism for transferring the explosives and propellants into the kiln. The rotary kilns of the chemical demilitarization plants are very similar to the APE 1236, the primary difference being that the CSDP kilns are longer and larger in diameter. Therefore, they are capable of demilitarizing the same munitions as the APE 1236 without any modification. The chemical demilitarization plant rotary kiln will be able to operate at a higher throughput rate than the APE 1236 because of its larger size. For smoke and riot agent munitions, it may be necessary to add a baghouse to the pollution abatement system to assure efficient collection of particulates.

The chemical demilitarization plant rotary kilns can also be adapted to incinerate bulk explosives and propellant charges by the addition of a feed mechanism, such as the one used on the EWI. The metal parts furnace of the chemical demilitarization plants could be used to decontaminate the munition bodies of large conventional munitions and the metal containers of some bulk explosives after their explosive content has been removed. The dunnage furnace would serve a similar function to that in the chemical demilitarization plant: incineration of wood pallets and packaging materials. The disassembly equipment in the chemical demilitarization plants could be used to disassemble large conventional munitions that are the high explosive version of chemical munitions. Some of the equipment may also be adapted for punching and/or shearing (or, in the case of the CIDP, cryotreating and shearing or crushing) mines, grenades, large munitions and bulk energetics. Washout/meltout facilities would have to be added to the demilitarization complex to remove the explosives from large mines, other large munitions, and bulk energetic containers.

This study indicates that the Army currently has sufficient capacity in existing APE 1236 incinerators with upgraded pollution abatement systems to dispose of the stockpile of small arms in the demilitarization and disposal inventory within a reasonable time period (<5 years). With the exception of the CAMDS facility, the operation and maintenance unit costs for demilitarization of small arms in the chemical demilitarization plants are more than twice the costs in existing APE 1236 incinerators. Additional costs would be incurred for permits, trial burns, and possible modifications. Therefore, use of the chemical demilitarization plants other than CAMDS for demilitarization of small arms, while technically feasible, does not appear to be economically desirable. The CAMDS deactivation furnace and associated pollution abatement system is competitive with the upgraded APE 1236 incinerator for demilitarization of small arms. It could be permitted for this service in about a year (Paulick 1991). The use of CAMDS for support of the chemical demilitarization program is being phased out over the next few years. Therefore it might be available for demilitarization of small arms in the demilitarization inventory at TEAD before the APE 1236 could be upgraded and permitted for that purpose. In this case, it might be desirable to use CAKDS to demilitarize the small arms at TEAD.

For demilitarization of smoke and riot agent munitions, the CAMDS, CIDP, and CDF plant operation and maintenance unit costs are competitive with the APE 1236 incinerators. The quantity of smoke and riot agent munitions in the demilitarization inventory at all sites, except Pine Bluff, is relatively small; therefore, the fixed costs of obtaining a permit, conducting a trial burn, and adding disassembly equipment and a baghouse are a significant fraction of the total cost of their disposal in the chemical demilitarization plants at those sites.

The existing APE 1236 incinerators appear to have sufficient capacity to demilitarize the smoke and riot agent munitions in the demilitarization and disposal inventory within about a year. However, it was noted that Pine Bluff Arsenal has the largest quantity of smoke and riot agent munitions among the chemical demilitarization plants (over 3.5 times the amount at the location with the next highest amount), Pine Bluff Arsenal is also equipped with two incinerators that already have permits to dispose of smoke and riot agent munitions. It may, therefore, be worth considering making Pine Bluff Arsenal a national disposal facility for smoke and riot agent munitions. If additional capacity is needed at Pine Bluff, consideration should be given to moving the BZ plant rotary kiln into the incinerator complex at Pine Bluff. When the Pine Bluff CDF completes its mission, its rotary kiln could also be incorporated into the Pine Bluff incinerator complex if additional or replacement capacity is needed. The Pine Bluff community is generally supportive of the activities at Pine Bluff Arsenal and is likely to support use of Pine Bluff as a regional facility for demilitarization of smoke and riot agent munitions.

Large conventional munitions and bulk energetics are preferentially disposed of by open burning and open detonation (OB/OD). This method of disposal is significantly less expensive than controlled burning by incineration. For large munitions the cost of OB/OD is between 10 and 20 percent of the O&M cost of incineration in the chemical demilitarization facilities. For propellants and bulk explosives the OB/OD costs are between 1 and 33 percent of the cost of incineration in the chemical demilitarization plants. The operating and maintenance unit costs for using the chemical demilitarization facilities for demilitarization of large conventional munitions and bulk energetics is several times greater than for using the conventional EWI and APE 1236 incinerators. Thus, although there is insufficient existing incinerator capacity to dispose of the large conventional munitions and bulk energetics in a timely manner, it is likely to be more cost effective to design and construct facilities specifically for this purpose if OB/OD is prohibited, rather than to use the chemical demilitarization plants for this purpose. If such facilities are built, consideration should be given to constructing regional facilities since, at locations with relatively small inventories (e.g., Anniston, Umatilla, Pine Bluff, and Lexington-Blue Grass), the fixed costs could be a major portion of the total demilitarization cost. CAMDS could be used to test and evaluate alternative technologies for demilitarization of large conventional munitions and bulk energetics.

6.1.2 Disposal of Nonstockpile Chemical Items

Nonstockpile chemical items include range recovered chemical munitions, unwanted chemical surety material, including neat agent, items contaminated with agent during maintenance of the chemical stockpile, spent decontamination solutions, CAIS, and empty or decontamination solution filled XXX agent ton containers. The two primary methods for disposing of these items are chemical decontamination followed by disposal in a RCRA approved hazardous waste landfill and thermal destruction by incineration. The latter is preferred because hazardous waste landfills are scarce and, in the case of contaminated metals, the thermally decontaminated metal might be salable as scrap.

The chemical demilitarization plants are specifically designed to destroy and/or decontaminate chemical warfare agent contaminated items and therefore are generally ideally suited for disposal of these items. Spent decontamination solutions can be incinerated in the afterburner of the liquid incinerator in the same way that such solutions that are generated during operation of the chemical demilitarization plants will be incinerated. Contaminated tools, protective clothing, and other items can be decontaminated or destroyed in the dunnage incinerator or the metal parts furnace. The CAIS can be incinerated in the deactivation furnace. The small numbers of CAIS or other buried items at Ft. Benning, Georgia and the Memphis Defense Depot, where no chemical demilitarization plants

are to be constructed, should be overpacked and shipped to a nearby CDF. The XXX ton containers can be thermally decontaminated to XXXXX in the metal parts furnace in the same manner as the ton containers that are in the chemical stockpile. Ton containers that are located at sites that will not have a chemical demilitarization plant need to be transported to one that does. In particular, there are 4,300 empty ton containers at Rocky Mountain Arsenal (AMXRM-PM memorandum, 29 August, 1989 as cited by SDSTE-PAV memorandum, 3 January, 1991) that should be transported to Tooele Army Depot for decontamination. They can be decontaminated in the CAMDS metal parts furnace, expected to be available for this purpose in 1994, much sooner than at other chemical demilitarization plants.

There are 4 ton containers of neat (bulk) VX agent at Aberdeen Proving Ground that are no longer needed. Since the Aberdeen CDF will be designed and permitted for mustard, and the quantity of VX is small, it is not recommended that the VX be destroyed in the Aberdeen CDF. It is recommended, instead, that the VX be chemically neutralized and the resulting solution be incinerated in an existing Decon/Detox incinerator facility that already has an environmental permit for this activity. The empty ton containers from this operation could also be thermally decontaminated in the same facility. Using this procedure, the VX would be eliminated well before any chemical demilitarization facilities became available.

Chemical munitions have been recovered from burial grounds and testing areas at Tooele Army Depot, Anniston Army Depot, Dugway Proving Ground, Aberdeen Proving Ground, Redstone Arsenal, and Pine Bluff Arsenal. In addition, chemical munitions from World War II have recently been found on islands in the South Pacific, specifically, the Solomon Islands. Depending on the condition of these munitions, they may be more difficult to demilitarize than the normal chemical stockpile items and may require additional specialized equipment for disassembly. Processing may need to be carried out in a slow, deliberate manner. The chemical demilitarization facilities are generally suitable for processing such items and can be flexibly operated. The chemical demilitarization plant at Aberdeen, however, is only scheduled to have a bulk item facility. Therefore, it will not be possible to use this facility for range recovered chemical munitions other than bulk items and bombs. An alternate means of disposal of the range recovered chemical munitions stored at Aberdeen will have to be investigated. It is recommended that the items in the South Pacific be transported to Johnston Island for processing, and items recovered at Dugway be sent to the Tooele Army Depot for disposal in the chemical demilitarization plant or at CAMDS.

It is not unreasonable to expect that chemical munitions might continue to be found on the islands of the South Pacific. Also, installation restoration activities at Army installations are likely to uncover

additional chemical munitions, particularly at Dugway, Tooele, Redstone, and Aberdeen, and possibly at Yuma Proving Ground and Hawthorne Army Ammunition Plant. One or more facilities may be needed to properly demilitarize these items if safe transportation methods for small numbers of range recovered items are developed and permitted. If transportation of such items is not permitted, then appropriate methods for demilitarizing these items would need to be developed and installed at each location where they are found.

The chemical disposal facilities are designed for demilitarization of relatively large quantities of munitions of uniform characteristics. They are likely to be inefficient for processing a wide variety of unique and possibly deteriorated munitions, such as are expected to be found during installation restoration activities. Therefore, it is not recommended that the chemical disposal facilities be maintained for such use after the existing stockpile, and such range recovered chemical munitions as are in storage when the chemical demilitarization plants complete their mission, are destroyed. The CIDP is potentially more flexible than the chemical disposal facilities and warrants further study since in the cryofracture process, munitions are crushed rather than disassembled, and thus the knowledge of the internal configuration of the munitions is of less concern. Use of the CIDP for disposal of nonstandard and range recovered munitions should be considered. The CARDS facility, being a pilot plant operation, is also inherently more flexible than the chemical disposal facilities and may therefore also be useful for demilitarization of range recovered munitions.

The chemical munitions buried at Redstone Arsenal represent an unknown quantity and condition. A program should be implemented to safely recover and store these items, and to assess their condition. At that time a decision can be made as to the wisdom of either moving them to the Anniston CDF for disposal or using a small on-site incinerator.

6.1.3 Disposal of Hazardous Waste

The incinerators of the chemical disposal facilities are inherently capable of disposing of combustible hazardous wastes. Such wastes consist of a variety of liquids, solids, and sludges in drums or bulk containers. Such wastes are generated at DOD installations during routine daily activities, particularly during maintenance of vehicles, aircraft, and facilities. Industrial and commercial activities in the U.S. and in the communities near the DOD installations also generate these wastes. The incinerators of the chemical disposal facilities are relatively small compared to incinerators used by commercial hazardous waste disposal companies. For example, a typical commercial rotary kiln is designed to handle 75-100 million Btu per hour whereas the present JACADS rotary kiln is designed to handle about 15 million Btu per hour.

Similarly, typical liquid injection incinerators have a capacity of 1,500 gallons per hour whereas the liquid incinerators for the CDFs are designed for about 70 gallons per hour. Therefore, the chemical demilitarization facilities would have higher unit operating and maintenance costs than the typical commercial facility. The higher unit cost occurs because the fixed costs for operating personnel and a laboratory do not vary significantly with the size of the incinerator. Only the CIDP rotary kiln, which is larger than the CDF or CAMDS kilns, is potentially competitive for disposal of hazardous waste by incineration.

6.1.4 Bemediation of Contaminated Soils

One method of decontamination of soils (contaminated with either chemical agent or any other organic compound) is excavation and thermal treatment in a rotary kiln incinerator to volatilize and incinerate contaminants. Potentially large volumes of contaminated soil exist at DOD installations that may require remedial action under CERCLA. It is estimated that there are over one million cubic yards of soil contaminated with explosive compounds at U.S. Army installations across the country.

On Johnston Island there is between 6,000 and 18,000 tons of Herbicide Orange contaminated coral. Over 2.4 million tons of potentially agent and agent byproduct contaminated soil might exist at the installations where chemical demilitarization plants are scheduled to be built. This material is a result of past testing activities, spills, and demilitarization and burial of chemical munitions. The capacities of the chemical demilitarization facility incinerators for soil incineration vary from 0.5 tons per hour in the CAMDS deactivation furnace to 5 tons per hour for the CIDP kiln. This compares with a range of 5 to more than 10 tons per hour for a commercial soil incinerator and up to 10 tons per hour for a specially designed mobile or transportable rotary kiln, Because of the potentially large volumes of contaminated soil and the relatively low soil incineration rates of the chemical demilitarization incinerators, it could take hundreds of years and cost billions of dollars to decontaminate the soils at Tooele Army Depot and Aberdeen Proving Ground, For these areas, it would be more appropriate to consider the following remedies:

- Excavate, store, and assess the materials (munitions and soils) in the chemical weapons landfills.
- Use a larger rotary kiln to decontaminate these soils and return the sites to an environmentally acceptable condition.
- Develop equipment to handle the recovered munitions on site.

The estimated relatively low volumes of contaminated soil at the other locations of the chemical demilitarization plants may make the option of using these plants for soil decontamination worth considering although at Newport Army Ammunition Plant, which will not have a rotary kiln, it could take over 7 years and 155 million dollars to decontaminate the soil. For this reason, the movement of the LBAD rotary kiln (i.e., deactivation furnace) from LBAD to NAAP to help speed this process and to reduce costs could be considered, once the LBAD operation is complete. Alternatively, the soil could be chemically decontaminated to XXX condition and shipped for processing to a CDF containing a deactivation furnace.

Incineration of the Herbicide Orange contaminated coral on Johnston Island in the JACADS deactivation furnace is viable if a less costly method to deal with the problem is not found.

6.1.5 Decontamination of Agent Contaminated Buildings and Equipment

Numerous buildings at Aberdeen Proving Ground, Pueblo Army Depot, Rocky Mountain Arsenal, Umatilla Depot Activity, and Newport Army Ammunition Plant might be contaminated with agent or agent breakdown products as a result of manufacture, testing, filling, and demilitarization of chemical warfare agent and munitions. Equipment in the buildings might also be contaminated. When these buildings are no longer needed and have to be torn down, they might need to be decontaminated before disposal. Agent and agent byproduct contaminated material and equipment may also be recovered from old burial grounds during remedial action, such as is occurring at Rocky Mountain Arsenal. A proven process for decontamination of these items is dismantling and thermal treatment in a metal parts furnace or rotary kiln. Thus, the chemical demilitarization plant incinerators can potentially be used for this purpose.

Because of the potentially large volume of building structures and equipment at Newport and Aberdeen, it is estimated to take about 5 and 8 years, respectively, to thermally decontaminate the items in the chemical demilitarization plants at those locations and is estimated to cost 86 and 119 million dollars, respectively, to do so. At UMDA and PUDA (including equipment from RMA) it would take about 1 month and 4 months, respectively and cost 1 and 9 million dollars, respectively. These estimates are for potentially contaminated metal structures and equipment. Concrete and masonry structures are more costly to decontaminate and there is potentially a large volume of such structures to decontaminate at Aberdeen and Pueblo Army Depot (including Rocky Mountain Arsenal). It is estimated to take over 50 years and cost close to 3 billion dollars to decontaminate concrete structures at these locations in the chemical

demilitarization plants, given the throughput rates of the furnaces in these plants. Other building decontamination methods currently under investigation by the Army, such as hot air thermal decontamination of monolithic concrete structures, may prove to be more cost effective.

6.1.6 Disposal of Municipal and Other Nonhazardous Waste

Incinerators for municipal and other nonhazardous wastes generally have capacities ranging from 25 to 3,000 tons per day. The capacity of the chemical demilitarization plants for such waste approaches the lower end of that range. However, because of the compartmentalized configuration of the chemical demilitarization plants--designed to assure safety for chemical surety activities--the plants are less efficient for other operations. Disposal costs for the municipal and other nonhazardous wastes in the chemical demilitarization plants ranges between 3 and 150 times the disposal costs in conventional plants. Further consideration of use of these plants for industry does not seem desirable at this time. Perhaps the best way to test this conclusion is to offer the chemical disposal facilities at locations scheduled for realignment (such as PUDA or UMDA) for sale either to state or commercial enterprises. Market economics and local political/waste disposal needs would ultimately decide the fate of the plants and equipment.

6.2 IMPLICATIONS OF REGULATORY REQUIREMENTS ON FUTURE USE OF THE CHEMICAL DISPOSAL FACILITIES

The laws and regulations that influence potential future uses of the chemical demilitarization plants were described in section 4.1. Those specific laws and regulations which, if not changed, could hinder future uses of the plants are discussed below. Amendments and other changes to these laws and regulations that could facilitate future uses are also noted. Because of the continuing evolution of regulatory requirements, it is recommended that any plant modifications that may be required for future use be delayed until the plants become available for other uses. This will allow compliance with legal requirements in effect at the time. Also, alternative and more cost effective technology may be developed in the interim.

6.2.1 Federal Regulations

Public Law 99-145. PL 99-145 is the focus of this study since, as it is currently written, it explicitly prohibits any subsequent use of the demilitarization plants upon completion of the Chemical Stockpile Disposal Program. For any intact uses of the plant (e.g., other than sale of XXXXX decontaminated, salvaged equipment and material), this law would have to be amended.

The law also needs to be clarified with respect to using the plants for disposal of non-stockpile chemical surety material. These items are not included in the list of chemical stockpile items existing on the date of enactment of PL 99-145. However, the law states that "facilities constructed to carry out this section '(destruction of existing stockpile of lethal chemical agents and munitions)' may not be used for any purpose other than the destruction of lethal chemical weapons and munitions, and when no longer needed to carry out this section, such facilities shall be cleaned, dismantled, and disposed of in accordance with applicable laws and regulation." This could be interpreted as allowing the use of the plants to dispose of range-recovered munitions containing or suspected of containing agent, as well as for disposal of any unwanted neat agent. Any use of the facilities for such purpose would need to be specified in any applicable facility permits in any case.

Public Law 98-407. This law, and its corresponding Army regulation (AR 200-1, 1-35 [a][6]), prohibit the use of any DOD facility for the storage or disposal of any non-DOD toxic or hazardous wastes. Thus, PL-98-407 will have to be changed to permit any future uses involving disposal of non-DOD wastes in any facility that remains in DOD custody, should such uses be considered desirable.

CERCLA. With the enactment of SARA, cleanup actions at DOD installations previously exempted from CERCLA requirements became subject to CERCLA procedures and subject to other environmental laws and regulations as a result of their being determined applicable, relevant, and appropriate (ARAR). As a result, RCRA, the Clean Air Act, the Toxic Substances Control Act and all other federal, state and local regulations and permitting requirements are potentially applicable to CERCLA actions at federal facilities. CERCLA § (2) (e), however, exempts CERCLA actions from RCRA permits if the remedial action is "on site", and meets the technical requirements of applicable laws and regulations (see section 4.1.1.2). The EPA has interpreted "on site" as including only the area1 extent of contamination and any contiguous area required for implementation of the response actions. Therefore, a demilitarization plant at an installation would require a RCRA incinerator permit or modifications to allow use in the remedial action, even though it is within the same installation boundaries. CERCLA § 121 could be amended to allow use of demilitarization plants (as well as other installation treatment and disposal facilities) for CERCLA-type remedial actions on DOD installations without the need for a RCRA permit, as long as applicable or relevant and appropriate standards are met, as is presently the case with the EPA-defined "on site" remediations. A clarification or amendment of this type could facilitate use of demilitarization plants for the cleanup of waste sites at federal facilities if their use for this purpose is otherwise feasible or desirable.

A special case exists that encompasses the cleanup of areas formerly used as chemical weapons landfills. The Army has raised concerns regarding the cleanup of such areas for several reasons: (1) adverse publicity for past practices; (2) lack of funding; and (3) fear of violating the complex body of environmental regulations enacted covering these hazardous chemicals. Consequently, for many years no action has occurred except for limited cases where such landfills were accidentally uncovered or where limited funding became available. Congress could promote the cleanup of these sites by (1) passing legislation mandating their cleanup and thus limiting debate over the subject; (2) providing specific funding for such a cleanup; and (3) wording the law so that it is understood that some limited quantities of agent might be released during cleanup operations, but that as long as the public health is not threatened, this is an acceptable counter-effect to the ultimate cleanup of sites that threaten land, water, and air resources.

RCRA. Beyond Public Law 99-145, RCRA has the largest potential to affect the demilitarization plant future use options. RCRA's comprehensive and prescriptive body of regulations, together with its involvement of state and local jurisdictions, introduce uncertainty and complexity in determining the regulatory desirability of any future use.

Under RCRA, full authority for issuance of permits and enforcement of regulations can be vested with individual states as long as their programs comply with federal standards and are approved by the EPA. Language in RCRA (e.g., 40 CER 271) allows the states to independently develop and enforce regulations of their own that can either be more stringent than, or in addition to, federal requirements as long as the federal requirements are met. The states, therefore, have considerable latitude in their RCRA enforcement programs in how permits are issued and what performance standards permit holders must meet (see section 4.1.3). Under this approach, state regulators if they so choose, may effectively preclude incineration of hazardous wastes in their states through the implementation of regulations and standards that make operation of incinerators neither technically feasible nor economically desirable.

To address the special cases where such prohibitive state requirements are preventing cleanups of federal facilities or treatment of specific hazardous wastes (e.g., obsolete conventional or chemical munitions), provisions should be added to RCRA to provide a means for resolving conflicts between federal and state regulations. This could be a process similar to that which can occur under the Hazardous Materials Transportation Act. Here, conflicts between state and federal laws are resolved by either the Secretary of Transportation or, failing this, in federal courts. With such an amendment to RCRA, conflicts between federal and state laws that are blocking hazardous waste disposal efforts could be

resolved by the EPA Administrator in cases where harm to the environment is imminent, or where there may be other overriding national considerations (e.g., treaty compliance, public and military personnel safety).

Clean Air Act. Clean Water Act. The situation with these laws parallels that for RCRA, that is, states are free to develop and enforce their own permitting and enforcement requirements as long as they have a federally-approved program and are in compliance with federal standards as a minimum. Again, these laws could be amended to provide a means for resolving state-federal conflicts in cases where there are overriding national needs for operating hazardous waste treatment and disposal plants at federal facilities.

6.3 MANAGEMENT ALTERNATIVES FOR FUTURE USE

This section is a summary of the management approaches for future use of the demilitarization plants and of the recommended application of these approaches to general categories of future use. The management alternatives discussed here were previously described and compared in section 5.0

Government Ownership and Operation. This approach is best applied to facilities where a variety of missions or uses will be carried out, in sequence or in parallel, and where management, staffing, and operational needs are expected to evolve. This would be the case for the CAMDS facility which, as previously described, has supported the entire Army chemical demilitarization effort by providing a technology test bed and a flexible, limited-scale demilitarization facility for processing relatively small lots of special chemical items. To continue to fill this need in both the Army Chemical Stockpile Disposal Program as a whole and to support disposal operations at TEAD, it is recommended that CAMDS remain as a GOGO for the above reasons. As a government-owned and operated facility it can also be a place where government personnel can obtain technical experience required to support other elements of the CSDP.

Government Ownership and Contractor Operation. This approach, known as GOCO, provides a management option whereby the government can obtain the required resources (management and operations capabilities) on an "as-needed" basis for larger, well-defined projects. The GOCO approach has been selected by the Army for operation of the CSDP plants, JACADS, and the BZ disposal facility because it provides a cost-effective means to carry out peak efforts for specific brief time intervals that also require special personnel capabilities that are either unavailable or costly and time consuming to duplicate in the government.

For those cases where the government either intends, or is required, to retain custody of a demilitarization plant and where a technically feasible and economically desirable use can be identified, use of GOCOs would probably be the most cost-effective approach. Examples might be development of a demilitarization plant into a regional or national facility for disposal of specific types of obsolete munitions (e.g., smokes and dyes), hospital wastes, or other non-stockpile chemical items. Issues concerning contractor indemnity and assignment of liabilities for environment, and health and safety matters need to be &fined in advance and specified in GOCO contracts. This may require a change to Army Regulations that only allow indemnity to be applied for after a contract award.

Transfer to Non-Government Ownership and Operation. This option is best suited to cases where the demilitarization plant is located at an installation scheduled for realignment (PUDA, UMAD and the Bluegrass Activity of LBAD) and for which the government has not identified a feasible or desirable future use. As stated in section 5, however, regulations require both XXXXX decontamination of chemically-contaminated items and RCRA clean closure before custody of the plant can be transferred, in whole or in part, to non-government parties. This would require the dismantling and decontamination of large portions of the plant, effectively necessitating substantial rehabilitation and reconstruction prior to any re-use.

Some equipment removed or salvaged from an excessed plant could be transferred to another plant for use (e.g., relocating the DFS from LBAD to NAAP or APG for reuse in those plants). Since this equipment or material would remain under government control, XXXXX-level decontamination would not be required before transfer and reuse.

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APPENDIX A

DESCRIPTION OF DEMILITARIZATION PLANTS

DCN 5860
Executive Correspondence

DESCRIPTION OF DEMILITARIZATION PLANTS

A.1 CHEMICAL AGENT BZ DEMILITARIZATION PLANT

The BZ Plant is located at Pine Bluff Arsenal (PBA). This plant was in operation from May 1988 to early 1990. It has completed its mission, which was to destroy the entire inventory of BZ-containing munitions, bulk containers of neat BZ, and any waste material containing BZ. Items to be processed were transported from storage to the Munition Holding Area (MI-IA), a small munitions magazine called an "igloo." From there, items were brought to the Munitions Demilitarization Building for processing. Munitions containing pyrotechnic mix were unpacked manually, inerted by soaking in water under pressure, and manually disassembled. Parts containing BZ and energetic material were charged to the Deactivation Furnace (DFS); munition casing and packaging material was charged to the Metals Parts Furnaces (MPF). Bulk BZ, which was contained in drums, was dissolved in acetic acid and the liquid solution was charged to the Liquid Incinerator (LIN).* Spent decontaminating solution and other liquids were also charge to the LIN. Combustion gases from the furnaces were discharged through a heat exchanger and a bag filter to a stack. A maintenance shop and laboratory are located in the Multipurpose Building (MPB). Other buildings at the facility include the Personnel Support Complex (PSC) and the Entry Control Facility (ECF).

The closure procedure for the plant was completed in June 1990. This involved the destruction of all process equipment except the furnaces. The control room and process control equipment remains, but has been disconnected from the process equipment. The remaining facilities include the following:

- Munitions Demilitarization Building.
- The DFS and its afterburner, without the feed chute or connecting fuel, power, and instrument lines. The retort is four feet in diameter. PBA has a self-imposed restriction not to exceed 600 grains of confined TNT explosives per section.
- Four MPFs, with connecting fuel, power, and instrument service intact. Two MPFs are equipped with fume burners and all four are ducted to a common pack-bed afterburner. The charge conveyor to the MPFs exists but is inoperable because the instrumentation and power for the conveyor have been removed.

*The liquid incinerator of the BZ plant is referred to as the LIN in contrast to the liquid incinerator of a CSDP plant which is referred to as the LIC. The LIN is different in design from the LIC.

- The LIN, without its feed system or connecting fuel, power, and instrument lines.
- Baghouse and stack will be dismantled to make room for the installation of the Pine Bluff Chemical Disposal Facility (CDF).
- The MPB will be converted to the Medical and Maintenance Building for the CSDP.
- The ECF will be used by the CDF.
- The PSC will be modified for use by the CDF.

Thus, substantial rehabilitation will be required if the BZ plant is to be used for waste incineration.

A.2 THE CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM

The Chemical Agent Disposal System (CAMDS), located in the South Area of Tooele Army Depot (TEAD), contains a variety of prototype hardware systems and support facilities (figure A-l) that were used for the development and testing of technology for the demilitarization of chemical weapons. CAMDS was also used to demilitarize some of the unserviceable chemical warfare stocks stored at TEAD. The facility continues to be used to refine the JACADS demilitarization process. Some aspects of the cryofracture process may also be tested at CAMDS.

The hardware and operating facilities at CAMDS are listed in table A-l and described below:

- The agent destruction system (ADS) is divided into two parts: the toxic cubicle, and the brine reduction area (BRA). The toxic cubicle is now unused. It consists of two storage tanks, two batch tanks, a chlorine batch tank, a caustic batch tank, and several detoxification reactors and pumps. The BRA is designed to process a variety of nontoxic CAMDS process brines. The BRA consists of holding tanks with transfer pumps, an evaporator, two twin-drum dryers with circulating pumps, two salt conveyors, and two drum loading stations. In the BRA, brines are dewatered and dried, and the solids are removed for disposal.

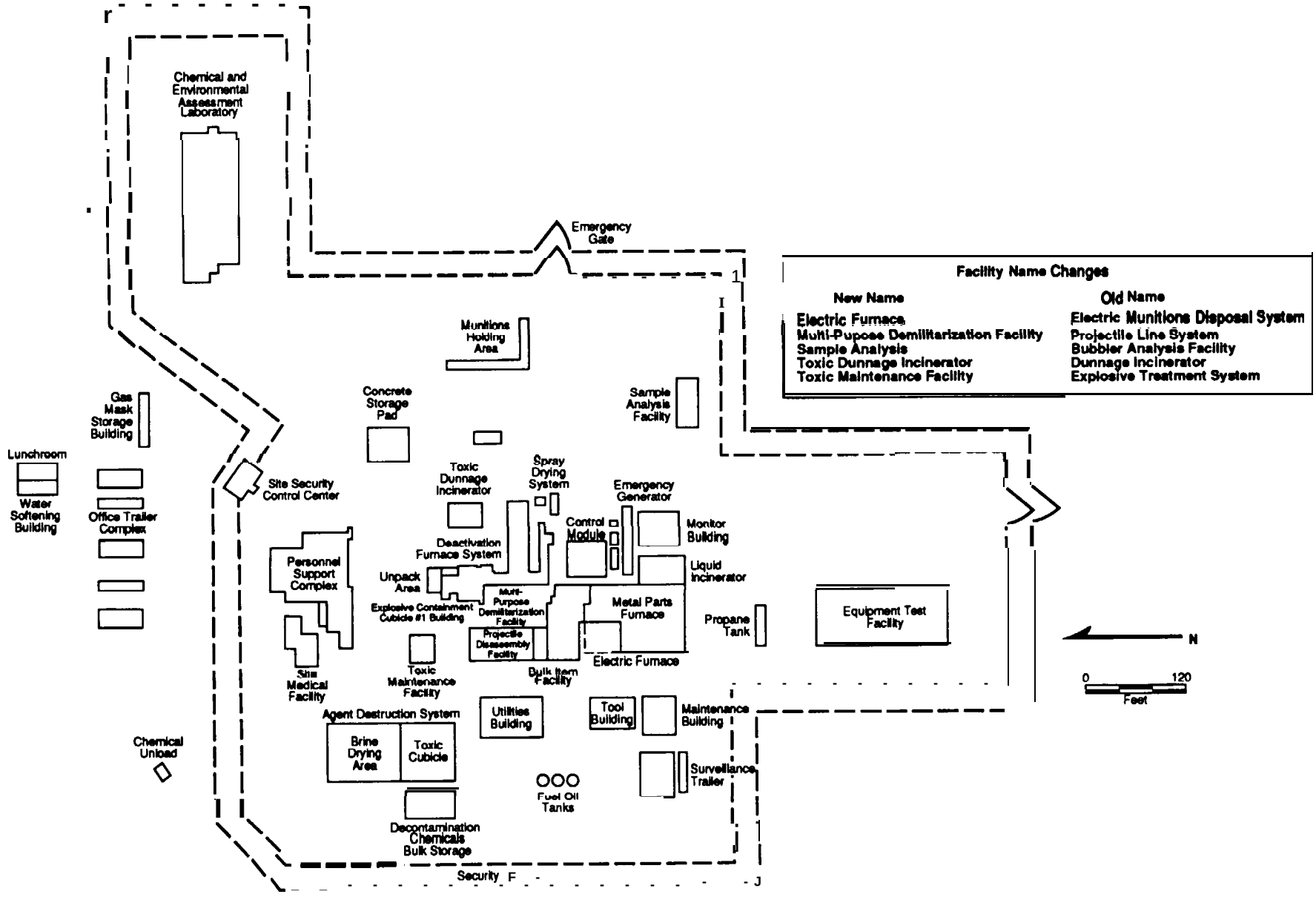

Figure A-I. CAMDS Facility Site Layout

Table A-l. Facilities at CAMDS Site

A. Operational Facilities (facilities handling chemical agent or munitions)

1. Agent Destruction System
2. Bulk Item Facility
3. Chemical and Environmental Assessment Laboratory
4. Deactivation Furnace System
5. Electric Furnace
6. Equipment Test Facility
7. Rocket Shear Machine
8. Liquid Incinerator
9. Metal Parts Furnace
10. Multipurpose Demilitarization Machine
11. Bulk Drain Machine
12. Munitions Holding Area
13. Central Decontamination System (CSD)
14. Sample Analysis Facility
15. Toxic Dunnage Incinerator
16. Toxic Maintenance Facility
17. Unpack Area

B. Support Facilities (facilities not handling chemical agent or munitions)

1. Chemical Unload Station
2. Control Module
3. Decontamination Chemicals Bulk Storage Facility
4. Emergency Generator
5. Fuel Oil Tanks
6. Life Support System
7. Lunchroom
8. Gas Mask Storage Building
9. Maintenance Building
10. Monitor Building
11. Office Trailer Complex
12. Personnel Support Complex
13. Propane Tank
14. Site Security Control Center
15. Site Medical Facility
16. Spray Drying System
17. Surveillance Trailer
18. Tool and Electronics Building
19. Utilities Building
20. Water Softening Building

- The bulk item facility (BIF) is designed to drain large agent-filled munitions and bulk containers. The BIF consists of a toxic room with a drain fixture where bulk items are handled, a tank containing decon solution, a sump tank for spent decon, and several pumps. The BIF also contains equipment to deliver the items to the input conveyor of the MPF.

  - The chemical and environmental assessment laboratory is capable of providing analytical chemistry services to support chemical agent demilitarization.

- The deactivation furnace system (DFS) is designed to incinerate explosives and propellant, and to thermally decontaminate explosive components and munition bodies with residual agent. The DFS explosive limit is five pounds/flight, and the minimum residence time is 12 minutes. It consists of a four foot internal diameter, 30 foot long, oil or gas fired, unlined rotary retort, a cyclone, a slagging afterburner, a heated discharge conveyor that maintains the scrap metal parts leaving the furnace at 1000°F for 15 minutes and a pollution abatement system containing a quench tower, a venturi scrubber, a packed bed scrubber, and a demister.

- The electric furnace (ELF) is designed to decontaminate a variety of nonexplosive configured chemical munitions excluding spray tanks. The ELF was procured, but currently it is in storage. When installed it would replace the MPF.

- The projectile/mortar disassembly machine (PMD) is designed to remove fuzes and bursters from projectiles and mortars. The PMD is housed in an explosive containment cubicle (ECC) that is designed to retain fragments and chemical agents that would result from an explosive incident.

- The rocket shear machine (RSM) is designed to punch a hole in an M55 rocket body, drain the agent from the rocket, and then shear the rocket body into several sections. The RSM is housed in an ECC designed to contain fragments and agent from the explosion of an 8-inch projectile. The ECC is a 2-inch thick steel cylinder with an inside diameter of 10 feet and an inside length of 24 feet.

- The liquid incinerator (LIC) consists of a burner, a refractory lined primary incineration chamber, and a refractory lined secondary incineration chamber with the capability of incinerating decontamination solution and collecting the resulting molten salt. The LIC shares use of a pollution abatement system with the metal parts furnace (MPF). The LIC is capable of incinerating up to 380 pounds of agent HD per hour at a temperature of 2800°F with a residence time of 0.5 seconds. The secondary chamber operates at 2000°F with a residence time of 1 second and can handle up to 1.5 gallons per minute of spent decontamination solution.

- The metal parts furnace (MPF) system is designed to decontaminate munition bodies and bulk agent containers containing residual agent but no explosives. The MPF consists of a direct-fired, two chamber roller hearth section, a primary fume burner, an auxiliary fume burner, a multiposition loader, a bulk item loading station, a burster well basket conveyor, and a pollution abatement system consisting of a quench tower, venturi scrubber and a packed bed scrubber. Scrap handling and cooling equipment are also a part of the system.

- The multipurpose demilitarization machine (MDM) is designed to remove burster wells and chemical agent from projectiles and mortar rounds after the explosive components have been removed (i.e. fuzes and bursters). It is also capable of removing nose closures from non-explosively configured projectiles, The MDM is housed inside a multipurpose demilitarization facility (MDF).

- The bulk drain station (BDS) is designed to punch an opening in bulk items such as bombs, spray tanks, and ton containers and drain the agent from the items. The BDS is housed in the MDF.

- The munitions holding area (MHA) consists of an L-shaped, 15-foot high, earthen and steel barricade and a non-standard, earth-covered igloo for overnight munitions storage prior to movement to the operations area.

- The central decontamination system (CSD) is designed to mix, store, and supply decontamination solution to all processing areas at CAMDS. It consists of a decon-supply tank, two holding tanks, and ancilliary control and monitoring equipment.

- The Sample Analysis Facility (SAF) is equipped with a toxic hood, emergency shower, bubbler decon/wash, cold bubbler wash, and various related equipment required for the analysis of bubblers, brine, and Depot Area Air Monitoring Systems (DAAMS). It also has a storage area, a break area, and an office.

- The toxic dunnage incinerator (TDI) is designed to incinerate non-metallic wastes including protective garments, wooden pallets, polystyrene packing materials, plastic bags, and sealing tape containing low levels of agent contamination. The DUN consists of a commercial multiple-chamber oil-fired incinerator, an afterburner, and a high velocity wet scrubber. It is designed to process up to 300 pounds per hour of dunnage.

- The toxic maintenance facility (TMF) is equipped with two 1600 gallon liquid storage tanks, a floor sump of 935 gallon capacity, ovens for heat decontamination of machine and parts, and a hood ventilated to an agent filter. The TMF is used when maintenance is to be performed on contaminated or potentially contaminated items, and to receive waste liquids for agent detection, decontamiantion, storage, and transfer to other processes.

- The unpack area (UPA) is where munitions are removed from shipping and storage containers in preparation for demilitarization. The UPA consists of an unpack operating area where non-leaking munitions are unpacked, a vestibule where potentially leaking munitions are unpacked, and airlocks for entry and exit to the ECC.

The support facilities at CAMDS include the following:

- A chemical unload station consisting of a tank-car unloading platform, a compressor building, and a pump station to deliver bulk chemicals to storage.

- A control module (CMO) that houses all centralized control equipment of CAMDS.

- A decontamination bulk storage facility consisting of a series of chemical storage and dilution tanks, emergency showers, eye washes, and a catch basin.

- An emergency generator designed to provide emergency power to selected equipment and facilities within 10 seconds after a power failure.

- Fuel oil tanks consisting of three 30,000 gallon diked-tanks that supply the boiler plant and the DFS.

- A life-support system (LSS) designed to provide the air supply at all toxic operations locations and to personnel in a demilitarization protective ensemble (DPE).

- A lunchroom.
- A maintenance building consisting of an office, a welding area, a general work area, a drill press, and other machine tools.
- A monitor building designed to provide space for storage and maintenance of new and existing agent monitors.
- An office trailer complex consisting of five trailers to house the offices and work area of personnel.
- A personnel support complex (PSC) consisting of a change house, a lunch room, a toilet and shower facilities.
- A propane tank designed to hold 20,000 gallons of fuel that provides on-site propane fuel to the DFS, the LIC, and the TDI.
- A site security control center designed to limit entry into the facility and to prevent unauthorized removal of chemical surety material. This center is manned 24 hours daily by security guards.
- A site medical facility cnsisting of a decon and shower area, an emergency room (4 beds), and one ambulance.
- A spray drying system consisting of a gas quencher, a spray dryer, a bag house, a chemical feed system, an induced draft fan, and a slurry recycle system.
- A surveillance trailer designed to provide office space for personnel involved in verifying agent or explosives entering CAMDS facility and then verifying the amounts of agent or explosives that have been destroyed.
- A tool and electronics building that houses calibration equipment and spare parts for CAMDS operations, Bench calibration and repair of some instruments (such as industrial TV cameras) are also performed in this facility.
- A utilities building consisting of boiler controls, two 600 hp boilers, two air compressors, an emergency generator control panel, and a 480 volt generator.
- A water softening building consisting of a water treatment system and chemicals. It is designed to provide softened water acceptable for boiler plant operations,

A.3 JOHNSTON ATOLL CHEMICAL AGENT DISPOSAL SYSTEM (JACADS)

The JACADS plant is located on Johnston Island, the main island of Johnston Atoll, a coral atoll in the central Pacific Ocean, approximately 720 nautical miles southwest of the Hawiian Islands. JACADS represents the first mixed-use, full-scale chemical weapons demilitarization plant. At JACADS, munitions (and other chemical items) undergo reverse assembly utilizing automated technologies. Munition items are segregated into parallel material flows and sent to one of four specialized incinerators according to composition: liquid agent to the liquid incinerator (LIC), propellant and explosives to the deactivation furnace (DFS), contaminated metal parts to the metal parts furnace (MPF), and dunnage (contaminated and uncontaminated packing materials and othe combustible chemical items) to the dunnage incinerator (DUN). The weapons material streams are thermally detoxified (and destroyed, if combustible) in primary combustion chambers. Off-gases from all four furnaces pass to secondary combustion chambers where residence time and temperature are maintained at levels necessary to destroy all remaining agent vapors and other organic contaminants. Exhaust gases flow from each afterburner to integral pollution abatement systems where gaseous and particulate pollutants are controlled to required levels of safety and environmental protection. Waste streams from the JACADS plant operations are cooled, cleaned, agent-free flue gases; salts remaining from brine evaporation and serop metals, and other solid residues. The major facilities and systems comprising the JACADS plant are dsicussed below.

A.3.1 Munitions Demilitarization Building (MDB)

The MDB is the principal structure of the JACADS plant. It contains the major munitions handling, disassembly and incinerator systems and equipment required to perform these steps of the demlllltarlzatlon process. The MDB is a two-story, 73,000 square foot structure constructed with prestressed concrete structural members and reinforced, poured concrete slabs. The materials flow in the MDB is from the second floor, where munitions disassembly and materials segregation steps occur, to the first floor, which houses the four incinerators.

The second floor includes the Unpack Area, the Explosion Containment Vestibule, the Explosion Containment Rooms (2), the Munitions Corridor, and Munition Processing Bay. The MDB first floor contains the Furnace Rooms (DFS, LIC, MDF, and DUN), the Toxic Cubicle, and the toxic Buffer Storage Area. Support areas include the Mechanical Equipment Room (MER) which houses various components of the Ventilation and Air Conditioning System and Life Support System (LSS); Electrical equipment rooms; various other equipment rooms and the Plant Control Room (CON). The first floor

also houses the Toxic Maintenance Area (TMA), a facility In which specialized, toxic equipment maintenance or munitions Inspection and disassembly operations can take place under engineering vapor containment controls.

A.3.2 Munitions Handling and Disassembly Machines

The following disassembly machines are located on the MDB second floor.

Rocket Shear Machine. The Rocket Shear Machine (RSM) consists of a punch-and-drain station, a rocket transport assembly, a shear station, a fuze segregator, and controls and Instruments for operating the machine. The RSM has been designed to allow reconfiguration to a Burster Size Reduction (BSR) machine, which Is used during projectile campaigns to-reduce burster size for feed to the DFS. There are two RSMs at JACADS.

Mine Machine. Machine (MIN) Is a two-station machine that punches the mine body to drain agent and then punches and removes the booster pallet from the burster cavity. The mines and bursters then pass through chutes to the DFS. Two Mine Machines are utilized • one In each ECR.

Projectile/Mortar Disassembly Machine. The Projectile/Mortar Disassembly Machine (PMD) is used to remove explosive components from mortars and projectiles In the ECR. There are two machines In operation during full operation • one In each ECR.

Multiposition Loader. The Multiposition Loader (MPL) picks up the Individual projectiles from the conveyor exiting the ECRs and places them vertically In the unit pallet trays. There Is one MPL at the exit of each ECR.

Multipurpose Demilitarization Mac-. The Multipurpose Demlllltarlzatlon Machine (MDM) removes burster wells, drains liquid agent, and crimps and reinserts the burster wells.

Bulk Drain Station. The BDS Is a powerful hydraulic press designed to penetrate the heavy-walled steel shells of bombs and ton containers. The BDS punches two holes In each bulk Item and drains the agent from the Items. JACADS has two BDSs, located In the MDB.

A.3.3 Furnace Systems

The JACADS plant uses four furnace systems--DFS, LIC, MPF, DUN--to Incinerate and detoxify munitions components and dunnage materials. Each Incinerator is a two stage system: a primary chamber In volatlllzatlon

and initial combustion occur, and a secondary chamber, or afterburner, in which primary chamber combustion gases are incinerated. After secondary combustion, the exhaust gases pass into one of four furnace pollution abatement system (PASs) for subsequent treatment.

Deactivation Furnace. The purpose of the Deactivation Furnace System (DFS) is to thermally destroy combustible material, inlcuding explosives, solid propellant, residual agent, fiberglass and fuzes, and to detoxify residual metals from rockets and mines. During the processing of projectiles and mortars, the DFS thermally deactivates all fuzes, bursters charges, and bursters removed from these munitions, and thermally detoxifies metal parts.

The DFS consists of four principal sections: rotary kiln, heated discharge conveyor, cyclone, and slagging afterburner.

The kiln is supported by flanges used to bolt the sections together. The flanges rotate on and are supported by trunion rollers. The kiln is designed with an internal spiral that conveys the material through the length of the kiln and also serves to impede the propagation of any explosions.

The kiln operating temperature is 1000' ± 150°F.

Materials enter the rotary kiln through two blast gates or tipping valves, which isolate the retort in case of explosion in either the retort or Explosion Containment Room (ECR). Pieces enter from the blast gate and slide down a chute into the rotary kiln.

Work pieces exit the rotary kiln at the discharge and drop onto the electrically heated discharge conveyor. The Heated Discharge Conveyor (HDC) is an electrically heated steel enclosure containing a steel mesh conveyor belt that accepts and conveys the material to a waste collection bin. The HDC gives munition pieces leaving the kiln an additional 15 minutes residence time at 1000°F minimum, to assure destruction of any residual agent.

Combustion gases from the kiln enter a cyclone that separates particulate matter such as glass fibers, soot, and dust from the hot flue gas by centrifugal action. Its major components are a vertical conical vessel with inlet shroud and trickle valve. The collected particles drop through the trickle valve in the cone shaped bottom of the cyclone to a sealed drum.

The slagging afterburner processes the exhaust gases from the cyclone. The afterburner operates at 2000°F ± 150°F to completely combust any residual uncombusted agent byproducts of resin decomposition,

hydrocarbons, and small amounts of particulatea. The slagging afterburner burners employ JP-5 fuel at rates controlled by a temperature monitor. Gases leaving the slagging afterburner enter the DFS Pollution Abatement System along with any excess room ventilation air.

Liauid Incinerator. The LIC is a refractory-lined two chamber furnace designed to incinerate agents GB, VX, and HD, as well as reduce spent decon solution to salt forms and water vapor. The two major components are the primary chamber and the secondary chamber. In the primary chamber, agents VX, GB, and HD are thermally destroyed by oxidizing them to basic compounds. The primary chamber consists of a vertical refractory-lined vessel, a specially designed burner, and a combustion air blower for the primary and secondary chambers. The primary chamber operates at 2700°F ± 150°F.

The purpose of the LIC secondary chamber is to thermally destroy any residual agent in the injected spent decon solution (NaOH or NaOCl), any trace agent in the flue gas from the primary chamber, and to separate and recover molten salt from the decon solution. The secondary chamber is composed of a vertical refractory-lined vessel, a burner and a brine injector. The feed rate 4-5 gallons/minute for spent decon or water. The operating temperature is 2000°F ± 150°F.

Metal Parts Furnace. The Metal Parts Furnace (MPF) is a roller hearth type furnace that burns any residual agent remaining on the metal parts of processed munitions. It consists of a charge airlock, a 3-zone burnout chamber, a discharge airlock, and an afterburner.

The burnout chamber is a refractory-lined steel enclosure that is fired by a series of propane/JP-5 fuel burners to heat the munition trays. Combustion air and fuel are metered to the burners to control the temperature of the chamber at 1600°F ± 150°F (except during ton container processing when the temperature will be 1300°F ± 150°F).

Ductwork from the burnout chamber leads to the afterburner. The afterburner incinerates and completely detoxifies gases from the burnout chamber, charge airlock and discharge airlock. The afterburner is a horizontal, cylindrical unit that operates at a temperature of 2000°F. The afterburner is fired with JP-5 fuel or propane.

Dunnaee Incinerator. The Dunnage Incinerator (DUN) consists of a furnace and an afterburner. It is designed to incinerate wooden pallet pieces, spent charcoal filters, laboratory solid wastes, used Demilitarization Protective Ensemble (DPE) suits, contaminated protective clothing, dunnage boxes, miscellaneous wastes, and to detoxify mine drums. Its major components are a horizontal refractory-lined chamber, charge door, ash discharge gate, access cleanout door, 4 burners, combustion air blower, and, lift and ram.

The DUN afterburner thermally oxidizes any residual agent and other unburned combustibles remaining in the flue gas from the primary chamber. Its major components are a vertical refractory-lined vessel, four burners and a combustion air blower. Its operating temperature is 2000°F ± 150°F.

A.3.4 Pollution Abatement System

The JACADS plant contains four pollution abatement systems--one for each of the four furnace/incinerator systems. The purpose of each furnace Pollution Abatement System (PAS) is to prevent pollution of the atmosphere with acid gases and particulates produced by combustion of chemical agents and other materials.

DFS. LIC. and MPF Pollution Abatement Systems. The DFS, LIC, and MPF each have a PAS that is similar in components and operate as a "wet" system. Each PAS consists of a quench tower, a Venturi scrubber, a packed bed scrubber, a demister vessel, induced draft (ID) fan, and various brine and makeup pumps. The PASs share a common exhaust stack. Operating parameters and dimensional details vary slightly with each PAS, but the overall configuration and component description is similar for all three.

The DUN Pollution Abatement System. The pollutants produced by the Dunnage Incinerator do not contain high concentrations of acid gas because no large quantities of agent or other materials that produce pollutants are incinerated in the DUN. Consequently, the DUN Pollution Abatement System (PAS) operates as a "dry" system and does not require all of the equipment employed in the PASs for the DFS, LIC, and MPF. The DUN Pollution Abatement System (PAS) consists of a quench tower, a baghouse, an induced draft (ID) fan, a caustic pump, and an exhaust stack.

A.3.5 Brine Reduction Area

Spent brine scrubbing solution from the PASs is dried to salt in the Brine Reduction Area (BRA). The BRA is housed in a separate building west of the MDB, and includes an evasporator, two double drum dryers, and the boiler subsystem.

Purge brine from the PAS scrubbers is fed on a continuous basis to the brine surge tanks located outside the BRA. The tanks provide buffer storage between the PASs and the dryers.

The brine evaporator system is designed to remove water from the brine solution. Concentrated brine is then dried in two rotary drum dryers. Steam in the dryers causes water evaporation from the brine and reduces the water content of the salt to about 10-15 percent. Steam required by the dryers is furnished by the boiler subsystem. Conveyors on each dryer discharge accumulated salts into 55-gallon storage drums for disposal at a hazardous waste landfill.

A.3.6 Plant Utility and Support Systems

In addition to the major process systems discussed above, the JACADS plant includes various utility systems that support the plant's operation.

A.3.7 JACADS Laboratory

The JACADS laboratory provides both agent and nonagent monitoring capabilities. The laboratory is required to monitor for chemical agents (GB, VX, and HD) during plant operation. Nonagent monitoring is also conducted for pollutants covered under EPA regulations. Oxygen and carbon monoxide are monitored continuously; water and particulates are monitored in the trial burns; and monitoring is performed on specific compounds related to agent being destroyed.

To accomplish monitoring for chemical agent, the laboratory is responsible for precise and accurate assay of samples; maintenance and operation of sampling equipment and alarms; quality assurance/quality control (QA/QC) of operations to ensure the reliability of the data generated; and proper handling, analysis, and reporting of the analytical data.

The laboratory is housed in a single-story, 6,700 square foot building north of the MDB. The Laboratory includes wet chemistry and instrument chemistry labs, instrument shops, agent calibration laboratories, adminsitrative offices, and storage facilities. A cascade ventilation system (similar to that in the MDB) help assure agent containment and ventilation of the building.

A.3.8 Personnel Support Complex

The PSC is a single-story building located northeast of the MDB and adjacent to the JACADS main gate. The PSC houses locker rooms, showers, a luch room/conference room, and a safety equipment room.

A.4 CHEMICAL STOCKPILE DISPOSAL PROGRAM (CSDP)

The CSDP refers to the Army Program for the destruction of the stockpile of lethal unitary chemical agents (nerve and blister) stored in various munitions and bulk containers at eight Army installations in the Continental United States (CONUS). These installations are:

1. Aberdeen Proving Ground (APG), Edgewood, Maryland.

2. Anniston Army Depot (ANAD), Anniston, Alabama.

3. Lexington-Blue Grass Army Depot (LBAD), Richmond, Kentucky.

4. Newport Army Ammunition Plant (NAAP), Newport, Indiana.

5. Pine Bluff Arsenal (PBA), Pine Bluff, Arkansas.

6. Tooele Army Depot (TEAD), Tooele, Utah.

7. Umatilla Depot Activity (UMDA), Hermiston, Oregon.

8. Pueblo Depot Activity (PUDA), Pueblo, Colorado.

Four different types of plants will be constructed depending upon the types of chemical munitions stored at a particular location. A "mixed use" plant, which is a modified version of the JACADS plant, will be installed at locations where all the different types of munitions are stored. Locations that have only rockets and projectiles will have a modified JACADS plant less the portion of the plant that processes mines and bulk items. Locations that have only projectiles and mortar rounds will have only those portions of the plant required to process these items; and locations that have only bulk items will only have the portion of the plant required to process bulk items. The Pine Bluff plant is unique in that even though mortar rounds are stored there it will not have the specialized equipment to disassemble mortar rounds i.e., the PMD and MDM machines. Instead, the rocket shear machine may be modified to process the mortar rounds, which are thin walled and readily sheared.

A.4.1 Mixed Use Plants

The full complement of the different types of munitions, i.e., rockets, mines, projectiles, and bulk items are stored at Umatilla Depot Activity, Tooele Army Depot, Pine Bluff Arsenal, and Anniston Army Depot. Therefore a full-scale JACADS-type chemical demilitarization plant will bebuilt at each of these locations. The current design of the CSDP mixed use plants is similar to JACADS, except for the differences in equipment design as listed in table A-2. In addition, the plants at Tooele Army Depot and Umatilla Depot Activity will have two liquid incinerators.

A.4.2 Rockets and Projectiles

Lexington-Blue Grass Army Depot (LBAD) is the only site to have a chemical demilitarization plant of this configuration. LBAD has only rockets, and projectiles of mustard, GB and VX. Therefore it will be equipped the same as a mixed use plant except that it will not have mine machines or bulk drain machines. This plant will be constructed on the Blue Grass portion of LBAD, where the chemical munitions are stored.

Table A-2. Incinerator Parameters for CSDP Plants

	CSDP Plants	JACADS
Liquid Incinerator		
Primary Chamber:		
• Temperature, °F	2700 ± 150	2700 ± 150
• GB incineration rate (lb/hr)	875	1050
• VX incineration rate (lb/hr)	580	700
• HD incineration rate (lb/hr)	1110	1330
• Internal height (feet)	8.16	8.16
• Internal diameter (feet)	4.34	4.34
• Refractory wall thickness (inches)	17.5	17.5
Secondary Chamber:		
• Temperature, °F	2000 ± 150	2000 ± 150
• Internal height (feet)	6.33	6.33
• Internal diameter (feet)	5.83	5.83
• Refractory wall thickness (inches)	22.0	12.0
Deactivation Furnace		
Retort:		
• Average internal diameter (feet)	4.75	5
• Length (feet)	30	30
• Typical operating temperature, °F	1000 ± 150	1000 ± 150
• Maximum shell temperature, °F	1600	1600
• Material	253 MA	310 ss
• Maximum rocket throughput, (rounds/hour)	40.0	46.1
• Maximum exhaust temperature ("F)	1800	1800
Afterburner:		
• Internal length (feet)	40.33	26.2
• Internal diameter (feet)	9.25	5.0
• Operating temperature, °F	2000 ± 150	2000 ± 150

Table A-2. Incinerator Parameters for CSDP Plants (Concluded)

	CSDP Plants	JACADS
Metal Parts Furnace:		
Primary Chamber:		
• Type of atmosphere	Oxidizing	Oxidizing
• Capacity (Number of trays)	3	3
• Operating temperature bulk, °F	1300 ± 150	1300 ± 150
• Operating temperature other, °F	1600 ± 150	1600 ± 150
• Process rate (ton container trays/hour)	1.72	1.72
Secondary Chamber:		
• Operating temperature, °F	2000 ± 150	2000 ± 150
• Internal length (feet)	35.5	35.5
• Internal diameter (feet)	4.0	3.5
Dunnage Furnace		
Primary Chamber:		
• Type of atmosphere (wood)	Reducing	Reducing
• Type of atmosphere (charcoal)	Oxidizing	Oxidizing
• Design capacity (lb(wood)/hour)	833	1000
• Operating temperature, °F	1600 ± 150	1600 ± 150
Secondary Chamber:		
• Operating temperature, °F	2000 ± 150	2000 ± 150
• Internal length (feet)	43.5	25.3
• Internal diameter (feet)	4 • 5.5	4 • 5.5

A.4.3 Projectiles and Mortar Rounds Only

At Pueblo Depot Activity only mustard containing projectiles and mortar rounds are stored. Therefore, the facility that will be constructed there will not have rocket shear machines, mine machines, or bulk drain stations. It will be the same as the mixed use plant in all other respects, e.g., it will have one of each of the incinerators and their associated pollution abatement systems that are used in a mixed use plant; and it will have the full complement of ancillary and support facilities.

A.4.4 Bulk Items Only

Aberdeen Proving Ground and Newport Army Ammunition Plant only have agent filled ton containers to dispose of. APG has mustard-filled ton containers and NAAP has VX-filled ton containers. Therefore, at these locations, the chemical disposal plant that will be installed will include only the items that are required for bulk items. These include the following:

- BDSs housed in the MDB for draining ton containers.
- Storage tanks for agent drained from the ton containers and for spent decontamination solution.
- A LIC equipped with an afterburner and PAS for incineration of mustard and spent decontamination solution. (NAAP will have two LICs).
- A MPF equipped with an afterburner and PAS for decontamination of drained ton containers.
- A BRA to dry the spent scrubbing solutions from the PASs.

The facility will also have an unloading area, unpacking area, toxic maintenance area, control room, and laboratory.

A.5 THE CRYOFRACTURE/INCINERATION DEMONSTRATION PLANT (CIDP)

The CIDP is a cryofracture thermal destruct process that involves embrittlement and crushing followed by incineration. The cryofracture/incineration demonstration plant (CIDP) may be used todemilitarize the agent/munitions stockpile stored at TEAD. It may also be used at other locations instead of a JACADS type plant. This process uses one basic processing line to process all chemical agent munitions and bulk items. It employs a heavy industrial hydraulic press to fracture

munition casings that have been cooled below their nil-ductility temperature in liquid nitrogen (LN_2). The press action also shears the bursters, exposing the explosives for burning. The entire fractured munition (agent, explosive, fuse, propellant, and metal components) drops from the press into a rotary kiln furnace. In the rotary kiln, the explosives and packaging materials are destroyed by incineration. The metal parts are 5X decontaminated, and the agent is volatilized and burned. Offgas from the rotary kiln flows through an exhaust duct and cyclone separator to an afterburner, where further thermal treatment completes the incineration process.

The cryofracture process also handles bulk items by shearing uncooled bulk agent containers in the press. The bulk agent is metered into the deactivation for combustion, and the sheared containers are simultaneously decontaminated, also in the kiln.

The throughput rate to be used for design of the CIDP process equipment for each munition will be the rate shown in table A-3. The design provides the capability to process munitions in their stored form, with no unpacking or with limited unpacking. In addition, it shall have the capability to process munitions in various unpackaged forms. The CIDP shall also be designed to process leaker overpacked items, at a reduced throughput rate if necessary. The hardware and operating facilities of the CIDP are described below:

- A bridge robotic system designed to remotely remove packing material from the munitions and immerse them in one of four cryobaths. It is also used to place cryocooled munitions in the ECR airlock. It consists of two bridge/trolley/mast robot units.

- A cryotreatment system consisting of four main cryobaths located in the unpack room and an auxilliary bath located in the press ECR.

- A material transfer robot system designed to remove munitions from the munitions airlock and place them within the cryofracture tooling of the press. It is also used to place a munition in an auxilliary cryobath and to transfer containers holding DPE and activated carbon to the DFS feed chute.

- A cryofracture press system designed to fracture cryogenically cooled rockets, mines, and projectiles using specially designed tooling for each munition type. The press also punches, drains, and shears uncooled bulk agent containers and bombs.

Table A-3. CIDP Design Throughput Rates

Munition Description	Burster Type	Agent	Processed Form[a]	CIDP Throughput Rounds/Hour (Dunnage Through Kiln)
115mm rocket M55	Comp B	GB	ST	43
M23 Land mine M23	Comp B	VX	D	30
4.2-in. mortar round M2/M2A1	Tetryl	H, AD, AT	B	97
105mm cartridge M360	Tetrytol, Comp B	GB	B	95
105mm projectile M360	None	GB	TA	240
155mm projectile M121A1/M121	Comp B	VX	SA	105
B-in. projectile H426	Comp B	GB	SA	56
500-lb bomb MK94	None	GB	SB	4
Weteye bomb MK116	None	GB	SB	1.6
750-lb bomb MC-1	None	GB	SB	4
Spray tank TMU-28	None	VX	SB	0.63
Ton container TC	None	H. HD. HT	SB	.93

[a] SB = Single bulk item with agent.
SA = Single munition with agent and burster.
D = Three M-23 mines in a storage drum with all fuses, bursters, booster charges, supplementary charges, and internal packaging.
B = Two munitions in storage box with all propellant. bursters, fuses, fiber tubes, and internal packaging.
ST = Single M55 rocket with fuse, burster. agent, and propellant; all contained in a fiberglass Launch tube with aluminum end caps.
TA = Two 105mm projectiles with agent.
SM = Single munition with agent.

- A thermal destruct system designed to incinerate agent, metal parts, explosives, propellant, packaging material, bulk agent, and spent decon. It consists of a rotary kiln, a blast attenuation duct, a cyclone separator, an afterburner (to heat gases to 2200°F for a minimum of 2 seconds), and a heated discharge conveyor that maintains solids leaving the kiln at 1000°F for 15 minutes. The kiln consists of sections with an inside diameter of 6 feet, bolted together to form a horizontal barrel 70 feet long. The explosive limit of the kiln is 7.3 pounds/flight.

- A pollution abatement system (PAS) containing a quench tower, a variable throat venturi scrubber, a scrubber tower, and a demister.

- A brine reduction area consisting of two 26,000 gallon brine storage tanks, and three double-drum dryers designed to process brines produced by the PAS.

- A dunnage processing system designed to incinerate dunnage at the rate it is generated. The system consists of a dunnage chute, feed conveyors, a dunnage incinerator with an afterburner, quench tower, bag house, and an ash screw conveyor.

- A process decontamination and collection system designed to distribute decontamination solution throughout the plant and to collect liquids from the floors in all process areas and directing them to storage tanks.

- Spent decontamination solution tanks consisting of three 26,000-gallon tanks that are used to hold spent decontamination liquids from throughout the facility prior to incineration in the thermal destruction system.

- A process ventilation system designed to provide filtered air, heated or cooled, to control agent contamination buildup in process areas. It would use high efficiency particulate air/charcoal filter units.

- A laboratory designed to conduct routine QA/QC analyses of samples from the processes and monitoring stations at the facility. The laboratory will be equipped to detect agents GB, VX, and mustard.

- Appropriate support facilities for maintenance and control of the operation.

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APPENDIX B

SITE SPECIFIC POTENTIAL USES OF THE CHEMICAL DISPOSAL FACILITIES

APPENDIX B

SITE SPECIFIC POTENTIAL USES OF THE CHEMICAL DISPOSAL FACILITIES

This appendix provides site specific information regarding potential future uses of the chemical disposal facilities (CDFs). The information presented was used as a basis for selecting potential future uses of the facilities. These potential uses were then subjected to further evaluation with respect to feasibility and desirability as described in sections 3 and 4 of this report. Included in this appendix are the following:

- A brief description of each site where a chemical demilitarization plant is present or planned;
- A discussion of the types and sources of and current disposal methods for waste materials generated at each site and at nearby installations;
- A discussion of the suitability of the chemical demilitarization equipment for disposal or decontamination of waste materials at each site; and
- A prioritization of potential future uses of the chemical demilitarization plant(s) at each site for further evaluation.

The following criteria were used as a basis for prioritizing the future uses that were subjected to further evaluation in sections 3 and 4.

1. The technical feasibility of the equipment for disposal of the candidate feedstock. The suitability of the furnaces, the PAS, and the disassembly devices was determined. Special problems, if any, e.g., the movement of items to the disposal site, were also considered. In determining suitability, applications requiring little equipment modification were preferred to applications requiring extensive modifications.

2. Environmental and institutional issues. The following issues were considered:

   (a) Rules and regulations (i.e., the difficulty of compliance with Federal, State, and DOD rules, and the uncertainty of obtaining permits and meeting environmental requirements);

(b) The likelihood that the candidate will be available for disposal in 1998 (i.e., the possibility of alternative methods of disposal being implemented prior to availability of the demilitarization facility);

(c) Public perception (i.e., opposition or support for future use of chemical demilitarization plants).

3. Alternatives to the future use of chemical demilitarization technologies. The alternative technologies were compared to the use of the chemical demilitarization equipment with respect to the following:

(a) Uncertainty about the utility of the disposal method;

(b) The environmental acceptability of the disposal method;

(c) The technical adequacy of the disposal method; and

(d) The economics of the disposal method (both capital and operating costs were considered).

4. The quantity of potential feedstock available. Those categories available in large amounts were considered more favorable candidates than those available in small amounts.

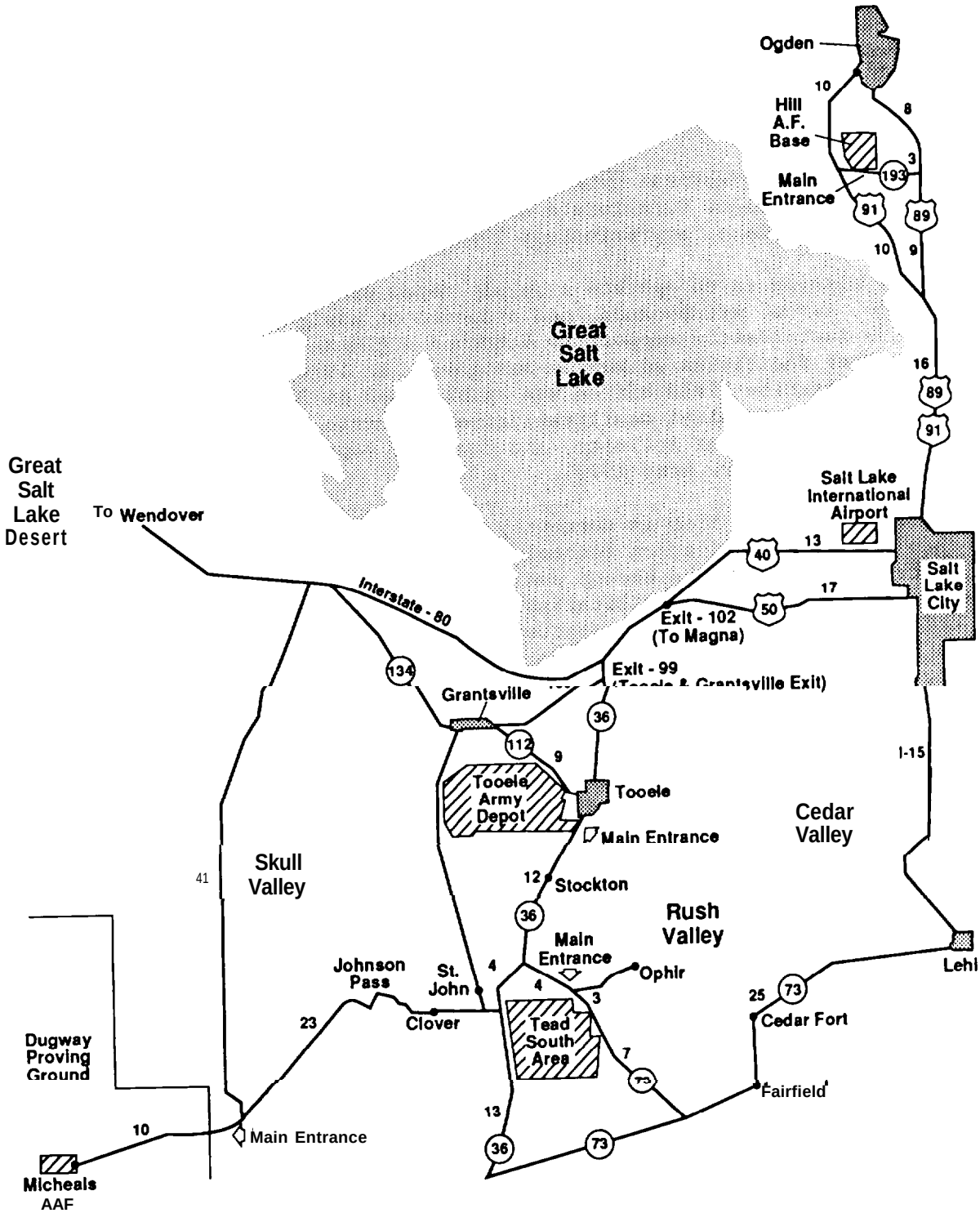
The purpose of this examination was to screen the candidates to select options for future use of the chemical demilitarization plants at each site that were then further evaluated with regard to feasibility and desirability.

In most instances, what initially appeared to be a potentially viable future use for the chemical demilitarization plants turned out to be, upon more detailed examination, economically undesirable. Therefore the potential future uses discussed in this appendix are not the final results of this study. These results are presented in the main text.

B.l TOOELE ARMY DEPOT

Tooele Army Depot (TEAD) is located in Tooele County in west central Utah (figure B-l). The TEAD complex consists of three physically separated areas.

a. The North Area, originally the Tooele Ordnance Depot, comprises 27,400 acres, and is situated approximately 36 miles southwest of Salt Lake City, Utah.



Source: U.S. Army December 1979

Figure B-l . . Tooele Army Depot Location Map

b. The South Area, the former Desert Chemical Depot, comprises 21,500 acres in Rush Valley, and is approximately 17 miles south of the North Area.

c. The Non-Tactical Generator and Rail Shop Division of the Maintenance Directorate is located within the boundary of Hill Air Force Base, approximately 15 miles north of Salt Lake City.

TEAD's mission is to operate a supply depot providing for the receipt, storage, issue, maintenance, and disposal of assigned commodities; to provide installation support to attached organizations; and to operate such other facilities as may be assigned. In 1974 a Chemical Demilitarization Field office was established at Tooele for advising and assisting all chemical demilitarization operations at Dugway Proving Ground, Pueblo Depot Activity, and Umatilla Depot Activity as well as at Tooele itself (U.S. Army 1979).

The south area of TEAD is currently the site of CAMDS, a test facility for chemical demilitarization technology. It is expected to cease operation in 1994 and thus could become available for alternative uses at that time. A mixed use chemical demilitarization facility (the TOCDF) is currently under construction and is expected to be operational by October 1993 and to complete operation by December 1998. A cryofracture/incineration demonstration plant (CIDP) for demilitarization of chemical warfare munitions and bulk items may also be constructed at TEAD and is expected to complete demilitarization operations by 1998.

Candidate future uses for the chemical demilitarization plants at TEAD are listed in table B-l and are discussed in some detail in the following sections.

B.1.1 Conventional Munitions

Table B-2 shows the types and weights of conventional munitions in the demilitarization stockpile at TEAD and at the nearby military installations of Navajo Depot Activity (NADA) and Fort Wingate Depot Activity (FWDA). The total amount of conventional munitions at TEAD is about 12,900 short tons.

The conventional demilitarization technologies available for the U.S. Army, excluding OB/OD, are listed in appendix D. The capabilities at TEAD for conventional munition demilitarization include: two sites for open burning, two sites for open detonation, one APE 1236, one TNT washout facility (this facility requires extensive refurbishing), and nine disassembly facilities (USADACS, Vol. III, 1990) among others. Small arms, TNT, and other conventional munitions are currently disposed of by open detonation or in an APE 1236. The latter is a rotary kiln that is

Table B-l. Candidate Future Uses for the Chemical Demilitarization Plants at Tooele Army Depot

1. Recovered munitions and other items containing (or contaminated with) agent. Included in this category are the items "found on post," and any other agent-contaminated items that may be found at a later time. Also included are items presently stored in igloos at TEAD such as M55 rocket parts, dunnage, etc, and items located at Dugway Proving Ground.

2. Small conventional munitions. This category includes small arms, fuzes, primers, and grenades, and mines.

3. Industrial waste obtained from TEAD and other DOD sites. Waste products, such as contaminated solvents and medical wastes, can be obtained by bidding from DRMS. The relatively large amount of industrial waste generated at TEAD is included in this category.

4. Smokes, riot agents and related munitions. Smokes, dyes, riot control agents, and pyrotechnics are in this category.

5. Soil contaminated with agent. This category represents soil recovered from dumps containing chemical agent munitions, which may be contaminated with agent (mustard and VX) or is suspected of such contamination. Drums of contaminated clothing and other items may also be considered to be in this category.

6. Large conventional munitions. Items in this category are projectiles, rockets, bombs, Navy ammunition, and inerts. Except for items containing inerts, these munitions contain high explosives or rocket fuel.

7. Bulk Energetics. High explosives and rocket fuel not contained in munitions are in this category.

a. Trash. Untreated wood and paper are considered trash will be developed. Thus, although the inventory is these items is relatively small, we believe this category of munitions should be considered for destruction in the Chemical Stockpile Plant.

9. Soil contaminated with hazardous substances. This category represents soil containing grease, oil, solvents, TNT, paints, plating wastes, and PCB.

Table B-2. Inventory of Conventional Munitions in the Demilitarization and Disposal Inventory at Tooele Army Depot and Nearby Military Installations

Munition Type	Amount (Thousands of Pounds) TEAD	NADA	FWDA
Small arms, fuzes, and primers	613	1,099	7
Smokes and dyes	69	•	1
Pyrotechnics	314	17	
HE loaded projectiles	12,481	8,628	14,737
Rockets and missiles	2,084	19,170	905
Bombs, torpedoes, depth charges and CBUs	7,295	1,435	•
Riot control agents	90	48	12
Bulk explosives	303		255
Grenades and mines	766		
Navy gun ammunition	249		
Special function projectiles	150		25
Propellant charges	491	962	
Inert loaded items	308	1	
Items not homogeneously grouped or categorized	595	95	
Total	25,808	31,456	15,982

Source: USADACS, 1990

very similar to the deactivation furnace that is used in CAMDS and the TOCDF and the rotary kiln used in the CIDP, therefore, the deactivation furnace and rotary kiln of the chemical demilitarization plant could be used in place of an APE 1236 to demilitarize conventional munitions, including the following:

- Small arms, fuzes, boosters, detonators, and primers.
- Some smokes and dyes, provided that the PAS is upgraded to include appropriate mist eliminators.
- Shredded hardware from pyrotechnics (by flashing).
- Shells/metals from HE loaded projectiles and exposed explosives (<5.0 pounds/flight) (by flashing).
- Shells/metals of rockets and missiles (by flashing).
- Shells/metals of drained bombs and torpedoes, and exposed explosives (<5.0 pounds/flight) (by flashing).
- Some riot control agents.
- Bulk explosives (if exposed) and at a rate of <5.0 pounds/flight. This is a limited use operation.
- Shells/metals of some propellant charges (by flashing).
- Grenades and mines (except those containing thermite).

Only the grenades and mines, which represent about one percent of the inventory of this group, will have to be disassembled (punch, remove fuze, remove cap). It may be possible to modify the existing mine machine to punch and remove the explosives, or an existing APE disassembly device may have to be installed for this purpose.

The pollution abatement systems that are connected to the chemical demilitarization plant kilns of the CAMDS, TOCDF, and CIDP create an added advantage since the existing APE 1236 furnaces must be upgraded with pollution abatement systems to comply with current environmental regulations.

Although the PAS at either of these plants has not been demonstrated when burning these items, it should be adequate for removing particulates and it should be possible to obtain permits without difficulty. Test burns will probably be required. The DOD regulations governing explosives can be met more easily for these items than for those containing large amounts of explosives.

The incinerators at CAMDS and the TOCDF could also be used for activities related to the demilitarization of conventional munitions. The TDI and the DUN would be used to incinerate the dunnage associated with conventional munition handling, including wood pallets and packaging materials. The MPF would be used for the decontamination of waste material that has been slightly contaminated with energetic material, thermal decontamination of medium and large metal parts/munitions and mines whose energetic material has been removed and for processing small smoke pots. The LIC would be used to decontaminate waste liquids resulting from non-lethal agent munitions demilitarization processes including scrubber solutions from the pollution abatement systems.

Other operational facilities such as the Agent Destruction System (ADS) could be used for neutralization; the bulk item facility (BIF) could be used for drainage; the laboratory could be used for testing and monitoring support; the explosion containment cubicle (ECC) could be used for explosive removal; and the UPA could be used to unload conventional and non-lethal agent ammunition.

Most of the support facilities such as the unload building, storage tanks and Life Support System (LSS) could be used as is or with some modifications.

B.1.1.1 Small Arms

Although Tooele has the capability to demilitarize small arms in an existing APE 1236, its capacity is not adequate to eliminate the inventory of small arms by the time the chemical demilitarization plants complete their mission. The CAMDS DFS could be used to supplement the APE 1236 capacity for demilitarization of small arms starting in about 1994. The TOCDF could provide additional small arms demilitarization capacity in 1998.

The use of the APE 1236 for the disposal of small arms at Tooele has not been opposed by the public, therefore, we do not anticipate opposition to the use of the chemical demilitarization facilities for the same purpose. On the contrary, the public could be expected to support a program that would reduce or eliminate the stockpile of potentially dangerous munitions. Using the demilitarization equipment for reducing the inventory (1,263 short tons) of similar items at nearby DOD sites is also an attractive possibility. The existing TEAD CSDP does not cover receipt of hazardous waste from locations outside the TEAD-South Area. Therefore, if the facility were to be used for wastes from other locations, the permit would have to be modified to allow this.

Although the CIDP furnace could handle small arms, the cryogenic bath and press would not be needed for these munitions. Therefore consideration

should be given to using the CIDP for items that require use of this specialized equipment (such as large rocket shells or modern conventional munitions) are more attractive.

The Deactivation furnace systems of the chemical demilitarization plants are also capable of disposing of smokes, riot agents, and related munitions (excepting FS and certain pyrotechnics). Some of the items will have to be disassembled but appropriate disassembly equipment is available for all but certain pyrotechnic items and could be installed.

It may be necessary to upgrade the PAS to remove different quantities of organic carcinogenic substances; however, the PAS should be adequate for removing particulates and it should be possible to obtain or modify RCRA permits without difficulty. Test burns will probably be required. The DOD regulations governing explosives can be met more easily for these items than for those containing large amounts of explosives.

B.1.1.2 Smokes, Riot Agents, and Related Munitions

The existing APE 1236 at Tooele could also be used to dispose of the stockpile of smokes, riot agents and related munitions. However the Army would need to provide funds for upgrading the PAS and the afterburner. If, this were done it may be unnecessary to use the chemical demilitarization equipment for this purpose.

B.1.1.3 Bulk Energetics

Bulk energetics (explosives and propellants) can be burned in the DFS at CAMDS and the CSDP plant with the necessary modification to the feed mechanism. The rate at which bulk energetics can be incinerated will be limited by the heat of combustion of the energetic material and the explosive limit of the furnace. No disassembly will be required, however the bulk energetics may have to be broken up into smaller units for feeding into the incinerator. The CIDP may be particularly suited to doing this. Moreover, the CIDP kiln is larger than the DFS at either of the other plants and thus can incinerate bulk energetics at a faster rate. Therefore, it may be desirable to use the CIDP for incinerating bulk energetics rather than any of the other chemical demilitarization plants at TEAD.

Although the PAS has not been demonstrated when burning all types of energetic materials, obtaining permits is not expected to be a significant problem. Test burns would probably be required.

OB/OD is technically and economically preferable, but environmentally less acceptable than controlled burning of bulk energetic. Recovering explosives for reuse is preferable to burning, for those substances for which this is possible.

The relatively small amount (about 1000 short tons) of bulk energetics at Tooele and the nearby sites may result in high unit disposal costs and may make bulk energetics less attractive as a candidate for disposal in the chemical demilitarization equipment at Tooele than other candidates.

B.1.1.4 Large Conventional Munitions

The energetic material and organic compounds in projectiles, rockets, bombs, Navy ammunition, and inerts can be burned in the DFS after removal from the munitions. The metal parts of these items can be decontaminated in the MPF. Furnaces at both the Chemical Stockpile Plants and the CAMDS Plant could be used for this purpose. The rate of burning will be limited by the heat of combustion of the energetic material. Energetics that are slurried in water will burn at a reduced rate. Revisions to the DFS feed system to accommodate the different waste forms will be required. The PAS is expected to be capable of reducing emissions to the required levels, although some changes in operating conditions will be required. A washout/meltout facility will have to be constructed for removal of energetic material from the munitions. Most munitions in this category will require new disassembly equipment. Size reduction of items containing Compound B will be required.

DOD rules are more difficult to comply with for munitions containing large amounts of explosive than for other munitions. Current rules require some concrete walls for explosion containment protection such as those in the Chemical Stockpile Plant's ECR, for the washout/steamout facility.

If OB/OD continues to be permitted, moving the large munitions to another site where this procedure can be performed is technically and economically preferable, but environmentally less acceptable than controlled burning in an incinerator. However, OB/OD will continue to the the only alternative for items which are too dangerous to move or process. Recovering explosives for reuse is preferable to burning, for those items for which this is possible. Because of the large inventory of these items throughout the U.S., it may be more economical to construct a facility designed specifically to burn or recover the energetic materials efficiently than to modify the chemical demilitarization equipment at Tooele to accommodate large conventional munitions. Although the public may support destroying the stockpile at Tooele, on balance, large munitions appear to be less attractive candidates for disposal in the CAMDS or CSDP equipment at Tooele than other categories of waste.

According to a study by Arthur D. Little (1985), some new buildings and process areas may need to be added to the chemical demilitarization plants in order to demilitarize conventional munitions. The requirements depend

upon the types of conventional munitions to be processed. Among the additions that may be required are the following:

- A gun ammunition demilitarization system consisting of breakdown and defuzing equipment and disassembly equipment.
- A smokeless powder accumulator *system* consisting of a propellant collection system.
- A mechanical reduction system that is designed to punch some small ammunition items, saw moderate and large size items, and defuze large caliber ammunition.
- An explosive meltout/steam out/wash out system.
- A waste water treatment system.

The front end of the cryofracture process is potentially useful for processing conventional munitions that must be (1) opened to expose the explosives and filler inside, and (2) reduced in size prior to incineration. It can be used for most conventional munitions within the demilitarization inventory, particularly those made of carbon steel, which easily fractures at cryogenic temperatures. Cryofracture may be particularly suitable for modern conventional munitions, such as cluster bomb units, because of the safety hazard associated with manual disassembly (GA Technology Meeting, Spitzer, July 5, 1990). Those few munitions types that are made of aluminum or thin stainless steel can be easily sheared by the cryofracture tooling. Large rockets could be handled in the CIDP if a wash-out (to remove explosives) facility is built next to the cryofracture plant. The cryopress (housed in an ECC) can handle up to 25-50 pounds of explosives. The cryobath is several hundred square feet in area and can handle relatively large sizes and quantities of munitions.

The rotary kiln of the cryofracture facility can handle conventional ammunition in the same manner as the DFS of the CSDP plant. The CIDP may should be able to handle larger munitions and process them at a greater rate than the CAMDS or TOCDF plants it has a larger size rotary kiln.

B.1.2 Nonstockpile Chemical Items

Nonstockpile chemical items at Tooele and nearby Army installations include range recovered munition items, empty chemical agent ton containers, and items contaminated with agent during maintenance of the chemical warfare stockpile. These items are discussed further below.

B.1.2.1 Range Recovered Chemical Munition Items

The varied inventory of range recovered munitions located at TEAD, NADA, FWDA, and at Dugway Proving Ground, located 30 miles west of TEAD South Area (see figure B-l) is listed in table B-3. These items, being similar to items in the chemical warfare stockpile scheduled for demilitarization, could be easily disposed of at any of the three demilitarization facilities.

B.1.2.2 Empty Agent Ton Containers

There are about 1,024 empty agent ton containers stored in the South Area of Tooele Army Depot that are labeled XXXB. This labelling is a local designation to indicate that these ton containers are to stay in Government custody for possible use for activities such as testing chemical demilitarization equipment. It is believed that these ton containers have previously been thermally decontaminated to the XXXXX level. However, because of a lack of confirming records, it may be necessary to thermally treat them.

The ton containers could be thermally treated in any of the chemical demilitarization facilities at TEAD in a manner similar to that of the ton containers in the stockpile. Since CAMDS will be available for future use before any of the other chemical demilitarization plants scheduled to be built at TEAD, it could accomplish the task sooner. CAMDS could also be used to decontaminate the empty agent ton containers currently at Rocky Mountain Arsenal provided transportation of the ton containers is approved by the responsible authorities, and the facility obtains a permit to receive hazardous waste from outside the facility.

B.1.2.3 Other Nonstockpile Agent Contaminated Items

There are many agent contaminated items (dunnage, M55 rocket parts, etc.) that were accumulated from maintenance activities on the chemical warfare stockpile and are currently in chemical storage igloos at TEAD. These items are not considered part of the CSDP inventory scheduled for disposal. They could be disposed of in the Toxic Dunnage Incinerator at CAMDS or the dunnage incinerators of the TOCDF and CIDP in a manner similar to that of the dunnage that will be generated during normal operation of those facilities.

Currently, disposal in a chemical demilitarization plant that is especially designed to handle agent is the most viable alternative for the disposal of agent-containing items and there is no reasonable possibility that another method will be developed. Thus, although the inventory of these items is relatively small, they should be considered for destruction in one of the chemical demilitarization plants.

Table B-3. Inventory of Range Recovered Chemical Items at Tooele Army Depot and Nearby Installations

Location	Description of Items	Number of Items
TEAD	CAIS[a]	56
	Chemical agent	25
Dugway Proving Ground*	Mortar rounds (H, WP, HE)	31
	105mm projectiles (H, WP, GB, HE)	3
	155mm projectiles (HD, GB, VX)	11
	Projectiles, 6" (GB)	1
	Gas bomb, M79 (750 lb)	2
	Bomblet (BZ)	4
	Other munitions (GB)	3
	Projectile Levins (H, AC)	1

AC Hydrogen cyanide.
[a]Chemical Agent Identification Sets.
Source: Kirkman, 1990.

B.1.3 Contaminated Material and Soil

According to the Installation Assessment of Tooele Army Depot (U.S. Army, December 1979) and (USATHAMA, Vols. I and II, 1988); there are several contaminated areas/pits at TEAD. In the North Area there are:

- Industrial operations, such as maintenance of combat vehicles, which generate waste waters containing heavy metals, grease, oil, solvents, acids, and caustics. Pits exist where the wastewater was once allowed to percolate into the ground. The wastewater is now directed to the industrial wastewater treatment plant.

- Open burning/open detonation pits where all types of conventional ammunitions are destroyed (from small arms up to 12,000-pound bombs, bulk explosives, and bulk WP). These pits contain TNT and its breakdown products.

- A sanitary landfill that contains plating wastes, PCB, and paint primer containing zinc.

- A transformer oil spill area near Igloo K281 that could have contaminated PCB soils.

In the south area (figures B-2 and B-3 and table B-4) there are 30 pits that were used for burial of chemical agents and munitions. Approximately 19,000 projectiles had been open burned and buried in 15 of these pits. The size of the contaminated area is about 1,934 acres (USATHAMA, 1988). Some of the other burial weapons pits in the south area are as follows (York, 1990):

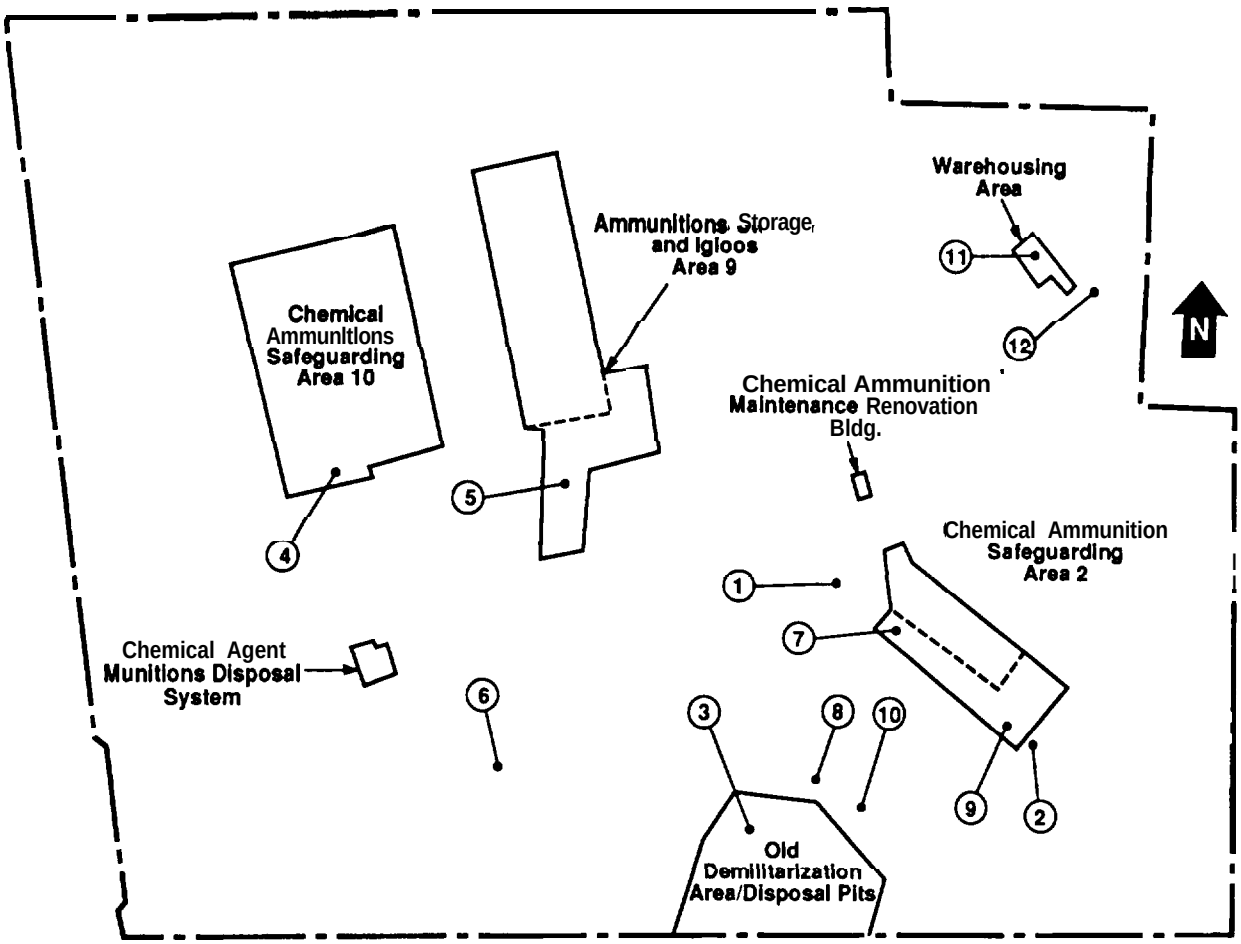
- A gravel pit approximately 5.8 acres in size and containing hand grenades, smoke pots and bombs, and mustard.

- An unlined drainage pond that received waste water from HE washout facility and from renovation of HC smoke pots, mustard projectiles, and white phosphorus. It is approximately 20 x 70 feet and 10 feet deep at the middle.

- A leaching pit that may be contaminated with chromium and white phosphorus. The size and the exact location is unknown.

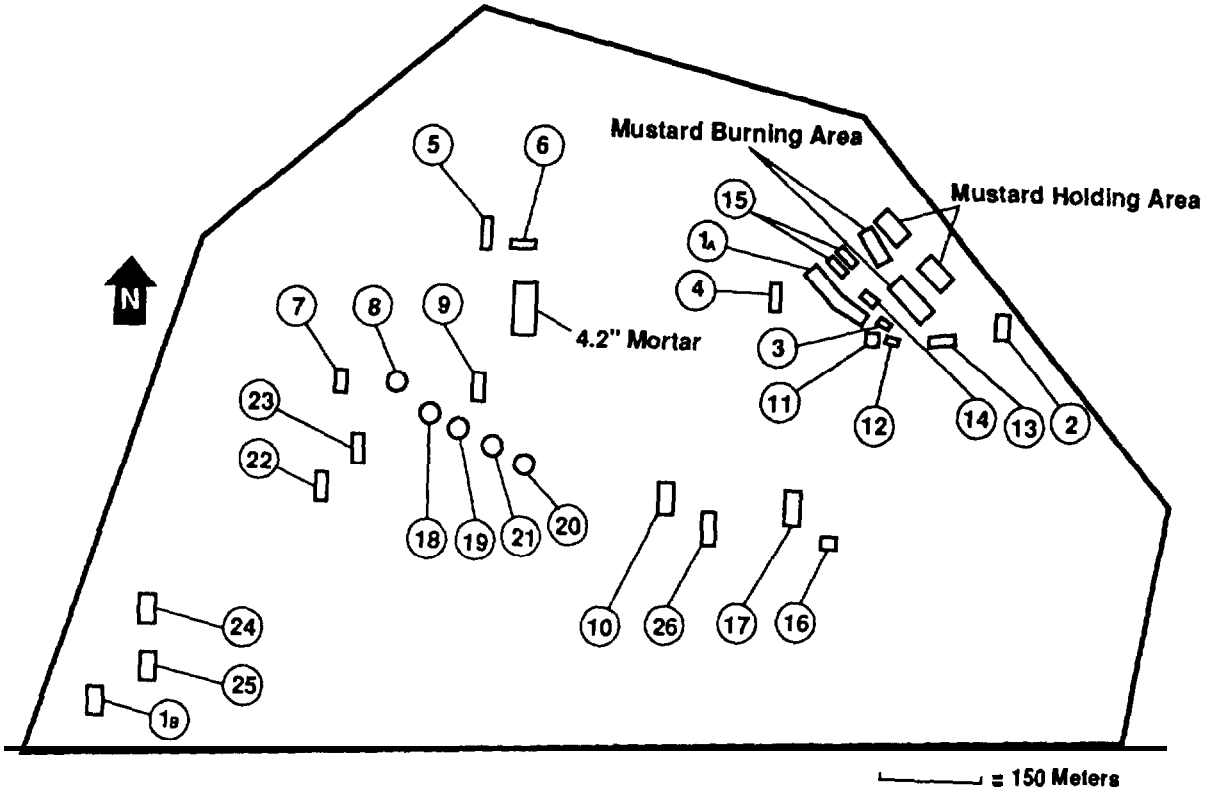
- Leaching pits that used to receive waste from industrial operations such as the renovation of WP grenades.

- A covered disposal pit located south of Storage Area 2 described as containing a little bit of everything including agent contamination. The size and exact location is unknown.



Source: US. Army Dec. 1979

Figure B-2. TEAD South Area Activity



Source: U.S. Army Dec. 1979

Figure B-3. Burial Sites in the Old Demilitarization Area In TEAD South

Table B-4. Contents of Covered Pits Within the Demilitarization Area, TEAD South Area

Pit Number	Contents
la	M70 Mustard Bombs
lb	Mustard Bombs, M4A2 Smoke Pots, White Phosphorus grenades, Trash
2	Thermite
3	Smoke Pots
4	M20 Bomb Clusters
5	Smoke Pots
6	Smoke Pots
7	Smoke Pots
8	M50XA3 Bombs
9	Smoke Pots
10	Thermite
11	Smoke Pots
12	Smoke Pots
13	M70 Mustard Bombs, one German Tabun Gas Bomb
14	M70 Mustard Bombs
15	M70 Mustard Bombs

Table B-4. Contents of Covered Pits Within the Demilitarization Area, TEAD South Area (Concluded)

Pit Number	Contents
16	M70 Mustard Bombs
17	M50XA3 Bombs
18	M50XA3 Bombs
19	M50XA3 Bombs
20	M50XA3 Bombs
21	M50XA3 Bombs
22	M70 Mustard and M47 Bombs
23	M70 Mustard Bombs
24	Trash Pit
25	Boosters
26	'Poison Gas" (probably mustard)
27*	Squibs, Hand Grenades, Smoke Pots, TNT Blocks, FS Smoke Bottles

*A letter signed by Colonel Peter G. Burbules dated 7 October 1977 identified one of the four missing pits (pit #27) and its contents.

- Leaching pits that used to receive waste from industrial operations such as the renovation of WP grenades.

- A covered disposal pit located south of Storage Area 2 described as containing a little bit of everything including agent contamination. The size and exact location is unknown.

conform to new requirements in the event the facility is used for a new purpose. The cost to modify the facility to conform to the new requirements could be prohibitive.

There are a variety of alternative methods for remediation of contaminated soil including:

- Stabilization and subsequent disposal of contaminated soil in an industrial landfill;

- Chemically neutralizing the agent in the soil and then disposing of the soil in an approved hazardous waste landfill;

- In-situ soil vitrification;

- Soil stripping; and

- Bioremediation.

Some of these may be more economic than thermal treatment and some may be able to be accomplished before the chemical demilitarization plants become available.

Recovered chemical munitions could also be demilitarized at all three plants which are designed and permitted for such activities. Demilitarization of recovered conventional munitions could be accomplished in the same manner as conventional munitions in the stockpile as described above. However, exhumed conventional munitions that are determined to be too dangerous to move would need to be destroyed in place by the Explosive Ordnance Disposal (EOD) Detachment.

It may be advantageous to use the CIDP in the clean up of munition burial sites. Buried munitions may be exhumed, radiographically examined to identify the contents, cryogenically cooled at the field, and then packaged and transported to the incinerator or transported directly to the plant for cryocooling and,incineration. On-site cryocooling would reduce or stop leaks from munitions. There is also the possibility that cryocooling could desensitize explosives and render the fuze mechanism less active, but this remains to be demonstrated. Tests should be run to verify that shrinking resulting from the cooling does not create undue force that could result in detonation.

B.1.4 Industrial Hazardous Waste

In general, wastes generated from industrial operations at TEAD were sent to leaching pits and holding areas. In the north area, washdown waters are now decontaminated in waste treatment facilities and no further contamination of soil is anticipated. The lagoon has been cleaned and lined. In the near future it is anticipated that the groundwater may be treated in a groundwater remediation facility.

TEAD's current activities generate various quantities of hazardous waste that could be incinerated in the chemical demilitarization facilities. Also, medical waste is available from nearby Hill Air Force Base. A list of the hazardous wastes generated at TEAD is presented in table B-5.

These quantities are based upon 1989 activity at TEAD and could either increase or decrease in the future depending upon the workload at TEAD, the implementation of a waste minimization program, and changes in environmental requirements.

The sludge from the TEAD water treatment facility (listed above) could be processed through the CSDP plant DFS to reduce its volume and detoxify it prior to landfilling.

Spent activated carbon produced at the industrial waste treatment plant is contaminated with chlorinated solvents and heavy metals and is difficult to regenerate. As much as 50,000 pounds per month of spent carbon is produced from the TEAD north area alone. While it may be possible to regenerate spent carbon in the deactivation furnaces of the chemical demilitarization facilities, such furnaces are not typically used in a carbon regeneration facility and therefore their use for this purpose would require a detailed investigation to determine feasibility.

Solvents, outdated paints, waste oil/fuel, and other liquid wastes could be incinerated in the LIC at CAMDS and CSDP Plants with minimal modifications to the nozzles; if not, this could be done in the DFS with changes to the feed system to allow liquids and sludges to be fed.

Solids, such as medical wastes and shredded filters could be destroyed in the DFS without difficulty. Medical wastes would pose no difficulty for the PAS. Fuel pumps, carburators, topographic equipment, electronic equipment, and automatic transmission valve bodies could be decontaminated in the MPFs. The resulting scrap metal could be sold thus avoiding the cost of disposal of these items in a hazardous waste landfill. Adjustments to the PAS operating conditions may be required depending on the contaminants in the feed. None of these materials would require use of the disassembly equipment.

Table B-5. Hazardous Waste Generated at Tooele Army Depot

Waste	Annual Estimated Pounds/Year
Activated carbon, spent (cannot be regenerated)	107,000
Blast grit	971,000
Carbon removing compound	56,000
Contaminated fuels	26,000
Oil-type sludge	5,000
Solvent waste	45,000
Paint liquids, waste	42,000
Paint sludges	303,000
Paint solid, filters	48,000
Sump sludges	50,000

RCRA permits to cover each of the types of hazardous substances to be burned may be obtained with no more difficulty than for other non-agent categories. At least one test burn could be required. DOD requirements for industrial wastes are minimal.

The public may be more likely to favor the disposal of more dangerous items before industrial waste, and strong statements by private companies appear to have been expressed opposing the future use of the demilitarization facilities for incinerating hazardous waste. This use may also violate Tooele County zoning laws that require all non-agent hazardous waste disposal activity be located in the West Desert Hazardous Industry Area 50 miles west of Tooele city. Also, commercial alternatives for the disposal of industrial wastes are as environmentally acceptable as incineration, perhaps even more so. Solvent recovery is likely to be more economical than incineration; also incineration of waste oil/fuel or shredded rubber tires to recover energy could be more attractive than simply burning them for disposal.

B.1.5 Municipal Trash

Sanitary landfills are operated in both the North and South Areas of TEAD. In the North Area, the sanitary landfill was used for the disposal of untreated paint sludges, grease, oil, and PCB containing oils. Other sites in the North Area have been used for disposal of wastes such as building rubble, garbage, rubber, and tires. The South Area has several old sanitary landfills and a new one. No hazardous materials were disposed in these landfills.

The combined fill for the North and South Area active landfills averaged approximately 169,400 cubic feet per month from September 1977 through November 1978 (Tooele Installation Assessment, U.S. Army, December, 1979).

Materials such as oils, grease, tires and general trash could be incinerated in the furnaces of the chemical demilitarization plants. General trash can be burned in the Chemical Stockpile Plant's Dunnage Incinerator (DUN). No environmental or permitting problems are expected. Since the DUN has a PAS, it is preferable to the existing disposal method at Tooele. An existing trash incinerator is able to keep up with current needs at Tooele so there is unlikely to be any need to use the chemical demilitarization plant dunnage incinerator for this purpose unless future environmental regulations become more stringent. Operating the TDI or DUN by itself would probably not be economical, but if the Tooele demilitarization plants are used to dispose of any of the other categories of waste, the dunnage furnaces could be used to burn trash with minimal incremental costs.

B.1.6 Other Potential Future Uses

Other potential future uses for the chemical demilitarization facilities at TEAD are:

- Regional DOD disposal of hazardous waste from Hill Air Force Base and Dugway. Coordination with state authorities would be required.

- Disposal of conventional munition inventories located at Navajo Depot Activity, Flagstaff, Arizona and at Fort Wingate Depot Activity at Gallup, New Mexico. The inventories at these sites were described above.

- Disposal of Dugway's waste. According to the Dugway Installation Assessment Report (USATHAMA, 1979), there are 22 test range areas where munitions containing chemical agents, biological agent, incendiaries, or high explosives have been tested. The presence of munitions containing chemical agents is suspected at 15 of these areas where such munitions were tested. The number of subsurface munitions is not known. The items that were used in tests, and which may be buried at an estimated depth of up to 5 meters, include the following:

  - Rockets, artillery projectiles, mortar rounds, mines, and bombs containing agents GB, H, or VX

  - Bulk containers and spray systems containing these agents

  - Cluster bombs containing BZ or CS

  - Projectiles and mortar rounds containing HE

  - Fire bombs and incendiary munitions

As it becomes necessary to clean up the test range areas at Dugway, use of any or all of the chemical demilitarization facilities should be considered as an option for decontaminating any recovered munitions and contaminated soil categories because the most stringent rules apply to items containing agent, especially those that are explosively configured. On the other hand, the plants are especially designed to process such items.

B.2 JOHNSTON ISLAND

Johnston Island (JI) is an unincorporated territory of the United States, and is located in a remote coral atoll (Johnston Atoll), approximately 720 nautical miles southwest of the Hawaiian Islands.

Johnston Island is presently under the command of the Defense Nuclear Agency (DNA), a result of the island's original mission of supporting U.S. nuclear weapons testing capability. (Johnston Island was used to support atmospheric nuclear testing from 1958 to 1962, and has been maintained in "standby" condition since that time).

In 1971, the Pacific inventory of unitary chemical weapons was relocated from Okinawa to Johnston Island under Operation Red Hat. Since that time, the munitions have been stored and maintained in a secure 41-acre storage facility, the "Red Hat Area", in earth-bermed structures called "igloos."

In 1983, the Army selected incineration as the preferred alternative disposal method for the demilitarization of the chemical munitions stored at Johnston Atoll, and construction of a demilitarization facility--the Johnston Atoll Chemical Agent Disposal System (JACADS)--was begun in 1986. JACADS commenced operations in 1990 and will progress through a four-phased program of operational verification testing (OVT) to confirm design and operational readiness, and to provide design verification and operating data for the CONUS baseline plant designs. Following OVT, full scale demilitarization operations will commence at JACADS to destroy the complete stockpile of chemical munitions remaining at JI. This is projected to be complete in 1994-1995. The Army completed relocation of chemical munitions stored in the Federal Republic of Germany to Johnston Island for destruction in the JACADS plant in November 1990.

Other activities at Johnston Atoll include operation by the U.S. Coast Guard of a LORAN-C navigation facility, and wildlife (seabird nesting) management activities by the U.S. Fish and Wildlife Service associated with the Atoll's status as a National Wildlife Refuge.

Testing or other use of chemical weapons has not occurred at Johnston Atoll and, therefore, there are no range recovered items expected to be found there. However, chemical munitions, mostly from the World War II era, are occasionally recovered in Hawaii and elsewhere in the Pacific Basin. These items are brought to Johnston Island. Recently, for example, 92 155mm M104 mustard-filled artillery rounds were discovered in the Solomon Islands.

Two candidate future uses for the Johnston Atoll Chemical Agent Disposal System (JACADS) were identified during this analysis: (1) disposal of nonstockpile agent contaminated items including thermal (XXXXX) decontamination of 264 ton containers containing spent decontamination

solution, destruction of "XXX" dunnage stored at Johnston Atoll, and demilitarization of range recovered chemical munitions found in Hawaii and the Asiatic-Pacific area, and (2) incineration of contaminated soils and other residue associated with the previous storage and disposal of Agent Orange herbicide on Johnston Island.

Part of the first candidate future use for the JACADS plant is already planned as part of the standard plant operation: incineration of brines in the LIC; decontamination of the 264 empty ton containers in the MPF; and incineration of stored dunnage in the DUN. The demilitarization of range recovered chemical munitions should also be accomplished during the programmed operating period of JACADS. These items can easily be processed while JACADS is operating with minimal impact from either a permit or operations aspect. The transfer of such items to Johnston Island for disposal should be continued. In the case of the specific items in the Solomon Islands, they can be destroyed at the end of OVT test 4 with the virtually identical M110 155mm projectiles currently stored on Johnston Atoll. These items would be destroyed at JACADS in a matter of hours. No modification to plant design, operation or permits would be required to allow this use.

Conventional munitions disposal will not be required on Johnston Island, since no such munitions are stored there. High transportation and operating costs preclude the shipment of such items to the Island. Limited quantities of hazardous waste are currently disposed of through the Defense Reutilization and Marketing Services (DRMS), and no landfills exist at Johnston Island.

B.2.1 Contaminated Soils

From 1972 to 1977, 1.37 million gallons of Herbicide Orange were stored in 55-gallon drums at a four acre site at the extreme eastern end of Johnston Island. The herbicide was destroyed by incineration using an ocean-going hazardous waste incinerator vessel, but leaks from drums resulted in soil contamination of dredged coral fill within the four acre storage area. Approximately 85 55-gallon drums of Herbicide Orange-contaminated materials and 13 contaminated "carbon-cylinders" are also stored at JI (U.S. Army, 1990). The Defense Nuclear Agency, and for them the U.S. Air Force, have responsibility for cleanup. While no approved cleanup approach currently exists to destroy the contaminated material, incineration is a proven method.

Since there are no other incineration facilities located at or planned for Johnston Island, use of the demilitarization plant to incinerate the Herbicide Orange contaminated soils would be an appropriate candidate future use of the plant. The drummed material, if it is similar in

content to contaminated dunnage, could be incinerated in the DUN without modification. The carbon cylinders could also be incinerated either in the DUN or possibly the DFS.

The largest potential waste stream is the contaminated soil (dredged coral fill). Soil would be excavated and transported for thermal detoxification under dust containment measures to the demilitarization plant for feed to the DFS. The actual extent and depth of Herbicide Orange contamination would determine the exact amount of material to be excavated and treated in the DFS, but amounts could range between 6,000 and 18,000 cubic yards. This is a relatively small amount of material and could be processed at JACADS in a matter of weeks. The decontaminated coral could then be replaced as clean fill.

Herbicide Orange was a commercial defoliant comprised largely of the n-butyl esters of 50 percent 2,4 dichlorophenoxyacetic acid (2,4 D) and 50 percent 2,4,5 trichlorophenoxyacetic acid (2,4,5-T) and was sometimes contaminated with various isomers of "dioxin" (chlorinated isomers of dibenzo-para-dioxin) and related compounds, which are side-products of Herbicide Orange manufacture.

Incineration of Herbicide Orange-contaminated soils and materials would be subject to RCRA Subpart 0 requirements, and an amended permit (pending outcomes of trial burns of each candidate material in each proposed furnace) would be required. An Environmental Assessment would be required and an amendment to the JACADS EIS may also be needed. Nevertheless, the timing, and the unavailability of any other suitable means for decontaminating the soil still make this a potentially attractive future use option for the JACADS plant. Further analysis of feasibility and desirability with regard to cost and in comparison with alternative methods of disposing of this material is required.

B.3 ABERDEEN PROVING GROUND

Aberdeen Proving Ground is a Test and Evaluation Command (TECOM) installation within the U.S. Army Materiel Command (AMC). It is located in Harford and Baltimore Counties, Maryland near the head of the Chesapeake Bay. APG is comprised of two general areas, the Aberdeen Area and the Edgewood Area.

The Edgewood Area of APG has been the primary chemical warfare research and development center for the United States. Its activities have included laboratory research, field testing of chemical materials, pilot scale manufacturing, and production scale chemical agent manufacturing. It is also a storage center for chemical warfare material and it has been a major receiving center for waste handling operations, including low level radiological wastes (Nemeth 1989). A bulk chemical demilitarization

facility is proposed for construction in the Edgewood area to dispose of mustard (HD) filled ton containers that are stored there. The scheduled date for the start of construction is mid 1993 and disposal of the mustard filled ton containers is anticipated to be completed by the end of 1997.

The Aberdeen Area of APG was formally established in 1917. Its primary mission is the testing and development of weapons, munitions, vehicles, and a wide variety of support materiel relevant to military operations. The variety of munitions on which tests are or have been conducted include bombs of up to 5,000 pounds, small arms, projectiles, rockets, high explosive ammunition, armor defeating projectiles, antipersonnel mines and weapons, incendiary and smoke grenades, and practice rounds. There is no history of large-scale manufacturing operations in the Aberdeen area of APG and chemical warfare agents havenot been used there. However, the riot control agent, CS, obscuring smoke, and white phosphorous have been used during testing and training operations. Because of the proximity of the Aberdeen Area to Edgewood, wastes that originate in the Aberdeen Area of APG are considered potential candidates for disposal in the chemical demilitarization facility after the mustard filled ton containers are disposed of.

Categories of waste items from Aberdeen Proving Ground that were evaluated for the future use of the chemical demilitarization plant that is scheduled to be constructed there include:

- Nonstockpile chemical items consisting of empty agent ton containers and excess VX;
- Conventional munitions consisting of experimental or malfunctioned munitions and artillery shells, range recovered unexploded ordnance, and propellant;
- Agent contaminated building structures and equipment scheduled for demolition and decontamination;
- Agent contaminated munitions and equipment from burial sites undergoing remedial action;
- Hazardous waste from burial sites undergoing remedial action;
- Agent and/or hazardous waste contaminated soil;
- Hazardous waste generated from continuing activities consisting of explosive and pyrotechnic contaminated waste, waste petroleum oils and solvents, spent decontamination solutions, laboratory chemicals and contaminated laboratory equipment, PCP treated wood, empty hazardous material drums and containers, and medical wastes.

B.3.1 Nonstockpile Chemical Items

There are 2,452 empty ton containers in storage at the Edgewood Area of APG. These containers were once used to store bulk chemical warfare agent including mustard, lewisite, and tear agent, CN. The ton containers have been decontaminated to the XXX level. Under Army regulations, if the containers are incinerated and therefore XXXXX, they may be salable as scrap metal. Since the chemical demilitarization facility that will be constructed at the Edgewood area will be designed to decontaminate ton containers to the XXXXX condition, it could be used to decontaminate the 2,452 empty ton containers with no modifications in about 3 months time. The disposition of the thermally treated ton containers must be carried out in accordance with the provisions of DoD 4160.21-M.

There are also four excess ton containers filled with VX agent at the Edgewood Area of APG. Since the chemical demilitarization facility that will be constructed at the Edgewood area will be designed and permitted for mustard ton containers, a permit modification would have to be obtained to demilitarize VX ton containers in the facility. Preparing the facility to process VX after processing mustard requires a changeover period lasting from two to three weeks and a VX trial burn would most likely be required. Incineration of the VX and decontamination of the ton containers in the demilitarization facility would require less than a full shift of plant operation, which is shorter than the period required for a full trial burn. Thus permitting of the facility for destroying a relatively small amount of VX could become complicated.

An alternative disposal method for the VX should be considered. This would be chemical neutralization of the VX and incineration of the resulting solution at Edgewood in the existing permitted Decon/Detox Facility. The Decon/Detox facility can also decontaminate the emptied ton containers to XXXXX at the same time. Because the work in the Decon/Detox facility is backlogged, a waiver would be needed to permit extended storage of the VX.

The Decon/Detox facility includes a batch operated car bottom incinerator with an afterburner and a pollution abatement system consisting of a quench tower, a packed bed scrubber, a venturi scrubber, and an entrainment separator. The combustion chamber of the car bottom incinerator rides on rails for loading and unloading. Combustible and contaminated material is loaded into the chamber and the chamber then moves under the top half of the incinerator and is reconnected. After the incineration and decontamination is completed and the incinerator is cooled, the car bottom is disconnected and the chamber is emptied of decontaminated metal parts and ash and reloaded with the next charge.

Although the Decon/Detox facility is technically capable of thermally decontaminating ton containers, it would not be feasible to use the facility for the stockpile of 2,452 empty ton containers at APG. The Decon/Detox facility can only process one ton container per day, thus it would take 10 years to process all the empty ton containers in the Decon/Detox facility compared with 3 months in the chemical demilitarization facility. However, using the Decon/Detox facility for the four VX filled ton containers would not be unreasonable and doing so would assure that the VX is destroyed in the near future.

B.3.2 Conventional Weapons

APG does not have an inventory of conventional weapons scheduled for demilitarization. However, the Aberdeen area has two facilities for removal and reclamation or disposal of explosives or inert ingredients from experimental or malfunctioned munitions and artillery shells. They are the following:

- a melt load facility where explosives are reclaimed from experimental or malfunctioned munitions; and
- a shell washout facility where explosives or inert ingredients are removed from artillery shells by steam cleaning.

The Aberdeen Area also maintains two demolition and burning ground areas for the disposal of small quantities of unneeded propellant, high explosives, unexploded ordnance and range recovered unexploded conventional ordnance by OB/OD. A permit for this activity was obtained from the State of Maryland.

OB/OD of range recovered conventional munitions is generally considered to be the most practical and safest means of disposal of those items at the present time.

The U.S. Army Chemical Research, Development and Engineering Center in the Edgewood Area of APG also annually produces small quantities of munitions which eventually require disposal. These include the following:

- Several hundred M18 and L8A1 smoke grenades (current inventory is about 2,000)
- Twelve smoke pots and cans (1 to 5 gallons) (current inventory is about 50)
- Expended rocket warheads (generation rate unknown) (current inventory is about 30)

- Twelve launcher tubes (current inventory is 30)

The metal parts furnace of the chemical demilitarization facility that will be constructed in the Edgewood Area of APG could be used to decontaminate conventional artillery shells that have had their explosive content removed, if that is required prior to sale or disposal as scrap. Other conventional munition items are more amenable to disposal through a deactivation type furnace (rotary kiln).

B.3.3 Contaminated Buildings and Equipment

A 1989 assessment of 29 buildings at the Edgewood area of APG, which are no longer needed to support mission requirements and, therefore, are candidates for demolition, found that 16 of the buildings were potentially contaminated with toxic agents, incendiaries, and/or incapacitants (EAI 1989). These buildings may also be contaminated with other hazardous substances such as nitrates, benzene, xylene, industrial cleaners and solvents, petroleum, oil and lubricants, simulants, activated carbon, and asbestos. Some of the buildings have a variety of equipment including chemical piping, ventilation ductwork, and storage tanks. Other buildings are empty shells. The building shells and floors are commonly concrete, however, some of the buildings have walls of corrugated metal, transite, tile, and/or wood. Roofs are made with concrete, corrugated metal, transite, or asphalt. Other buildings are undergoing similar assessments and may be added to the inventory of potentially contaminated buildings scheduled for demolition and decontamination (White 1990). It has been estimated that there are 251 contaminated or potentially contaminated buildings at the Edgewood Area of APG (EAI 1989).

The U.S. Army Chemical Research, Development and Engineering Center (CRDEC) is currently in the process of dismantling and demolishing a Pilot Plant (Building E5625) located at the Edgewood Area of APG. The pilot plant is a four story building to which two and one story annexes were added. The building was constructed primarily of concrete and brick and consisted of a number of different laboratories where pilot plant studies were conducted of manufacturing and filling, testing and evaluating, and the demilitarization and disposal of nerve, blister, blood, incapacitating, and riot control chemical agents (Carpenter and Hill 1990). To date most of the equipment and piping in the building have been dismantled and reduced in size after having been chemically decontaminated. An estimated 700 tons of equipment was removed from the facility and loaded on 1,400 pallets in preparation for thermal treatment in the Detox/Decon Facility.

The MPF of the chemical demilitarization plant that will be constructed in Edgewood could be used to thermally decontaminate the contaminated equipment and other contaminated items from buildings scheduled to be

demolished so that they can be sold as scrap instead of being disposed of in a hazardous waste landfill. This use should not require any major modifications to the metal parts furnace. The demilitarization plant metal parts furnace would be more efficient than the Detox/Decon facility because it will be designed for higher throughputs than the Decon/Detox facility.

Methods for decontaminating and demolishing the building structure are under evaluation. If the building is converted to rubble, the rubble could be thermally decontaminated in the MPF of the chemical demilitarization facility. However, if other decontamination methods such as chemically washing the building, or hot gas decontamination is determined to be effective and cost effective, the MPF would not be needed for decontamination of the building structure.

The potential removal of a large number of buildings at Aberdeen Proving Ground that contain equipment that may be contaminated with agent provides a potential future use of the chemical demilitarization plant at Aberdeen: decontamination of agent contaminated building rubble and equipment.

B.3.4 Contaminated Material and Soil from Sites Undergoing Remedial Action

As a result of munitions testing, large sections of the Aberdeen Area of APG contain unexploded ordnance containing white phosphorous, beryllium, titanium, RDX and TNT explosives, and depleted uranium, as well as inert ordnance (McMaster, et al 1981). Also as a result of past munitions testing, chemical munitions that were fired between 1918 and 1969 are periodically recovered. There are 164 of these range recovered chemical munitions currently stored at Aberdeen (See table B-6). These items cannot be processed by any methods presently available or planned for APG. Many of the items are explosively configured.

Also, two sanitary landfills are located in the Aberdeen area of APG. One of them was closed in 1980. The landfills reportedly received PCBs, pesticides, waste oils, chemicals, herbicides, and paints. In addition several smaller landfills reportedly were used to bury various chemicals (McMaster, et al 1981).

In the Edgewood Area numerous sites have been identified where chemical munitions and chemical wastes from research, development, and manufacturing activities were disposed of by burial or open burning, where chemical munitions were tested, or that served as impact areas for chemical or conventional munitions. Areas have also been identified that were landfill disposal locations for drums which may have contained hazardous substances such as chlorinated solvents, paint, and excess chemicals (Nemeth 1990). Of particular notoriety is a site called Old "O"

Table B-6. Inventory of Range Recovered Chemical Munitions at Aberdeen Proving Ground

Description	Unspecified	Fuzed	Unfuzed
Mortar, 4.2 in.		26	50
Projectile, 105 mm		10	2
Projectile, 75 mm	1	8	4
Stokes, 4 in.			5
Projectile, 155 mm			2
Projectile, 175 mm			17
Bomb, M47/70(?) (100lb)	3		
Bomb, M78(?) (5001b)			1
Bomblets, Ml25			
Rocket Warhead M56	11		
BZ Canister			
CAIS*			1
Levins projectiles		6	12

'Chemical Agent Identification Sets.

field, a 4 1/2 acre hazardous waste and ordnance disposal site. It was used for the disposal of chemical agents, munitions, contaminated equipment and various other hazardous materials including potentially shock-sensitive explosive materials during the 1940s and 50s (Kipp et al 1987). It has been estimated that if Old "0" field is excavated it will yield 153,710 cubic yards of contaminated equipment/scrap, drums, munitions, etc., and 95,000 cubic yards of contaminated soil. The quantity of munitions could range from several hundred to several thousands (White 1990).

It is also anticipated that construction activities may uncover pockets of contamination not currently identified such as occurred during construction of the Wheeled Vehicle Training Facility (WVF) in the Edgewood Area of APG. This particular contamination may have resulted from training exercises involving clothing impregnation and decontamination (Nemeth 1990). The 15,000 cubic yards of contaminated soil from the WVF is currently in a mound on site with a grass cover for stabilization pending determination of a cost effective means of disposal (White 1990). Excavation of other contaminated soil areas could result in millions of cubic yards of soil and debris requiring decontamination and disposal (White 1990).

Removal and remediation of the contamination at these various locations is likely to be a long term activity depending upon funding and identification of appropriate remediation techniques.

Soil decontamination by incineration is most efficiently carried out in a rotary kiln type incinerator because fresh soil surface is continuously being exposed to the heat in the kiln as the kiln rotates. Thus, the MPF of the chemical demilitarization facility that will be constructed at Edgewood would not be useful for this purpose. However, the chemical demilitarization plant could be used for thermal treatment of equipment and munitions recovered from burial sites such as "O" field. This use may require installation of additional specialized equipment to identify and remove the contents of recovered whole munitions. Empty munition shells and contaminated equipment can be readily thermally treated in the metal parts furnace. The demilitarization facility at Edgewood will not have the capability to handle or destroy explosively configured munitions. The liquid incinerator of the chemical demilitarization facility could be used to incinerate hazardous liquids or agent recovered from the munitions. However, procedures would have to be developed to identify and segregate incompatible liquids and to operate the incineration system within the constraints of environmental permits.

B.3.5 Hazardous Waste

A variety of hazardous wastes are generated by activities in both the Aberdeen and Edgewood areas of APG. The total quantity of hazardous solid and liquid wastes and sludges (as defined by the EPA) generated annually is estimated to be over half a million pounds. A discussion of the sources of these wastes is provided below.

B.3.5.1 Aberdeen Area Hazardous Waste Generation

In the Aberdeen Area of APG hazardous wastes are generated by the following activities (McMaster, et al 1981):

- an Army hospital (Kirk Medical Center) that generates infectious wastes;
- a small printing plant that uses standard printing inks and solvents;
- a vehicle maintenance and paint shop;
- photographic laboratories;
- chemical laboratories;
- a melt load facility where explosives are reclaimed from experimental or malfunctioned munitions; and
- a shell washout facility where explosives or inert ingredients are removed from artillery shells by steam cleaning.

Medical and pathological wastes generated by the Kirk Medical Center are currently destroyed in an in-house contaminated waste incinerator.

Petroleum and solvents from the vehicle maintenance and paint shop, printing operations, and chemical laboratories are disposed through DRMS.

Spent photographic solutions from the photographic laboratories are processed to reclaim silver before being discharged to the sanitary sewer system.

Less than 2,000 gallons of wastewater containing TNT are generated annually by the shell washout facility and the melt load facility. The wastewaters are discharged into the Main Sewage Treatment Plant (STP).

B.3.5.2 Edgewood Area Hazardous Waste Ceneratfon

In the Edgewood Area of APG hazardous wastes are generated by activities in the following facilities (Nemeth 1990):

- A weapons assembly plant (G-Field) for rockets and projectiles used in testing programs.
- The H-Field armored vehicle test range.
- The L-field ballistic track test facility.
- The Chemical Transfer Facility (CTF).
- The pyrotechnic loading facility.
- Chemical munitions test chambers.
- Medical research laboratories.
- Photographic laboratory.
- The airfield.
- Chemical laboratories.

The weapons assembly plant packages floor sweepings that may contain small amounts of explosives and transfers it to the Aberdeen area for disposal. Most of the waste generated at the facility consists of wood, cardboard, fiberboard, and steel strapping that is disposed of with other sanitary solid waste.

The armored vehicle test facility, the ballistic track test facility and the airfield generate waste petroleum oils and solvents from maintenance activities and cleaning of metal parts.

The CTF, the test chambers and the chemical laboratories generate spent decontamination solutions and spent activated carbon filters from the ventilation systems. The laboratories also dispose of a variety of laboratory chemicals, and equipment that has been decontaminated to XXX status.

The pyrotechnic loading facility generates pyrotechnic and explosive contaminated waste. The waste is drummed and disposed of by the U.S. Army Tech Escort Unit.

The medical research laboratories generate animal bedding, animal carcasses, and infectious laboratory wastes. They have an incinerator which operates from 3 to 5 days per week and disposes of 400-600 pounds of waste per day. The incinerator is also used as a backup for the Kirk Medical Center incinerator at the Aberdeen Area of APG.

The photographic laboratories reclaim the silver from spent photographic processing solutions.

Other hazardous wastes generated at APG are small quantities of polychlorophenol (PCP) treated pallets and ammunition boxes and discarded drums and containers that may have contained hazardous material.

Hazardous material in storage at APG and awaiting disposal include an estimated 132,000 pounds of PCB contaminated liquids and solids, 125,000 pounds of solid and debris contaminated with EP toxic metals, PCBs, and solvents, and 500,000 pounds of soil contaminated with DDT.

The combustible liquids could conceivably be mixed with fuel for the furnaces either during the chemical demilitarization campaign or if the furnaces are used subsequent to chemical demilitarization.

The total quantity of hazardous wastes described above is small relative to the capacity of the incinerators that will be installed in the chemical demilitarization plant. Ongoing waste minimization efforts may further reduce the quantity of hazardous waste generated. Thus, it is probably not economically justifiable to use the incinerators only for the hazardous waste generated at APG.

In addition, regulations regarding the incineration of different types of waste, e.g., hospital wastes, PCBs, may discourage the incineration of small quantities of multiple kinds of wastes in the same incinerator.

Nonhazardous Waste

APG generates about 2,000 cubic yards of sewage sludge annually from the wastewater treatment plants in the Aberdeen and Edgewood areas. The incinerators that will be installed in the chemical demilitarization plant in Edgewood are not particularly suitable for incineration of sewage sludge. Conventional trash from APG goes to a privately owned waste to energy facility operating on land leased from APG. The facility incinerates the trash and the resultant steam is purchased by APG.

B.4 LEXINGTON-BLUE GRASS ARMY DEPOT

The Lexington-Blue Grass Army Depot (LBAD) is located in central Kentucky and is actually comprised of two sites, the Lexington Activity and the Blue Grass Activity. The Lexington Activity is located in Fayette county, about 16 km east of Lexington, KY. The Blue Grass Activity is located in Madison county, about 9.6 km south of Richmond, KY. The sites are approximately 40 miles apart. The Lexington activity was originally responsible for overseas signal support through the New Orleans and New York ports. The Lexington Activity is scheduled to be closed by September, 1995. The Blue Grass Activity is primarily an ammunition storage depot. The chemical munition stockpile is stored at the Blue Grass Activity. The chemical demilitarization facility is proposed to be constructed there and it will be of the "rockets, projectiles" type. The March 1990 schedule shows the construction of the chemical demilitarization facility beginning in March, 1992 and ending in August, 1995 (Program Manager for Chemical Demilitarization, 1990). Completion of the chemical demilitarization mission is scheduled for September, 1998. Therefore, the potential future use of the chemical demilitarization facilities will be after September, 1998. There are several sources of wastes that may be available for future use of the chemical demilitarization facilities: conventional weapons, range recovered munitions, contaminated materiel and soil from landfills, other contaminated soils, and on-post hazardous wastes.

One of the key factors in the determination of feasible future uses for the LBAD chemical demilitarization facility is the strong public opposition to the plant itself. The public is very vocal and well-organized in their opposition to on-site chemical demilitarization. The Kentucky legislature has responded to public pressure by passing two laws affecting the site. One sets extremely strict limits for hazardous waste incinerators. The other gives the county government approval power over incinerator permits (Chemical & Engineering News, 1990). The State has also proposed passage of very stringent air quality regulations for hazardous waste incinerators. Eighteen potential future use feedstocks for the chemical demilitarization plant at LBAD have been identified. These are listed in table B-7 and are discussed below.

B.4.1 Conventional Weapons

The Blue Grass Activity has a small conventional munition demilitarization inventory. Table B-8 shows the types and amounts of munitions as of June, 1990. It also summarizes the disposal capability of these munitions in the chemical demilitarization facility. Only the small arms, fuzes and primers can be destroyed in the chemical demilitarization facility without modifications or use of additional equipment. Most of the other munitions require additional equipment for disassembly. The disassembly equipment

Table B-7. Potential Feedstocks for the LBAD Chemical Disposal Facility

Potential Feedstock	Comment
Small arms, fuzes, primers and grenades	Well suited to disposal int the DFS, moderate quantity
Smokes, dyes, riot control agent, and pyrotechnics	Well suited to disposal in the DFS, moderate to large quantity
Bulk explosives and propellant charges	Suited to disposal in the DFS, large quantity
Projectiles, rockets, bombs, and inerts	Suited to disposal in the DFS, large quantity
"Found on Post" munitions	Very few, great variety, strong competition (OB/OD)
Old Landfill material and soil (Lexington)	Contaminants may include heavy metals and PCBs
Industrial and Sewage Sludge Disposal Area material and	Contaminants may include heavy metals and PCBs
New Landfill material and soil (Lexington)	Contaminants may include heavy metals
Landfill/Burning Area material and soil (Blue Grass)	Batteries do not require incineration, other contaminants not well characterized
Property Disposal Yard (Lexington)	Can be disposed of much less expensively
Building 63 Area soil (Lexington)	Contaminated with solvents and paints, well suited for disposal in the DFS
Heating Plant Area soil (Lexington)	Contaminated with coal pile runoff, well suited for disposal in the DFS

Table B-7. Potential Feedstocks for the LBAD Chemical Disposal Facility (Concluded)

Potential Feedstock	Comment
Mustard Burning Ground (Blue Grass)	Remediation not likely to be required
PCB contaminated electrical equipment	Will not be available when chemical demilitarization facility is available: PCBs must be destroyed by 1992
Underground Storage Tanks (Lexington)	Likely to be disposed of prior to chemical demilitarization facility availability
Industrial Waste Lagoons (Lexington)	Contaminated with heavy metals
Waste water treatment sludge from the washout facility	No current method for disposal, explosives contaminated
Spent carbon filters from waste water treatment of the washout facility	No current method for disposal, explosives contaiminated

Table B-8. Conventional Munition Demilitarization Inventory at Blue Grass Activity as of June, 1990

Munition Description	Weight (lbs)	Dissassembly Required	Required Changes	Comments
Small arms, fuzes, and primers	502303	No	NO	
Smokes and dyes	35686	Some	PAS?	PAS may need modification. Colored dyes have carcinogens.
Pyrotechnics	39022	Yes	No	
High explosive loaded projectiles	4978640	Yes	DFS feed system	OB/OD preferred method. Projectile only in MPF. Propellant in DFS.
Rockets and missiles	1134285	Yes	DFS feed system	OB/OD preferred method. Metal only in MPF. Explosives in DFS.
Bombs, torpedoes, depth charges end cluster bomb unit*	99553	Yes	DFS feed system	Metal only in MPF. Explosives in DFS.
Riot control agents	21312	Punch	DFS feed system	DFS OK for grenades. May require longer residence times for bulk agent.
Bulk explosives	307598	No	DFS feed system	
Grenades and mines	210950	Yes	No	DFS OK for grenades and antitank mines. DFS inadequate for thermite loaded munitions.
Special function projectiles	177702	Yes	DFS feed system	

Table B-8. Conventional Munition Demilitarization Inventory at Blue Grass Activity as of June, 1990 (Concluded)

Munition Description	Weight (lbs)	Dissassembly Required	Required Changes	Comments
Propellant charges	1326436	Yes system	DES teed	
Inert loaded items	72931	Yes system	DFS feed	
Non-homogenous item	900016	?	N/A	No capability to dispose.
Uncategorized items	311114	?	N/A	No capability to dispose.
Total	------			
10117630				

used in the chemical demilitarization mission is highly specialized and cannot be easily adapted to other uses. Destruction of many of the munitions or their explosive components requires modifications to the feed mechanism of the deactivation furnace (DFS). In some cases, the metal parts furnace (MPF) can be used to decontaminate the empty metal parts.

From a technical standpoint, the chemical demilitarization facility can be used to demilitarize a large portion of the conventional stockpile at Blue Grass. The current methods for conventional stockpile demilitarization at Blue Grass are open detonation and washout. Open burning is performed on an emergency basis only. The washout facility at Blue Grass was constructed in 1976 and contains efficient, modern equipment. There are two incinerators at Blue Grass: an old deactivation furnace that is currently not operational and is undergoing pollution abatement upgrades, and a Contaminated Waste Process incinerator (CWP) used for dunnage and flashing empty munition parts. Neither of these are currently permitted as hazardous waste incinerators. After the pollution abatement upgrade to the deactivation furnace is complete, Blue Grass plans to apply for a hazardous waste permit to use the deactivation furnace for the destruction of small arms. The pollution abatement upgrade will include an afterburner, cyclone and baghouse. One of the technical uncertainties in this upgrade is whether the pollution abatement system will be able to handle metal particles. This will be an important factor in determining if the incinerator can be used to destroy small arms (Hazle 1990).

Demilitarization of the small stockpile of conventional munitions is a candidate future use of the LBAD chemical demilitarization facility because this use requires no modifications to the DFS or PAS. In addition, permitting requirements are not excessive. There is a moderate amount of small munitions requiring disposal at Lexington-Blue Grass Army Depot, A disassembly and washout facility will have to be added.

The smoke-type stockpile conventional munitions are another candidate for disposal in the chemical demilitarization facility. While these generally require no modification to the furnaces or pollution abatement system, there is a very small inventory of these munitions.

The large stockpiled conventional munitions are another feedstock for the chemical demilitarization facility. This is primarily due to the quantity of this type of munition at Lexington-Blue Grass. The relative number of munitions have been fairly stable, although there have been some variations in the absolute amounts (Manning, 1990). It is difficult to predict what stockpiles will exist at Blue Grass when the chemical demilitarization facility will be available for future use. The DFS can be used, although the rates will be limited by the amount of explosives charged.

The bulk stockpiled conventional munitions are also a candidate for demilitarization in the chemical demilitarization facility. This use requires feed mechanism modifications to the DFS. Permitting may be somewhat more difficult because of the large amounts of explosive involved. In this respect, the bulk munitions are very much like the large munitions. However, the weight of bulk munitions is only about a fifth that of large munitions. There are also good alternative methods available for recovery or disposal of bulk items.

B.4.2 Range Recovered Munitions

Some unexploded ordnance in the Blue Grass burning and demolition area were reported in the 1980 Installation Assessment (USATHAMA, 1980). Unexploded ordnance is still found from time to time (Hazle, 1990). The current disposal method is open detonation soon after the ordnance is discovered. These range recovered munitions could be considered a potential feedstock for the chemical demilitarization facility. However, as with all range recovered munitions, the munition type and condition is generally unknown. This makes determination of technical feasibility and permitting very difficult.

B.4.3 Contaminated Material and Soil from Landfills Undergoing Remedial Action

There are several landfills on the Lexington Activity that contain various types of contaminated material: heavy metals, solvents, paints, and cyanide (Ebasco Environmental, 1990). These areas are being investigated in the Installation Restoration Program, which must be completed before the base can be closed. This program will develop an action plan for cleanup of these sites. It is possible that the contaminated material could be transferred to the Blue Grass Activity and stored, where it could be disposed of in the chemical demilitarization facility when it is available for future use.

The Old Landfill at the Lexington Activity contains many types of material: industrial waste sludges, sewage sludges, dunnage, contaminated plating shop solutions, and transformer fluids of unknown types. It is reported to have been an unlined, area-fill operation approximately 250 ft by 250 ft, and 10 to 15 ft in depth (23,000 to 35,000 cy). Interviews with personnel involved with the operation indicate that the length of the landfill may have been much longer than previously reported. While it is currently leaking a small amount of leachate, it is not certain that the remediation plan will require excavation of the landfill. Improvements to the cap may be sufficient to permit base closure (Ebasco Environmental, 1990).

The Industrial and Sewage Sludge Disposal Area at the Lexington Activity is approximately 300 ft by 300 ft and 10 to 15 ft in depth (33,000 to 50,000 cubic yards). This area contains solvents, paper, wood, construction debris, metal plating sludge, sandblasting dust containing chrome, and transformer fluids suspected of containing PCBs. It is not clear what remedial actions will be required for this landfill. Improvements to the cap may be sufficient to permit base closure (Ebasco Environmental, 1990).

The major drawback to incinerating the soil from either the Old Landfill or the Industrial and Sewage Sludge Disposal Area is the permitting process. Since in both of these cases, the exact contaminants are unknown, quite varied and possibly include PCBs and heavy metals, permitting may be nearly impossible. Permitting generally requires a trial burn for the bounding case of waste streams. Determining the bounding case would be quite challenging for these old, poorly documented landfills.

The New Landfill at the Lexington Activity contains waste paper and office scrap, some plating and paint waste, infectious waste from the facility and Fort Knox U.S. Army Medical Department (burned prior to covering), and sewage sludge. It consists of unlined trenches 13 to 16 ft wide, 3 to 7 ft deep and roughly 300 ft long (430 to 1245 cy). As before, it is not known what remedial actions will be required to permit base closure. Improvements to the cap may be sufficient (Ebasco Environmental, 1990).

This landfill also has some permitting problems if it is to be treated in the chemical demilitarization facility since the contaminants are not well identified. There may also be technical problems. In particular, the plating waste may have some heavy metals that are not amenable to thermal treatment.

The Blue Grass Activity has one landfill. This is the old landfill that was the site for two burials of batteries. The first burial involved 2,000 to 3,000 zinc-carbon dry cells buried in 1970. The second burial, in 1971, involved 200,000 batteries of unknown types. Several weeks after the second burial, the batteries spontaneously ignited (USTHAMA, 1980). Discussions with LBAD personnel indicated it is likely that many of the batteries were AA batteries (Manning, 1990). These batteries may not be a significant hazard (Hazle, 1990). An environmental study to determine the status and make recommendations for remediation of this landfill is ongoing (Hazle, 1990). Even if the batteries are found to require other means of disposal, an incinerator is of no benefit for battery disposal. This landfill may have other contaminants that need to be destroyed, but there is inadequate documentation to make a determination at this time.

Most of the material in the landfills that might possibly become feedstock for the chemical demilitarization facility is soil. Soil requires agitation during incineration to ensure even heating. Since it is a rotary kiln, the deactivation furnace (DFS) is the best choice of furnace for this application.

B.4.4 Contaminated Soils

The landfills described in section B.4.3 all contain soils contaminated with hazardous substances that may require treatment. In addition, there are several known and suspected contaminated soil locations due to spills or burning activities.

The property disposal yard at Lexington was contaminated by petroleum, oil and lubricant discharges of unknown composition (USATHAMA, 1980). The area around building 63 is contaminated with solvents and paints. The last area of contaminated soil at Lexington is the area around the heating plant which is contaminated with solvents and coal pile runoff (Ebasco Environmental, 1990).

As described in the previous section, soils are best treated in the deactivation furnace because it is a rotary kiln. The mixing action of the kiln is important to evenly heat the soil. The property disposal yard soil could be incinerated in the deactivation furnace. However, this may be an expensive disposal method for a rather small problem (Hazle, 1990).

From a technical standpoint, the areas around building 63 and the heating plant are good candidates for incineration in the deactivation furnace, however, the volume of material is small. Solvents, paints and coal pile runoff could be handled adequately in the chemical demilitarization plant. Permitting may be difficult, however, since the specific nature of the contaminants is unknown and different from the contaminants identified in the chemical demilitarization permit. It is also unknown whether the cleanup of these areas will be required. Thus decontamination of soil around building 63 and the heating plant is a less favorable future use of the chemical demilitarization plant than conventional munition demilitarization.

The Blue Grass Activity has a burning ground that was used for burning approximately 900 rounds of mustard-filled munitions. However, numerous soil and water samples of this area have been performed with no indication of mustard contamination (Hazle, 1990). If it is determined in the on-going environmental study that this area requires remediation, the soil is a potential feedstock for the chemical demilitarization facility. Since the soil is potentially contaminated with mustard, permits may be easier

to obtain, since the chemical demilitarization permits already include destruction of mustard. Also, technical problems will be minimal because the facility is designed to destroy mustard. The major question is whether cleanup of the burning ground will be required.

B.4.5 Other Hazardous and Toxic Waste

There are 34 PCB contaminated transformers and 4 PCB transformers at the Lexington Activity. The contaminated transformers contain between 50 and 500 ppm PCBs. The PCB transformers contain greater than 500 ppm PCBs. Use of the 4 PCB transformers will be prohibited after October, 1990 (Ebasco Environmental, 1990). The 1980 Installation Assessment did not address PCBs, so it is unknown how many PCB transformers are located at Blue Grass. Federal law (TSCA) requires that all managed PCB be destroyed by 1992 so this problem will not exist when the chemical demilitarization facility is available for future use.

There are eight underground storage tanks at Lexington that originally contained petroleum hydrocarbons but are currently not in use. These must be decontaminated prior to base closing. LBAD personnel are presently soliciting proposals from contractors to perform this work (Hazle, 1990). It is highly likely that the tanks will be disposed of before the chemical demilitarization facility is available for future use. If that does not occur, another option is to remove the tanks, store them at Blue Grass and incinerate them in the metal parts furnace when it is available for future use. This may be an expensive solution to a simple problem. The tanks and any contents would have to be stored in a RCRA permitted facility. Such a facility is expensive to establish and maintain, especially for such a small volume of waste. Also, there are more desirable disposal methods such as chemically decontaminating the tanks, sending them to another, less costly incinerator or otherwise disposing of them in a timely fashion.

The Enhanced Preliminary Assessment (Ebasco Environmental, 1990) describes the industrial waste lagoons at the Lexington Activity that may be contaminated with heavy metals and cyanide. The industrial waste lagoons are not strong candidates for the chemical demilitarization facility for several reasons. First, the lagoon waste is primarily sludge. Treatment of sludge in the metal parts furnace or deactivation furnace may require modification to the furnaces and pollution abatement system. Also, thermal treatment will not destroy the heavy metals suspected to be in the lagoon waste. Other treatment methods are more appropriate for these wastes.

The washout facility at Blue Grass generates some explosive-contaminated waste streams that may be potential feedstock for the chemical demilitarization facility (Hazle, 1990). There is no current method for disposal of

these wastes, so they are accumulating in 55 gallon drums. One waste is waste water treatment sludge from the washout facility. A second waste is the spent carbon filters used in the treatment of waste water from the washout facility. It is estimated that approximately 500 drums of this material are currently on site awaiting disposal and more may be accumulated by the time the chemical demilitarization facility is available for use unless a method for filter disposal is developed in the interim. To dispose of sludge the feed mechanism to the deactivation furnace will require modification. Other modifications may be required to because of the high liquid content in the sludge. Permitting may be difficult because of the large variety and high concentration of hazardous material that may be in the sludge. The carbon filters can probably be processed in the metal parts furnace provided they are made the appropriate size. Feed rates may need to be adjusted to ensure adequate treatment.

One of the striking aspects of this analysis is that there are no outstanding candidates for incineration in the Lexington-Blue Grass chemical demilitarization facility. Conventional munitions could be incinerated there, but there are a number of good alternative disposal methods for the munitions that can be handled in the chemical demilitarization facility. Also, shipment of conventional munitions does not appear to be difficult, so it might be better to incinerate conventional munitions at a national or regional incinerator. If no strong future use of the chemical demilitarization facility at Lexington-Blue Grass Army Depot is identified, perhaps the incinerators themselves could be transported to another location where they are needed.

B.5 ANNISTON ARMY DEPOT

Anniston Army Depot (ANAD) is located 10 miles west of Anniston in eastern Alabama. The facility occupies approximately 18,000 acres, portions of which have been in use since its establishment as an Army Depot in 1941. Major activities at ANAD are overhaul and repair of military vehicles and artillery, small arms reconditioning, tank modification, ammunition storage and maintenance, and logistics support for several Army tactical missile systems.

Chemical munitions are stored in the northeast portion of ANAD. Included are artillery and mortar projectiles, rockets, mines, and ton containers. Chemical agents at ANAD are the nerve agents GB and VX and the blister agent H, or mustard. ANAD will therefore be the site of a full-capability, mixed-use, CSDP demilitarization plant. Construction is currently scheduled for 1992 and 1993, with operations to start in 1995 and conclude in 1998.

Redstone Arsenal (RSA) is located about 100 miles northwest of ANAD near Huntsville, Alabama. RSA was the site of chemical munitions manufacturing and storage activities during the World War II period, and large quantities of chemical agents or compounds and obsolete chemical munitions have been discarded there. Chemical agents made at Redstone Arsenal include mustard, lewisite, phosgene, phosphorus, and chlorine. Waste disposal operations from these and other explosives manufacturing activities were not adequately documented, so the extent and nature of hazardous waste contamination is not well known.

There are several waste streams at ANAD in quantities suitable for incineration in the CSDP plant to be built at Anniston. Review of these waste streams and their general characteristics (quantity, composition, handling, and incineration) and analysis of promising options led to an initial screening of future use options. These options are discussed below.

B.5.1 Conventional Munitions

As shown in table B-9, ANAD currently stores approximately 8,000 tons of conventional munitions, with the largest portion being projectiles and fuzes and various types of smoke-producing munitions (105-155mm smoke cartridges, signal flares, illuminant projectiles, etc.). These two categories combined account for about 70 percent of the total conventional munitions stored at ANAD, with the remaining amount allocated among 2000-pound bombs, bulk propellants, and artillery propellant charges.

Current conventional munition demilitarization capabilities at ANAD are an APE-1236 Deactivation Furnace, and several open burning and open detonation (OB/OD) grounds. Modifications of the APE-1236 to allow compliance with RCRA emissions requirements have been completed (1990), and issuance of an amended permit by the State of Alabama is in process, pending completion of a trial burn. ANAD also has a RCRA permit for OB/OD of permitted items (bulk explosives, propellants). No other demilitarization facilities presently exist at ANAD.

The projectiles and fuzes, and small arms ammunition are processed in the APE-1236 deactivation furnace at ANAD. Incineration of bulk explosives and propellants would be possible in the APE-1236 if the feed system were suitably modified as for the EWI. However, at present, bulk explosives and propellants are not incinerated in the APE-1236 at ANAD.

The various smokes and dyes at ANAD cannot be demilitarized in the APE-1236 or through OB/OD due to restrictions on incineration of smoke items. Modifications to the APE-1236 could allow incineration of some smaller smoke items pending RCRA permits (trial burns) for these items.

Table B-9. Inventory of Conventional Munitions at Anniston Army Depot

Munition Type	Amount (Thousands of Pounds)
Small arms, fuzes, and primers	2,281
Smokes and dyes	351
Pyrotechnics	1,434
HE loaded projectiles	3,724
Rockets and missiles	4,367
Bombs, torpedoes, depth charges	1,797
Riot control agents	60
Bulk explosives	2
Grenades and mines	247
Navy gun ammunition	1
Special function projectiles	847
Propellant charges	1,010
Inert loaded items	162
Items not homogeneously grouped or categorized	636
Total	16,919

HE-loaded projectiles may be destroyed by open detonation, or by a combination of washout and incineration. ANAD does not presently have washout facilities.

The 2,000-pound bombs and cluster bomb units (CBUs) at ANAD would require disassembly and washout. Submunitions could be incinerated in an APE-1236, with larger munitions and explosives quantities requiring washout or steamout prior to incineration.

Small and medium-sized munition demilitarization is a candidate for future use of the ANAD chemical demilitarization facility owing to large quantities, minimum technical risk, lower potential environmental uncertainties, and reduced permitting difficulties. The largest single component by weight of conventional munitions at ANAD are small arms ammunition and small to medium-size HE projectiles. These items can be incinerated in deactivation furnaces such as the APE 1236 (with upgrades) and, in fact, this is the primary, proven method for disposal of these items. The ANAD DFS is therefore technically compatible with this use. Modifications to furnaces and related equipment would be few or none, and there is also limited potential use of the projectile disassembly and handling machines to remove fuzes and move conventional munitions and their containers through the plant. Permitting uncertainties associated with this application would also be less, and some categories of small arms (e.g. small arms ammunition with solid projectiles of 50 caliber and less) may be exempted from RCRA permitting requirements. Small to medium sized HE projectiles are considered a hazardous waste under current RCRA regulations and therefore the facility would have to be permitted in order to dispose of these items.

Smokes and dyes stored at ANAD represent another future use application. This category, however, is complex in that there are numerous smoke inducing munitions types with widely-diversified compositions. Some may be amenable to incineration in the DFS (or its counterpart, the APE 1236) but others such as thermite pyrotechnics are not suitable. Potential future uses involving smoke items would need to be evaluated on a case-by-case basis, but overall appear to be promising in the time frame considered.

Limits on the feed rate of explosive materials in the DFS is the principal concern with regard to demilitarization of large projectiles and bombs in the chemical demilitarization plant at ANAD. Control of burning rate would be heat rate-dependent. Modifications to the incinerator feed mechanism would also be required. Environmental and permitting risk are relatively low. The large quantity of large projectiles at ANAD (as much as 1,500-2,000 tons) also make this application potentially desirable in the time frame considered. Some disassembly and/or washout may be required as pre-processing steps before incineration. Washout facilities

are not presently available at ANAD. Modification of the CSDP plant after completion of its initial mission would be required to add this capability.

The rate of incinerating bulk propellants and cartridges in the chemical demilitarization plant is limited by the heat of combustion and the explosive limit. The PAS will require minor changes in operating conditions. OB/OD, if it continues to be permitted, is more economical. However, permitting difficulty and environmental uncertainties are low for bulk incineration. Again, the availability of an APE 1236 at ANAD may mitigate against use of the chemical demilitarization plant for this purpose in the time frame considered.

The PASs in the chemical demilitarization plant should generally be adequate for meeting emission control requirements when incinerating conventional munitions. The dunnage incinerator may be used to dispose of packing materials. The CSDP plant's disassembly equipment will not be useful for most of the conventional items. In many cases, disassembly technology is available, but the equipment would have to be installed in the plant. Incineration of energetic materials removed from munitions by washing or steaming would require the installation of equipment for removal of energetics. The MPF would be used for removal of residual energetics from the metal parts of these munitions. The LIC would not be used.

Use of the CSDP plant for destruction of conventional munitions would require, at minimum, modifications to existing RCRA and air permits. Test burns would be required, and NEPA documentation would be required.

On the negative side, timing of this application (8 years or more before the chemical demil efforts are complete) together with the availability of an APE 1236 at ANAD may reduce or eliminate some of the volume of conventional munitions that make use of the chemical demilitarization facilities for this purpose desirable.

B.5.2 Nonstockpile Chemical Items

As a result of maintenance activities for the chemical munitions stockpile, about 10 tons per year of chemical agent contaminated items classified as XXX, including protective garments, tools, and dunnage items, and spent decontamination solution are generated at Anniston. These items can readily be decontaminated in the chemical demilitarization plant that will be constructed at ANAD since they are similar to the contaminated materials that will be generated and incinerated during operation of the plant. Protective garments and other contaminated dunnage can be processed through the dunnage furnace, which is designed to incinerate dunnage contaminated with agent. Decontamination solution can

be dried to an agent-free brine in the secondary chamber of the liquid incinerator. This can be accomplished during or after the destruction of the stockpile. Once the stockpile is destroyed, no new chemical agent contaminated items will be generated at ANAD.

B.5.3 Contaminated Material Recovered from Landfills/Burial Sites Undergoing Remedial Action

At present, no landfilled or buried materials at ANAD are known to be contaminated with chemical warfare agents, but there are large volumes of material at burial sites listed only as sand blasting and other solid wastes. Depending on composition (e.g., content of heavy metals, any organics), some of this material could be incinerated in the DFS. However, modifications would be required to the furnace to handle large quantities of bulk solids and to the PAS to accommodate high particulate loading. This would be especially critical if the solid material is contaminated with metals. A far more economical approach for such wastes, however, is removal and deposit in a RCRA-permitted landfill. Quantities of this material at ANAD (in excess of 1,000 tons) would also make landfilling a more feasible approach than incineration. Owing to the likely economics of plant modification and operation as compared to landfilling, and the potential for particulate emission problems, this future application of the CSDP will not be considered as economically desirable. Eighteen range-recovered 4.2-inch mortar rounds were transferred from Redstone Arsenal to Anniston. The munitions are suspected to have a chemical fill, but this would have to be verified by x-ray.

B.5.4 Soil Contaminated with Hazardous Wastes

Disposal of liquid wastes in lagoons and leaching beds at ANAD has resulted in a current estimate of 7,000 cubic yards of soil contaminated with hydrocarbon residues (e.g., TNT and other VOCs).

Redstone Arsenal has a burial ground that contains chemical containers and munitions that have been buried for at least 40 years. If the Army were to undertake a program to exhume the items in the burial ground, the items could be packaged and transported to ANAD for disposal in the chemical demilitarization plant. The condition of the buried items is largely unknown. However, they may generally be considered to be in a poor or highly deteriorated condition, so their exhumation and treatment for disposal would be a complex remedial action. The expected condition of exhumed chemical items would also make their overpack and transportation to ANAD a difficult, costly and controversial undertaking. The wide variety of "non-specific" munitions items and chemical agents (e.g., phosgene, chlorine) would pose considerable operating problems for the CSDP plant and would likely necessitate extensive plant modifications.

Permitting such a project, including transportation aspects, would also entail regulatory complexity. These risks and technical difficulties make use of the chemical demilitarization plant at ANAD for disposal of range recovered items from Redstone less desirable than other uses of the plant. However, the Army could consider undertaking the recovery and disposal of buried chemical items at RSA with their type and condition as recovered being the deciding factor between on-site disposal in an incinerator specifically designed for the purpose or transport to ANAD for disposal.

Thermal decontamination of soils could be accomplished in the DFS of the chemical demilitarization plant at ANAD. However, sizeable modifications would be required to permit handling large quantities of bulk material. Some modifications could also be needed to upgrade the performance of the PAS to accommodate bulk materials.

Modifications of the plant RCRA and air permits would be required along with NEPA documentation. The wide variety of contaminants and concentrations in the contaminated soils results in considerable uncertainty regarding waste stream composition. Therefore, technical parameters and environmental permitting requirements are uncertain.

B.S.5 Industrial Hazardous Wastes

ANAD generates liquid hazardous wastes from its major industrial operations: vehicle, artillery and missile system maintenance and support. Waste compositions are typical of those arising from these operations. In 1989, these included:

Used oil, non-recyclable	--	183 tons
Paint wastes, sludges	--	290 tons
Used solvents	--	215 tons

With land disposal of virtually all liquid hazardous wastes now banned, incineration is an attractive option for these waste streams. The DFS and LIC could be utilized in such applications, with modifications limited to feed (pumps, valves, tanks) for the DFS and burner (and possibly refractory) modifications to the LIC. The primary technical difficulties are compatibility of solvents (and solvent contaminants) with the LIC refractory materials, and with burner operation (sensitivity to heat rates, composition, fuel requirements). Sludges and liquids could be injected into the DFS along with other solid wastes. Modifications to the LIC and DFS would likely have to be made to support this option.

In all cases, revised RCRA hazardous waste and air permits would be required with the concomittant trial burns (RCRA). The variety of

contaminants, and the possibility of trace metals contamination could also complicate the permitting process. Appropriate NEPA documentation would be required. Nevertheless, new bans on land disposal of liquid hazardous wastes make incineration an attractive option.

B.S.6 Trash and Other Nonhazardous Solid Wastes

Large volumes of waste wood (e.g., munitions packaging, wood pallets, railroad ties) and building rubble have been previously disposed of at an area known as the "Sink Hole" on the grounds of ANAD. While most of this material is not hazardous, the widely varying composition (e.g., creosoted or other preserved wood), moisture content and other properties make disposal in a furnace difficult. The large volume (40,000 cubic yards) also necessitates landfilling. Nevertheless, some suitable wood waste (e.g., unpreserved pallets, building materials) might be incinerated in the DUN. Also, if the demilitarization plant were to be used for one of the other alternatives, the DUN could be used to reduce the amount of wood to be landfilled.

B.5.7 Contaminated Buildings

An abandoned explosives washout building contaminated with explosives residues exists at ANAD. Several methods of in-place decontamination of explosives residue are available for use in this building, after which it could be demolished, and the decontaminated rubble landfilled. This would likely be far less costly and require fewer environmental permits than use of the CSDP plant at ANAD. For these reasons, this future use option is not considered as possible to be desirable.

B.6 PINE BLUFF ARSENAL

Pine Bluff Arsenal (PBA) is located at Pine Bluff, Arkansas. It has been the manufacturing site for a variety of munition types and chemicals. At one time or another the following chemicals have been manufactured at PBA: HC smoke; chemical agents mustard, and lewisite; QL and DF (components of binary munitions); chlorine and arsenic trichloride. The following operations have also been performed: filling munitions with WP, mustard, lewisite, BZ, CS, FS, and pyrotechnics; production of biological warfare materials; manufacture of the M74 rocket clip. At the present time, smoke devices containing WP, red phosphorus, HC, and colored dyes are produced at PBA. Other activities at PBA included the storage of munitions containing lethal chemical agent and conventional munitions.

B.6.1 Disposal Facilities at Pine Bluff Arsenal

Some items are currently being destroyed by incineration in the furnaces located at the incinerator complex, which includes the following equipment:

1. Deactivation Furnace. The deactivation furnace is an APE 1236 furnace modified to collect gases emitted from the feed system and the discharge chute. Waste products (WP, red phosphorus, CS, and colored smokes) from the manufacture of smoke devices are burned here. Although the furnace was installed as an adjunct to the manufacturing operation, munitions containing smokes and dyes from the conventional munition demilitarization and disposal inventory have also been disposed of in this furnace. The capacity of the furnace system for those munitions for which feed rates have been established is given in table B-10.

2. Fluidized Bed Incinerator. The fluidized bed incinerator is designed to process smokes, dyes, and explosives dissolved or slurried in a liquid or in solid form. WP, CS, and colored smoke wastes from the production of smoke devices, in bulk form, are burned in this incinerator.

3. Static Incinerator. The static incinerator is used to burn non-PCP treated wood and paper.

4. Chain Grate Incinerator. The chain grate incinerator is designed to process scrap metal, dunnage, packing material, and munitions hardware. Currently, it is used to incinerate non-hazardous medical waste generated at various Department of Defense sites. PBA bids on disposal contracts for this material through the Defense Reutilization and Marketing Services. This practice has proved effective for supplementing conventional demilitarization funds and stabilizing workload.

5. Central Afterburner and Pollution Abatement System. The afterburner thermally processes gases from the deactivation furnace, static incinerator, and chain grate incinerator. Effluent gas from the Munition Test Chamber (MTC) is also processed in the afterburner. (The MTC, which is not part of the incinerator complex, is used to test items from the production of pyrotechnic munitions). The combustion gas from the afterburner is quenched and passed to the pollution abatement system, which consists of a variable throat wet venturi scrubber and a hydro-sonic scrubbing system (which is in the process of being installed).

Table B-10. Capacity of the Modified APE 1236 Deactivation Furnace at Pine Bluff Arsenal

ITEM	PROCESSING RATE (UNITS/HOUR)
Grenades	254 - 330
M25A2 (CS1) G924 G928	330
Ml8 Colored Smoke G940 G950	440
M8 HC G930	264 - 330
105mm Canisters HC C396	330
105mm Canister Colored Smoke C397 C399	330
Expelling Charge M84 1315-143-7127	1760
Primer M28 M84 Download N158	264
Fuze MT & SQ M501 M84 Download N276	264
Ml9 Burster ZUT	264
M206A1 & A2 Fuze	1320
M201A1 Fuze	6600
155mm Colored Smoke Ogive D451 D452 D454	264
155mm Straight Side Smoke	171
M118	1640
Lead Cup Assembly	264
4.2-inch CS Canister	264
Cylinder & Tray Assembly for L8A3 RP Grenade	1320

Source: Gayle, Zajicek and Ansell, 1990

There is also an air curtain pit burner, used to burn non-PCP treated wood and paper.

PBA has a permit for open air burning of thermite and propellant. Munitions that are considered dangerous to keep in storage are destroyed in this way. Items in the conventional munitions inventory are not disposed of by open burning.

There is no Explosive Waste Incinerator (EWI) at PBA. This incinerator is preferred over the APE 1236 for burning bulk energetic materials, but the latter can be modified and used for this purpose. There is no equipment at PBA for munition disassembly, or for explosive steamout, washout, or meltout.

Two chemical demilitarization facilities may be available for disposal of various items that can be incinerated:

1. The BZ Demilitarization Plant was started up in May 1988 for the destruction of BZ munitions. All BZ-containing munitions have been destroyed and the closure completed in June 1990. All of the BZ-contaminated equipment was destroyed, with the exception of the furnaces used to incinerate BZ.

2. The facility for disposal of the chemical stockpile at PBA is scheduled to start up in May 1995; closure is scheduled to be completed in October 1998.

The various candidates for disposal in the chemical demilitarization plants at PBA were consolidated into nine categories (see table B-11). Each of the categories were evaluated to identify candidate future uses for the chemical demilitarization plants at Pine Bluff Arsenal.

B.6.2 Conventional Munitions

B.6.2.1 The Inventory of Conventional Munitions

There is a large inventory of conventional munitions in the demilitarization and disposal inventory at PBA and at nearby military bases: Red River Army Depot (READ) and McAlester Army Ammunition Plant (MAAP). The inventory of conventional munitions at each of these sites is listed in table B-12. All categories of conventional munitions are found in the inventory, including small arms, high explosives, smokes, and riot control devices. At PBA smokes and dyes comprise 45% of the inventory, the largest amount being items containing FS (a mixture of SO3 and chlorosulfonic acid); riot control agents (mostly CS-containing items)

Table B-11. Categories of Candidates for Disposal at Pine Bluff Arsenal

1. Recovered munitions containing (or contaminated with) agent. Included in this category are the items "found on post," and any other agent-contaminated items that may be found at a later time.

2. Empty Ton Containers There are 4,000 empty ton containers that have been decontaminated to the XXX level.

3. Small conventional munitions. This category includes small arms, fuzes, primers, and grenades, and mines.

4. Smokes, riot agents and related munitions. Smokes, dyes, riot control agents, and pyrotechnics are in this category.

5. Soil contaminated with agent. This category represents soil recovered from dumps containing chemical agent munitions, which may be contaminated with agent or is be suspected of such contamination. Drums of contaminated clothing and other items may also be considered to be in this category.

6. Large conventional munitions. Items in this category are projectiles, rockets, bombs, Navy ammunition, and inerts. Except for items containing inerts, these munitions contain high explosives or rocket fuel.

7. Bulk Energetics. High explosives and rocket fuel not contained in munitions are in this category.

8. Industrial waste obtained from other DOD sites. Waste products, such as contaminated solvents and medical wastes, can be obtained by bidding from DEWS. The small amount of industrial waste generated at PBA is included in this category.

9. Trash. Untreated wood and paper are considered to be trash.

Table B-12. Inventory of Conventional Munitions in the Demilitarization and Disposal Inventories at Pine Bluff Arsenal, Red River Army Depot, and McAlester Army Ammunition Plant

Munition Type	Amount (Thousands of Pounds) PBA	RRAD	MAAP
Small arms, fuzes, and primers	53	1,394	8,867
Smokes and dyes	3,064	6	178
Pyrotechnics	174	763	339
HE loaded projectiles	682	1,061	3,942
Rockets and missiles	141	484	5,030
Bombs, torpedoes, depth charges and CBUs	847	11	1,932
Riot control agents	1,731	1	790
Bulk explosives	1	32	265
Grenades and mines	2	174	407
Navy gun ammunition			2,470
Special function projectiles	•	276	656
Propellant charges	28	958	3,141
Inert loaded items		4	9
Items not homogeneously grouped or categorized	100	823	3,982
Total	6,823	5,987	32,008

comprise 25% of the inventory. At Red River the largest munition category is small arms, fuzes, and primers, which comprise 23% of the inventory; 18% of the inventory is HE loaded projectiles. At McAlester the largest category is also small arms, fuzes, and primers (28%); 16% of the inventory is rockets and missiles.

B.6.2.2 Alternative Technologies Available for Demilitarization of Conventional Munitions

There are a number of alternative demilitarization technologies either currently in use or that might become available before the chemical demilitarization plants become available. These technologies are applicable to the following types of conventional munitions:

Small Arms, fuzzes, and primers. These items can generally be disposed of in a deactivation furnace, such as the modified APE 1236 at PBA.

Smoke Devices Containing White Phosphorus (WP). The WP to phosphoric acid recovery process can be used on all devices with the possible exception of those in which the WP is contained in felt wedges. It is not known whether any of the WP items in the inventory contain felt wedges. Equipment for recovery of WP has not been installed at PBA. WP can also be disposed of in the modified APE 1236.

Smoke Devices Containing Dye. The upgraded/modified APE 1236 can be used.

Smoke Devices Containing FS. Neutralization technology is available but the Army does not currently have the capability of using it. Since FS consists of non-combustible and highly corrosive substances, burning is not a suitable method of disposal.

Smoke Devices Containing Petroleum Products. Any of the incinerators in the incinerator complex could be used.

Items Containing Pyrotechnic Mix. These items may be burned in a modified APE 1236, but many pyrotechnic devices contain enough magnesium or aluminum to burn through the metal kiln. Such items can be incinerated only if they are disassembled or sheared and the contents diluted with other materials. Certain flares can be incinerated without difficulty. Items containing thermite must be disassembled and the thermite recovered for reuse, but no disassembly equipment is available at this time.

HE Loaded Projectiles. These items could be moved to sites where open detonation can be used as long as EPA permits are applicable. Alternatively, they could be moved to sites where washout or meltout

methods are available or under development. Explosives removed by these methods may be destroyed in an incinerator or, in some cases, recovered for use. The EWI is the preferred incinerator for explosives removed from munitions.

Rocket Motors and Loaded Rockets. The types of rockets in the inventory can be moved to a site where they can be disassembled and the explosives steamed or melted out. In some cases, it may be necessary to shear the motors. The energetic material may be destroyed in an EWI.

Bombs, Torpedoes, Depth Charges, and CBUs. Submunitions may be disassembled and incinerated in the modified APE 1236 but the larger items must be moved to a site where the explosives can be steamed or washed out and incinerated in an EWI.

Riot Control Agents. Munitions containing CS or CN may be incinerated in the modified APE 1236. DM is not incinerated at PBA because it contains arsenic. DM items are sent to TEAD for disposal. Bulk agent may be destroyed in the Fluidized Bed Incinerator.

Bulk Explosives. An EWI is preferred, but the modified APE 1236 may be used. Explosive detonating cord may pose a problem because it could result in explosive buildup.

Grenades and Mines. Most of the inventory of these items contains explosives, which can be destroyed in the modified APE 1236. The few items containing thermite must be disassembled and the thermite recovered for reuse. No disassembly equipment is available at this time.

Navy Gun Ammunition. These items may be moved to a site where the explosives can be washed out and incinerated in a rotary kiln incinerator. An APE 1236 would not be efficient in this service because it is not refractory lined.

Propellant Charges. An EWI is preferred, but the modified APE 1236 may be used. In some cases, disassembly is required.

Inert Loaded Items. An EWI is preferred, but the modified APE 1236 may be used. Disassembly is needed.

Items that Cannot Be Grouped. These items are non-homogeneous and there is currently no capability to dispose of them,

Although the modified APE 1236 at PBA is capable of destroying a number of the types of conventional munitions listed above, its primary mission is to support the production facility by destroying waste smokes from that operation. Support for production requires only about 10 percent of its

capacity. Although it is available for the disposal of items from the conventional munitions inventory, very little of this has been done because of the Army's failure to fund the disposal. If the full capacity of the modified APE 1236 were used, the inventory could be substantially reduced. Since new items are being added to the inventory from time to time, an inventory will remain in 1998 of items that could be demilitarized in a rotary kiln. Additional capacity would be needed to demilitarize all of the smoke devices, riot control agent, and small arms, fuzes, and primers at PBA, BEAD, and MAAP.

B.6.3 Conventional Weapons Disposal

The DFS at the Chemical Disposal Facility or the BZ Plant and the PAS can accommodate small arms, fuzes, primers, grenades and mines (except those containing thermite). Only the grenades and mines, which represent about five percent of the inventory of small conventional munitions, will have to be disassembled. It may be possible to modify the existing mine machine to punch and remove the explosives, or a new device may have to be installed for this purpose. Although the modified APE 1236 at PBA is a technologically and environmentally acceptable alternative method of disposal of small munitions, and also is likely to have a lower operating cost than the chemical demilitarization plant for this purpose, it is more advantageous to use it to reduce the inventory of smokes, riot agents, and related munitions.

Smokes, riot agents, and related munitions (excepting FS and certain pyrotechnics) can be disposed of in the DFS at the Chemical Disposal Facility or the BZ Plant. FS is best disposed of by chemical neutralization. Some of the items will have to be disassembled. Appropriate disassembly equipment is available and could be installed, except for certain pyrotechnics.

As indicated above, the modified APE 1236 is currently being used to dispose of this category of munitions. The stockpile of these items could be reduced to a very low level if the Army were to provide funds for this operation. Since this alternative is technically and environmentally acceptable and would incur lower operating costs than operation of the chemical demilitarization facility, if the Army provides the funds to operate the existing modified APE 1236 on smoke munitions, it will be unneccesary to use the chemical demilitarization equipment for this purpose. Moreover, WP can be economically recovered as phosphoric acid in the phosphoric acid process.

Consideration could be given, however, to moving the DFS at the BZ Plant to the incineration complex in the south area of PBA so that it could be used to supplement the operation of the existing APE 1236.

The energetic material and organic compounds in projectiles, rockets, bombs, Navy ammunition, and inerts can be burned in the DFS after removal from the munitions. The metal parts can be cleaned up in the MPF. Furnaces at both the Chemical Disposal Facility and the BZ Plant could be used for this purpose. The rate of burning will be limited by the heat of combustion of the energetic material. Some energetics will be fed as a slurry, thus further reducing the production rate. Revisions to the DFS feed system will be required. The PAS is expected to be capable of reducing emissions to the required levels, although some changes in operating conditions will be required. A separate facility will have to be constructed for removal of energetic material from the munitions. Most munitions in this category will require new disassembly equipment. Size reduction of items containing Compound B will be required.

Bulk energetics can also be burned in the DFS with the necessary modification to the feed mechanism. As for large munitions, the rate will be limited by the heat of combustion of the energetic material. No disassembly will be required. However, the small amount of bulk energetics at PBA and the nearby sites makes this category less attractive than large munitions as a candidate for disposal in the chemical demilitarization equipment at PBA. Further, controlled burning of bulk energetics may be more easily performed in the fluidized bed.

If OB/OD continues to be permitted, moving the large conventional munitions and bulk energetics to another site where this procedure can be performed is technically and economically preferable, but environmentally less acceptable than controlled burning. Recovering explosives for reuse is preferable to burning, for those items for which this is possible.

Because of the large inventory of these items throughout the U.S. it will probably be more economical to construct a facility designed specifically to burn the energetic materials efficiently than to modify the chemical demilitarization equipment to accommodate large conventional munitions. The public may support moving the stockpile to another site where this can be carried out rather than destroying them at PBA. On balance, large munitions appear to be less attractive candidates for disposal in chemical demilitarization equipment than some of the other categories.

The PASs of the chemical demilitarization plants should be adequate for meeting the regulatory requirements. The dunnage incinerator may also be used to dispose of packing materials. The plant's disassembly equipment will *not* be useful for *most* of the conventional items. In many cases, disassembly technology is available but the equipment would have to be installed in the plant. Incineration of energetic materials removed from munitions by washing or steaming would require the installation of equipment for removal of energetics. The MPF would be used for removal of

residual energetics from the metal parts of these munitions. The LIC would not be used. The support facilities would be used. The staffing would be substantially less than that needed for the disposal of chemical munitions.

The DFS at the BZ Plant could also be used in the same way as that at the CDF. However, since most of the equipment and buildings associated with the BZ Demilitarization Plant have been destroyed or allocated for use as part of the new CDF, any thermal destruction at the BZ facility would require, at a minimum, installation of the following:

- A pollution abatement system, including a wet scrubber.
- Fuel, power, and instrument lines for any furnace to be used.
- Feed equipment for any furnace to be used.
- Support facilities such as maintenance, laboratory, and personnel support.

Moreover, no new use of this facility would be feasible until after the destruction of the chemical stockpile has been completed because of the proximity of the CDF to the BZ Demilitarization Plant. The current plan calls for enclosing the entire facility within the security fence and using some of the BZ buildings for the new facility. Even if this plan were changed, it would be difficult if not impossible to operate the BZ facility during construction or operation of the Chemical Stockpile Disposal Plant unless the new plant were moved to a different location. The current site plan for the Chemical Stockpile Plant was approved on the basis that there would be nononrelated facilities (e.g., a renovated BZ facility) within 1,200 feet. It is doubtful whether a site plan calling for operation of the BZ Plant on conventional munitions would be approved.

None of the equipment in the BZ Demilitarization Plant is more useful for any disposal purpose than the equipment in the CDF. However, consideration might be given to supplementing the CDF by using the BZ facility to destroy some of the same items that would be destroyed in it. This should be considered only if the amount of material to be destroyed is too great for the CDF to dispose of in a reasonable time. If this were done, the BZ facility could be incorporated into the CDF and operated as one facility. A separate pollution abatement system would have to be installed but no new buildings would be required.

The use of either the CDF or the BZ Plant for demilitarization of conventional munitions will require, at the minimum, modifications of the existing permits. NEPA documentation will be required. Although the PAS

has not been demonstrated when burning all types of energetic materials, obtaining permits is not expected to be a significant problem. One or more test burns will probably be required. DOD rules are more difficult to comply with for munitions containing large amount of explosive than for other munitions. However, current rules do not require thick concrete walls, such as those in the CDF's ECR, for the washout/steamout facility.

B.6.4 Munitions Recovered From Burial Sites

Most of the items that have been recovered at PBA were found at a burial site known as Site 12 as the result of an effort to remove devices containing chemicals to prevent further contamination. These range recovered items are listed in table B-13. All of these items, except for the drums of mustard simulant, contain, or are suspected of being contaminated with a lethal chemical agent; some are thought to contain energetic material.

The incinerators of the PBA Chemical Stockpile Plant are capable of destroying the lethal agent in the range recovered inventory. The ventilation system, building design, and pollution abatement system will meet safety and regulatory requirements. It will be possible to dispose of some of the items (glass bottles, vials, and identification kits) in the DFS without disassembly. Bulk mustard simulant may be removed from containers manually (it is not a lethal chemical) and burned in the LIC. The existing disassembly equipment may be used for the mortar rounds and "other munitions." However, process and procedural changes will have to be made to handle these items. Due to their thin wall construction the limited number of 4.2 inch rounds at Pine Bluff Arsenal will be processed through the rocket shear machine (RSM).

The Traktor rockets pose a problem for disassembly because the existing equipment is not designed for these items. Unlike the M55 rockets, for which the RSM was designed, the Traktor rockets are made of hard steel. It may be possible to modify the rocket shear machine to drain and shear the Traktor rockets or it may be necessary to design equipment to do this. Once drained, the agent may be incinerated in the LIC and the rocket fuel and metal parts disposed of in the DFS.

Those items whose contents have not been definitely identified will have to be examined prior to disposal to identify the agent involved.

The BZ plant is not designed to accommodate the destruction of lethal chemical agents. Therefore, the items listed in table B-13 cannot be destroyed in the BZ equipment, with the exception of the mustard simulant. This could be burned in the LIN. It would be necessary to reconnect instrument, fuel, and power lines to the LIN and to install a feed system. Auxiliary equipment, such as pumps, would have to be installed. A

Table B-13. Inventory of Range Recovered Items at Pine Bluff Arsenal

DESCRIPTION OF ITEM	NUMBER OF ITEMS
Mortar rounds	726
150 mm Traktor rockets	477
Other munitions	2
Glass bottles containing mustard	3518
Vials and identification sets (CAIS)	43
Mustard simulant, gallons	209
Empty drums	6

complete pollution abatement system would have to be installed, or the effluent from the LIN conveyed to the PAS at the Chemical Stockpile Plant. This would require extensive ductwork and possibly a new fan to draw gases from the LIN through the PAS.

The use of either the Chemical Stockpile Plant or the BZ Plant for this purpose will require, at the minimum, extensions of the existing permits. Since the Chemical Stockpile Plant will be permitted for all three lethal agents, a test burn will probably not be required. This would be contingent on a determination that no other hazardous constituents would be in the incinerator feed. NEPA documentation will be required.

Agent-containing items are good candidates for disposal in the Chemical Stockpile Plant but not in the BZ Plant. The following factors apply only to the former facility.

Agent from items such as Traktor rockets and mortars would be incinerated in the LIC and metal parts in the DFS. Bottles and other items can be destroyed or decontaminated in the DFS. No modifications to these furnaces or the PAS would be necessary because they are designed specifically for such items. Mortars can probably be disassembled in the existing equipment. It might be possible to modify the existing rocket shear machine to accommodate the Traktor rockets. The other recovered items will not require disassembly.

Obtaining permits for destruction of agent should not be a problem because the plant is already permitted for all agents. Test burns probably will not be required. Meeting DOD requirements, especially during transportation, would present more difficulty than for other categories because the most stringent rules apply to items containing agent, especially those that are explosively configured. On the other hand, the plant is especially designed to process such items. Since these items will not be destroyed until the end of the CSDP, the range recovered inventory will remain or may increase as other items are found.

Ton Containers Formerly Used to Store Agent

There are about 4,000 ton containers at PBA that were formerly used to store agent. The agent has been removed and the containers decontaminated to the XXX level. Thermal decontamination of the ton containers to the XXXXXX level could make them suitable as scrap metal. The processing and disposition of the ton containers must be in conformance with DOD 4160.21-M.

The MPF at the CDF is designed to heat treat ton containers. They could be decontaminated to the XXXXX level in that furnace without any modifications to the equipment. Since there is no alternative method of

achieving the XXXXX level, this would be a good use of the chemical stockpile plant. Treatment of the 4,000 containers could be completed in less than half a year.

Obtaining permits for this operation should not be a problem because the plant is already permitted for agents. Test burns probably will not be required.

B.6.5 Agent Contaminated Material and Soil Recovered from Landfills

Although Site 12 is the only site known to contain chemical warfare munitions, such items may be found at another site. If these items are similar to those listed in table B-13, they may be disposed of in the Chemical Stockpile Plant as described in Section B.6.3.

There are 43 drums of agent-contaminated soil, clothing, and other items, most of which are from the recovery effort at Site 12. This soil, and any other agent-contaminated soil found at PBA, may be treated with decontamination solution and placed in an approved hazardous waste landfill on post. Alternatively, it may be decontaminated by incineration in the DFS at the CDF. For the relatively small amount now in drums it will be necessary only to modify the feed system so that the soil can be dumped manually through the double-tipping valve into the DFS. More extensive modifications would be necessary if large amounts of contaminated soil were identified at PBA.

The PAS is designed to remove the products of agent destruction but small amounts of other substances in the soil are likely to be in the off gas, thus requiring adjustments to operating conditions. BZ Plant equipment cannot be used because that facility is not designed to handle agent-containing materials.

The use of the CDF for this purpose will require, at the minimum, a modification of the existing permit. Since the CDF will be permitted for all three lethal agents, a test burn will probably not be required; this is contingent on a determination that no other hazardous wastes or constituents are in the soil feed. NEPA documentation will be required.

Although obtaining environmental permits for the destruction of agent is not likely to be difficult, permits for other components of soil might also be required. A test burn will probably not be required. There are stringent DOD rules for anything containing agent.

The alternative of chemically destroying the agent in the soil and then disposing of the soil in an approved hazardous waste landfill is technically feasible and environmentally more attractive than waiting

eight or more years for the CDF to be available. The cost of disposing of the relatively small amount of contaminated soil and other items by either method will be relatively small.

Since the amount of contaminated material is small and an alternative disposal method is more acceptable, agent contaminated soil and recovered material are not an attractive candidates for disposal in chemical demilitarization equipment.

B.6.6 Soils Contaminated with Hazardous Chemicals

According to the Installation Assessment of Pine Bluff Arsenal (Department of the Army, 1977) there was extensive contamination resulting from manufacturing operations. Contaminated sites have been identified and remediation has been implemented. The Environmental Directorate does not anticipate any need for thermal treatment of contaminated soils.

B.6.7 Industrial Waste

Solid waste from the manufacture of smoke devices are destroyed in the modified APE 1236, as described in Section B.6.1. The incinerator will be adequate for this purpose for the foreseeable future. The DFS at the CDF could be used if it were needed. Solid wastes such as ash from the incinerators and residues from testing munitions are landfilled.

Wastewater from the manufacturing facility is discharged into the central wastewater treatment plant. No other treatment is needed to meet regulatory requirements.

The only waste product that is not treated or disposed of on site is the small volume of contaminated solvents generated by the manufacturing process. The volume of solvents is too small to justify the installation of equipment to incinerate them. They are removed by a commercial disposal firm for recovery or destruction. The LIC at the CDF could be used to burn the solvents, together with solvents that could be brought to PBA from other DOD sites. The PAS and BRA should make it possible to burn solvents in that facility without major modifications.

A large variety of waste materials generated at various DOD sites are available through DRMS by competitive bidding. It should be possible to obtain suitable materials for disposal in chemical demilitarization equipment, such as contaminated solvents and medical wastes. Currently, PBA incinerates non-hazardous medical waste in the chain grate incinerator. This and similar wastes could be incinerated in the CDF or the BZ plant if the latter is integrated into the CDF. The DFS, MPF, or DUN could be used to burn solid wastes, depending on the characteristics of the waste material. It might be possible to incinerate solvents in the

LIC or LIN with minimal modifications to the nozzles; if not, this could be done in the DFS with changes to the feed system to allow liquids and sludges to be fed. Solids, such as medical wastes, could be destroyed in the DFS without difficulty. Medical wastes would pose no difficulty for the PAS. Depending on the solvent and its contaminants, adjustments to PAS operating conditions would probably be required. None of these materials would require disassembly. In the case of the CDF, this could be done without extensive revisions. The BZ Plant would require extensive revisions, as described above.

Permits to cover each of the types of substances to be burned may be obtained with no more difficulty than for other non-agent categories. Burning contaminated solvents or solid waste from other DOD sites at the CDF or the BZ Plant would require, at the minimum, modifications of the existing permits. In order to obtain a RCRA permit for the solvents a test burn would be required. The variety of contaminants in solvents could complicate obtaining a permit for burning them. NEPA documentation would be necessary. DOD requirements for industrial wastes are minimal.

Commercial alternatives for the disposal of industrial wastes are as environmentally acceptable as incineration, perhaps even more so. Solvent recovery is likely to be more economical than incineration and medical wastes from DRMS are burned in existing equipment at PBA. Despite this competition, the volume of waste available may be large enough to make the use of chemical demilitarization equipment an attractive possibility.

B.6.8 Trash

Paper and wood that has not been chemically treated is burned in the air curtain pit burner. As long as the existing air permit is valid, the needs of the arsenal for size reduction of wood and paper by-products from normal operations will be met. If the air permit should expire, the DUN at the CDF could be used for this purpose. An air permit for the DUN would be needed. No environmental or permitting problems are expected. Since the DUN has a PAS, it is preferable to the existing disposal method at PBA. However, since the existing system is able to keep up with current needs at PBA, there is unlikely to be any need for the DUN unless the permit for the existing furnace expires. Operating the DUN by itself would not be economical but if the CDF is used to dispose of any of the other categories, the DUN could be used to burn trash with minimal incremental costs.

B.7 PUEBLO DEPOT ACTIVITY

The Pueblo Depot Activity (PUDA) is located in southeastern Colorado, approximately 14 miles east of the city of Pueblo. The installation was

created in 1942 as a supply depot providing storage and maintenance of assigned commodities. PUDA is a storage location for conventional munitions and chemical agent munitions. The chemical agent munitions consist of mustard filled projectiles and mortar rounds only. A facility designed for the demilitarization of the stockpile of chemical projectiles and mortar rounds is scheduled to be constructed at PUDA beginning in June 1993. The demilitarization of the chemical munitions is scheduled to be completed by the end of 1998.

Past activities at the depot included surveillance testing of munitions and weapons, including 40mm grenades, 20mm cartridges, tracer rounds, and tank weapons; complete maintenance, repair, and rebuilding of 155mm artillery munitions; repair and maintenance of standard and chemical munitions; completion of assembly of mustard projectiles; loading of explosives and explosive components into pineapple grenades; renovation of 155mm howitzer shells; modification of .30 and .50 caliber cartridges, and 8 inch and 155mm shells; reclamation of TNT from various Army projectiles; cleaning of rocket fuel tanks; and repair, maintenance, and testing of the Pershing Missile System.

PUDA is scheduled for realignment under the Defense Authorization Amendments and Base Closure and Realignment Act of 1988, Public Law 100-256. Areas of the property planned for release must be investigated to identify and resolve any environmental concerns first. A 1990 Enhanced Preliminary Assessment of PUDA identified potential locations of soil contaminated with explosives, chemical agents, pesticides, and other hazardous substances; buried munitions; unexploded ordnance; and contaminated structures (Ebasco Environmental 1990).

Rocky Mountain Arsenal (RMA) in Colorado is doing a CERCLA mandated feasibility study for clean up of contaminated sites and buildings on the Arsenal grounds. The Arsenal was the site of chemical agent manufacturing and filling activities during and after World War II. It was also the site of demilitarization of chemical munitions. It has been suggested that the chemical demilitarization plants at Pueblo, Umatilla, and/or Tooele might be used to assist in the decontamination of XXX ton containers, structures, equipment, and buried items retrieved from landfills at RMA.

Categories of waste items from Pueblo Depot Activity that were evaluated for the future use of the chemical demilitarization plant that is scheduled to be constructed there include:

- Conventional munitions including small arms, fuzes, primers, smokes and dyes, pyrotechnics, high explosive loaded projectiles, rocket and missile motors, riot control agents, bulk explosives, grenades and mines, propellant, and inert loaded cartridges;

- A XXX designated mustard contaminated laboratory building;
- Material and soil from remedial action sites:
  - Contaminated materiel and soil from agent burial grounds;
  - Contaminated materiel and soil from hazardous waste burial grounds;
  - Hazardous and explosive waste contaminated soils;
- Hazardous wastes generated from continuing activities including petroleum oils and solvents, and paints;
- Empty agent ton containers from Rocky Mountain Arsenal;
- XXX designated agent production equipment from Rocky Mountain Arsenal;
- Buildings that currently house agent production equipment from Rocky Mountain Arsenal.

B.7.1 Conventional Weapons Disposal

There are approximately 15,000 short tons of conventional munitions in the demilitarization inventory at PUDA. This inventory includes small arms, fuzes, and primers, smokes and dyes, pyrotechnics, high explosive loaded projectiles, rocket and missile motors, riot control agents, bulk explosives, grenades and mines, propellant, and inert loaded cartridges.

PUDA currently operates an open burning area for the destruction of Pershing rocket motors in accordance with the INF Treaty. No other open burning is allowed by the Colorado Department of Health, Air Pollution Division. The burned rocket motors are disposed of in a permitted Landfill.

Open detonation of munitions is actively carried out in 14 pits in a designated OD area. The use of the area is regulated under RCRA.

Approximately 150 tons of munitions, including bombs, grenades, and artillery rounds, are detonated annually.

Demilitarization of fuzes, boosters, primers and small arms munitions was carried out in an APE 1236 furnace until November 1989. There are no current plans to replace or upgrade the furnace. The chemical demilitarization plant that will be built at PUDA will have a deactivation

furnace that is sufficiently similar to the APE 1236 so that it could replace the furnace that was taken out of service and be used to demilitarize the fuzes, boosters, primers and small arms after the chemical stockpile has been demilitarized.

B.7.2 Nonstockpile Chemical Items

There are approximately 4,300 "empty" one ton containers that were used to store chemical agents at Rocky Mountain Arsenal. Current plans are to ship these containers to Tooele Army Depot for decontamination to the XXXXX condition. Such decontamination is readily carried out in the metal parts furnace of the chemical demilitarization plant and thus could conceivably be carried out at PUDA after the chemical agent inventory there is destroyed. Although Pueblo only has chemical agent projectiles and mortar rounds to dispose of, and therefore will not have a bulk drain station to puncture the ton containers prior to incineration, it is possible to open up the containers by removing valves and plugs. However, intrastate transportation of the ton containers may be more difficult from a regulatory standpoint than interstate transportation. Thus, due to current strict Colorado laws, decontamination of the ton containers at Rocky Mountain Arsenal in the Chemical Demilitarization Plant at PUDA may not be desirable. Also, since the CAMDS facility at Tooele has the technical capability to process ton containers and will be available for future use in 1994, CAMDS could be used to decontaminate the RMA ton containers at an earlier date than the PUDA chemical demilitarization plant.

B.7.3 Agent Contaminated Buildings

There are indications that mustard agent was handled in laboratory Building No. 299 at Pueblo (Ebasco Environmental 1990). The structure has been chemically decontaminated to the XXX condition. The chemical demilitarization facility that will be constructed at Pueblo Army Depot could be used to thermally decontaminate the building rubble to the XXXXX condition after the building is demolished. However, it may also be possible to thermally decontaminate the building prior to demolition by the hot gas technique previously described,

There is an estimated 6,800 cubic yards of agent production equipment located in 54 structures at Rocky Mountain Arsenal. The equipment consists of glass lined reactors, tanks, distillation and reflux apparatus. Nickel, stainless steel, and other corrosive resistant alloys were used in fabrication of the equipment. In addition, there is an estimated 15 miles of steam and process piping of various sizes that are also considered contaminated by agent. The building structure that will have to be removed will contribute an additional 250,000 cubic yards of contaminated debris. The metal parts furnace of a chemical demilitarization plant can be used to decontaminate these materials.

Hot gas decontamination of the building structures prior to demolition may offer an alternative to thermal decontamination of the building debris in a metal parts or deactivation furnace, after demolition.

B.7.4 Contaminated Material and Soil from Sites Undergoing Remedial Action

A number of disposal areas and drainage ditches have been identified in Pueblo's Enhanced Preliminary Assessment Report (Ebasco Environmental 1990) which may be contaminated with explosives, mustard or mustard degradation products, and hazardous waste. There is a chemical munitions burial ground where mustard shells and bombs were treated with bleach and then open burned. There is also a mustard disposal area where an unknown number of 105 mm mustard rounds were open burned.

The ammunition demolition areas may be contaminated with explosives and unexploded munitions. A one square mile area on the installation is posted with signs denoting unexploded ordnance hazards as a result of 75mm rounds having been scattered in the area when lightening struck an outdoor storage pad.

Certain portions of the PUDA permitted landfill are reported to be releasing contaminants such as chlorinated solvents. It has been reported that between 150 and 200 drums of unknown substances were buried in the landfill during the early 1980s (Ebasco Environmental 1990).

Explosives were washed from standard munition casings in the TNT Washout facility into a series of leaching beds. These beds have high levels of explosives (Ebasco Environmental 1990).

PCBs, TNT, pesticides, and solvents have been identified in a plating shop waste drainage ditch. Open ditches in the warehouse area received waste water from vehicle cleaning and paint booth cleaning operations and reportedly contain paint solvents and grease (Ebasco Environmental 1990).

If remedial action is determined to be required for the above potentially contaminated areas, the chemical demilitarization plant that will be constructed at PUDA should be considered as a possible option to be used. The deactivation furnace is potentially useful for thermally treating the contaminated soils. In particular, the soil and recovered munitions from excavation of the mustard munition burial grounds could be processed since the plant is designed for mustard projectiles. Once it is decided to operate the plant for the mustard burial grounds, it would then make sense to use the plant to thermally treat explosive and hazardous waste contaminated soil from other contaminated sites at Pueblo. An estimated 500 cubic yards of XXX equipment has been retrieved from burial grounds at Rocky Mountain Arsenal and may also require incineration prior to disposal.

The metal parts furnace that will be part of the chemical demilitarization plant to be constructed at PUDA is potentially useful for thermally decontaminating the XXX equipment from Rocky Mountain Arsenal. The metal parts furnace could be used while the deactivation furnace is demilitarizing small arms. This use would require intrastate transportation of the equipment between Rocky Mountain Arsenal and Pueblo, and may, however, meet public opposition. Another alternative for decontaminating this equipment would be to send it to Tooele instead of Pueblo. This would require interstate transportation. The Tooele metal parts furnace is as well suited to decontaminate the Rocky Mountain Arsenal equipment as the Pueblo metal parts furnace.

The buildings at Rocky Mountain Arsenal that currently house the agent production equipment are constructed of monolithic concrete. They may be good candidates for the hot gas method of decontamination once that method is fully developed. If not, an onsite method of decontamination still will be preferred because of the difficulties in moving the large quantity of building rubble (an estimated 250,000 cubic yards from 29 buildings). A portable incinerator designed for this purpose may be required.

B.7.5 Hazardous Wastes

Hazardous wastes generated by activities at PUDA include petroleum, oil, lubricants, solvents, and paints from motor vehicle maintenance and other general maintenance. These wastes are containerized and stored in a RCRA permitted hazardous waste storage facility at PUDA. Collection, disposal, and recycling of hazardous substances is the responsibility of the Defense Reutilization and Marketing Service. Transformers containing PCBs are being replaced as they are removed from service for maintenance or scheduled replacement. The removed transformers are stored in a building set aside for this purpose (Building 100) pending commercial disposal. Under current regulations, stored items containing PCBs must be disposed of by 1992. Therefore, these items will not be available for disposal in the chemical demilitarization facility.

Since Pueblo is designated for realignment it is not likely to continue to generate sufficient quantities of hazardous waste to justify operation of the demilitarization plant for disposal of such waste. Other items considered for disposal in the demilitarization plants can be readily disposed of by other means.

B.8 UMATILLA DEPOT ACTIVITY

The Umatilla Depot Activity (UMDA) is located in Hermiston, Oregon, which is in northeastern Oregon, in Umatilla and Morrow Counties. It was established by the U.S. Army in 1941 and has been used to store, demolish,

renovate, and maintain conventional and chemical munitions. No manufacturing operations have been conducted at UMDA. Neither have chemical weapons been tested or used at the Depot. However, conventional ammunition testing, rework, demolition and disassembly operations have been performed.

A mixed use type chemical demilitarization plant is scheduled to be constructed at UMDA in mid 1992 with operations to be completed by the end of 1998.

Plans are being made to realign Depot areas not affected by the chemical demilitarization project in the mid-1990s. Remedial action to clean up identified contaminated areas is required before the property can be sold for public or private use by others. A 1990 Enhanced Preliminary Assessment for Umatilla stated that because of the large number of locations, types of suspected contamination, and potential migration pathways (PMPs), it does not appear that there are any large tracts of land at the Depot that can currently be excessed (Ritchie et al 1990). In the assessment, 80 site locations are identified where activities may have contaminated soil with explosives, pesticides, chemical warfare agents, breakdown products, decontamination solutions, PCBs, oils, solvents, unexploded ordnance, or other hazardous materials. Forty-one buildings are also identified that are potentially contaminated with explosives and/or other hazardous materials.

Categories of waste items from Umatilla Depot Activity that were evaluated for the future use of the chemical demilitarization plant that is scheduled to be constructed there include:

- conventional munitions scheduled for demilitarization;
- agent contaminated dunnage items;
- spent decontamination solution;
- buildings and equipment contaminated with hazardous materials and explosives;
- hazardous material contaminated soil;
- hazardous waste from on-site activities;
- DOD waste from DRMS; and
- commercial hazardous waste from activities at UMDA.

B.8.1 Conventional Weapons Disposal

Umatilla has approximately 4,200 short tons of conventional munitions in the demilitarization inventory. Included in the inventory are incendiary, CS and pyrotechnic munitions, small arms, rocket motors, grenades, and antipersonnel mines. At present there are no facilities available for demilitarization of this inventory by methods other than open detonation. A demilitarization furnace that had been used since 1950 to incinerate small munitions up to 50 caliber, with reclamation operations for brass, lead, and steel was shut down in 1988. Munitions that were demilitarized included cartridges, boosters, primers, mines, fuses, grenades, simulators, charges, and detonators. It is estimated that it may be feasible to demilitarize 83.8 percent of the conventional munition stockpile in the chemical demilitarization plant (Sweet 1990). The deactivation furnace of the chemical demilitarization plant is particularly suitable for demilitarization of small arms and could replace the demilitarization furnace that was shut down in 1988.

Twelve thousand tons of conventional weapons scheduled for demilitarization are also stored at locations in Washington state and California that do not have facilities for demilitarization other than possibly by open burning or open detonation. It is conceivable that some of the inventories at these locations could be demilitarized in the chemical demilitarization plant to be constructed at UMDA.

B.8.2 Nonstockpile Chemical Items

As a result of maintenance activities for the chemical munitions stockpile, an inventory of chemical agent contaminated items classified as XXX, including protective garments, and other contaminated dunnage is being accumulated. In addition spent decontamination solution is generated by these activities and stored. Decontamination solution from past Drill and Transfer System (DATS) operations on leaking chemical munitions is also stored at UMDA (Ritchie et al 1990). These items can readily be decontaminated in the chemical demilitarization plant that will be constructed at UMDA since they are similar to the contaminated materials that will be generated and incinerated during operation of the plant. Protective garments and other dunnage can be processed through the dunnage furnace, and decontamination solution can be processed through the secondary chamber of the liquid incinerator. The items could probably be disposed of while the plant is operating to demilitarize the chemical stockpile at Umatilla since they are similar to items that will be generated by the operation. Protective clothing and other dunnage will be routinely destroyed in the dunnage furnace. Spent decontamination solution will be disposed of in the secondary chamber of the liquid incinerator.

B.8.3 Contaminated Buildings

A laboratory building was identified as potentially contaminated with agent as a result of analyzing samples from igloos storing chemical agent. Other buildings were identified as potentially contaminated with pesticides, PCBs, agent orange, petroleum, oils, lubricants, paints and solvents, rocket fuel, and explosives on the basis of past or present activities. Contamination has not been confirmed in any of these buildings, most of which are currently in active use (Ritchie et al 1990). If contamination is verified in some or all of these buildings, use of the chemical demilitarization plants to decontaminate equipment and rubble from those buildings should be evaluated.

B.8.4 Contaminated Material and Soil from Sites Undergoing Remedial Action

A recent report (Weston, 1989) concluded that UMDA contains multiple contamination source areas, including the Explosive Washout Lagoons, the Ammunition Detonation Area (ADA), the Deactivation Furnace, and selected Septic tanks. Suspected contaminants include explosives, nitrate/nitrite, cyanide, certain metals, and agent degradation products (Ritchie et al, 1990).

In 1987 the Explosive Washout Lagoons at UMDA were placed on the National Priorities List (NPL). The burning, demolition, and burial sites within the ADA are contaminated with explosives and explosive wastes including TNT, Composition B, Tritonal, Amatol, heavy metals (lead), rocket fuels (RFNA and UDMH) and insecticides (Ritchie et al 1990)

Soil contamination by metals, explosives, and nitrates has been determined to exist at the Smoke Canister Disposal Area, Flare and Fuse Disposal Area, Missile Fuel Burning Areas, K block ore storage area, laundry area dead spot, and mustard storage area (Ritchie et al 1990).

Sites with potential agent contamination include several septic tanks that received laundry waste and decontamination solutions, a remote munitions/GB bomb disassembly area, some areas where decontamination solutions were disposed of, and a site of a laboratory trailer set up to perform analyses on samples suspected of containing GB or VX agents (Ritchie et al, 1990).

There are also areas potentially contaminated with oil and grease, PCBs, and pesticides from leaks, spills, and accidental discharges.

Soils and sludges contaminated with agent, explosives, pesticides, and/or other hazardous organic substances can be processed through the

deactivation furnace of the chemical demilitarization plant for decontamination. If, after additional study and evaluation it is determined that remedial action is required for sites at UMDA, then incineration in the chemical demilitarization plant is an option that could be considered. Studies are currently underway by Roy F. Weston to evaluate composting as a way to eliminate explosives from soil at UMDA (Ritchie et al, 1990). Composting may be a preferable alternative to incineration for soil containing explosives.

B.8.5 Hazardous Wastes

Industrial hazardous wastes that are accumulated as a result of activities at UMDA include diesel fuel, pesticides, paints, thinners, industrial solvents, and used oil. These items are generated at a rate of between 3 and 5 barrels per month. Currently the wastes are disposed of through the Defense Reutilization Marketing Service (Sweet, 1990). Although these wastes are amenable to disposal by incineration, it would probably not be cost effective to continue to operate the chemical demilitarization plant incinerators for these wastes alone. Also, since most of the activities at UMDA may be discontinued in the future, the volume of these kinds of waste are expected to diminish. However, it may be possible to incinerate these wastes by using them as a supplementary fuel while the chemical demilitarization plant incinerators are used for other purposes.

Umatilla also has pentachlorophenol (PCP) treated wood used for pallets (Sweet, 1990). This wood could be disposed of in the chemical demilitarization incinerators, either the dunnage furnace or metal parts furnace, since they are equipped with pollution abatement systems that are designed to capture the pollutants that are generated when chlorinated hydrocarbons are burned.

There are 77 transformers at UMDA that have been determined to contain more than 10 ppm of PCB. Depot records indicate that 60 of these transformers are leaking. Twenty five of the leaking transformers have been removed and placed in the Hazardous Waste Storage Facility (building 203). All of the transformers containing more than 10 ppm of PCBs are scheduled to be replaced by transformers without PCBs (Ritchie et al, 11990). All PCB containing items in storage are required, by regulation, to be disposed of by 1992. Therefore, these items will not be available for disposal in the chemical demilitarization plant.

It has also been suggested that the chemical demilitarization plant be made available for commercial hazardous waste disposal after its mission is completed. The Hermiston Development Corporation is particularly interested in exploring the possibility of having the facility turned over to the private sector for this purpose (Personal Communication). There is a market for such services in the area since Chemical Waste Management operates such a facility approximately 50 miles west of Umatilla in

Arlington, Oregon (Bassi, 1985). However, whether expanded capability for this service can be supported would require a detailed study. The plant capacity is relatively small for such use but may have utility as supplementary capacity for specialized uses.

Since the facility is being used for disposal of chemical agent, those parts of the facility that are potentially contaminated with agent would have to be decontaminated to the XXXXX level because the Army cannot release property to the private sector unless it is decontaminated to that level. This would require dismantling and demolition of some equipment and buildings for processing through the chemical demilitarization furnaces. Since the furnaces and associated pollution abatement equipment are inherently XXXXX they could probably be released to the private sector with minimum modification. The control room and other uncontaminated facilities could also be made available.

Another possible use would be to maintain the facility intact and under Army control for use in the disposal of military hazardous waste in the inventory of the Defense Reutilization Marketing Service. Under current law, the Army would not be able to operate the facility for disposal of non-military hazardous waste. However, since Umatilla is scheduled for realignment, use of the chemical demilitarization plant for disposal of waste from DRMS or for waste from continuing activities at Umatilla does not appear to be a viable option for future use of the UMDA CDF.

B.9 NEWPORT ARMY AMMUNITION PLANT

The Newport Army Ammunition Plant (NAAP) is located near Newport, Indiana. It was used for production of RDX from 1941 to 1946. Some of the RDX facilities were incorporated in a Composition C4 plant operated between 1951 and 1957, and again between 1961 and 1964. Most of the RDX/C4 production facility was razed circa 1977. The acid plant and many support buildings still exist. A heavy water plant was built in 1943 and operated until 1957. It was subsequently reconfigured into a VX manufacturing plant in 1961. The VX plant operated until 1968. A TNT plant was completed in 1973 after a prolonged (4 year) construction period. Two of the five TNT lines were operated. Line 1 operated for six months followed by operation of line 2 for 6 months for a total production of one year (USATHAMA, 1979.) The current mission of NAAP is to safeguard the ton containers of VX that will be destroyed in the chemical demilitarization program and to maintain the standby TNT plant in case it is needed again. This base is on a suggested list of base closures. It is uncertain if and when the base will be closed. It is currently staffed with about 270 employees, 100 of whom are security forces.

Construction of the chemical demilitarization facility at NAAP is scheduled to begin in March, 1992 and be completed in May, 1995. Since the only chemical agent on site is bulk containers of VX, the plant will only have 2 types of incinerators--a metal parts furnace and a liquid incinerator. The chemical demilitarization facility is scheduled to complete destruction of the VX by July, 1997 (Program Manager for Chemical Demilitarization, 1990). Therefore, the potential future use for the chemical demilitarization facility will be after July 1997. There are several sources of wastes that may be available for future use of the chemical demilitarization facility: the old VX production facilities (buildings and equipment), contaminated materiel and soil from landfills, sludge from settling ponds, and on-post hazardous wastes.

Seventeen potential future use feedstocks for the Chemical Disposal Facility at Newport Army Ammunition Plant (NAAP) have been identified. These are listed in table B-14 and are discussed below.

B.9.1 Conventional Weapons Disposal

Newport Army Ammunition Plant does not have any stockpiled conventional weapons stored on site. Crane Army Ammunition Activity, also in Indiana, does have a large inventory of stockpiled conventional weapons that conceivably could be shipped to NAAP for destruction in the chemical demilitarization facility. However, since most conventional munitions require a deactivation furnace (DFS) for destruction and the NAAP chemical demilitarization facility will not include a deactivation furnace, there is very little reason for such a shipment, unless a deactivation furnace is moved from another location.

B.9.2 Old Chemical Agent Production Facilities

The old VX production facilities are promising potential feedstocks for the chemical demilitarization plant. The VX production process consisted of 4 steps, named Steps 0, I, II, and III. Steps 0, I and II converted raw materials to QL. Step III converted QL to VX. The Step 0, I, and II equipment is outside in open bays. It has had virtually all asbestos removed from it. It is unknown what breakdown products may reside in the equipment, particularly equipment such as valves and pumps that contain small crevices which are difficult to sample. Sampling will be conducted on the larger pieces of equipment to determine breakdown products. The Step III equipment is housed in a six story metal building called Building 143. The equipment has much asbestos on it, and there are no current plans to remove the asbestos. The building has deteriorated somewhat, but does not appear to be in danger of collapsing. Most of the metal floors have been corroded away by chlorine from bleach water that was once stored

Table B-14. Potential Feedstocks for NAAP Chemical Demilitarization Facility

Potential Feedstock	Comment
Step 0, I, II equip.	Large volume of equipment, thermal treatment would ensure adequate decontamination, easily accessible.
Step III equip.	Large volume of equipment, agent contaminated, has asbestos.
Building rubble	Large amount of material, includes Building 143 (mostly metal) and concrete pad on which VX is presently stored. Agent contaminated.
Bulk storage tanks	Agent contaminated, includes some asbestos
Night Soil Pits	Small amount of 3X material
Decontaminated Waste Burial Ground--Soil	More material than in the Night Soil Pits, especially 3X material. Soil is potentially contaminated.
Decontaminated Waste Burial Ground--Contents	More material than in the Night Soil Pits, especially 3X material.
Closed Sanitary Landfill	No obvious contamination.
TNT Burning Gound	Metal Parts Furnace is not well suited to incinerate soils.
RDX Burning Ground	Metal Parts Furnace is not well suited to incinerate soils.
Red Water Ash Basin/Gypsum Sludge Basin	Metal Parts Furnace is not well suited to incinerate soils.
Sludge from the Chemical Plant Waste Settling Basin 6 Sludge Basin	Difficult to dispose of without an incinerator, contains VX byproduct waste.

Table B-14. Potential Feedstocks for NAAP Chemical Demilitarization Facility (Concluded)

Potential Feedstock	Comment
Boneyard (miscellaneous VX solid waste)	Relatively small quanitiy, quite varied material.
Old VX Deocontamination Furnace	Very small, potentially contaminated on outside.
Toxic Laboratory solid waste	Small amount of material.
Toxic Laboratory equipment	Not known when this will require disposal.
PCB items	PCBs will be destroyed by 1992, so these will not be available for feedstock when the chemical demilitarization facility is available for future use.

on the sixth floor. The ventilation scrubber system is no longer functional. The floors and ventilation system would need to be restored prior to removing equipment from this building. The chemical demilitarization facility is well suited to treat VX contaminated metal. The asbestos would have to placed in drums to ensure containment of fibers. After decontamination, the drums of asbestos would require disposal in the normal manner for asbestos. Permitting for this waste stream should be very similar to permitting for the bulk storage tanks discussed previously. One additional complication is that the Step III equipment may include some QL chemical contamination because Step III was designed to convert precursor QL to VX. There are no strong competing methods to decontaminate this equipment. An incinerator with an adequate pollution abatement system is required to treat the agent. There is a relatively small amount of this equipment.

Finished VX was stored in eight large product storage tanks. Six of the tanks are 50,000 gallon tanks and two are 30,000 gallon tanks. These tanks have some asbestos on them that is not currently scheduled for removal. The bulk storage tanks are a potential feedstock for the chemical demilitarization facility. The asbestos would probably have to be placed in drums to contain the fibers, incinerated to destroy the VX contamination and then disposed of in the normal manner for asbestos. The tanks would be carefully decontaminated to the XXX level, cut into pieces, and incinerated. However, other decontamination processes should be investigated since chemical decontamination of the tanks may generate a large volume of spent decontamination solution. The furnaces and PAS are fairly well suited for this application since the primary contaminant is vx. Permitting may be somewhat difficult since asbestos is involved. The tanks are a good candidate for the hot gas method of decontamination. It is possible that these tanks will be treated with hot gas prior to the availability of the chemical demilitarization facility for future use. The tanks are the smallest waste volume considered in this analysis.

Building 144 is the old chemical filling building. Part of the building is used to store fill machines and part is used to store the VX ton containers. The building, foundation and fill machines may all be potential feedstocks for the chemical demilitarization facility. It is estimated that the VX facility contains 6,100 cubic yards of production vessels, tanks and piping (including the product storage tanks). The piping alone is 6.8 miles. The steel debris, primarily Building 143, is estimated at 5,100 cubic yards. Concrete debris, primarily building and equipment foundations, is estimated at 2,900 cubic yards (Mason and Hanger, July, 1990).

The Step 0, I, and II equipment is easily accessible for dismantling since it is outside. AMCCOM plans to coordinate programming of Defense Environmental Restoration Account (DERA) funding for the dismantlement of

this equipment in the next few years. None of the Step 0, I and II equipment is agent contaminated, but is contaminated with the various precursor chemicals of the VX production process (QL, SW, etc.) and their breakdown products. USATHAMA is studying a washout and scrapping process for the large process vessels. This process would not be suitable for smaller and more complicated equipment because it would not ensure thorough decontamination. This smaller and more complicated equipment could be stored for later incineration in the chemical demilitarization facility to ensure thorough decontamination. The furnaces and pollution abatement system in the chemical demilitarization facility should require little or no modification to incinerate this equipment. However, changes in operating conditions will be required. There is a moderate amount of this equipment that requires disposal. The permitting process may be somewhat difficult for this application because it is uncertain what breakdown products are contained in the equipment. Since no VX was produced in Steps 0, I, and II, the contaminants that exist in the equipment are different from those that the chemical demilitarization facility is already permitted to incinerate. There is a slight possibility that the equipment will be processed either by chemical neutralization, in another furnace, or perhaps in a landfill prior to the availability of the chemical demilitarization facility. In that event, it would not be a potential feedstock for the future use of the chemical demilitarization facility.

The Step III equipment is contaminated with QL, VX and their breakdown products. There are no current plans to remove this equipment from Building 143. The Step III equipment could be removed, cut into pieces that are of an appropriate size for the MPF, chemically decontaminated, and stored until they could be incinerated in the MPF. This is similar to the work ongoing at Edgewood to dismantle the Pilot Plant. The metal parts furnace (MPF) and pollution abatement system (PAS) will not require any modification. The permits should be relatively straightforward to obtain because the only contaminant is VX and the chemical demilitarization facility will already be permitted to incinerate VX. The rubble will almost certainly still be contaminated when the chemical demilitarization facility is available to process it because some of the rubble will come from the present VX storage area. That area cannot be demolished until the VX is processed through the chemical demilitarization facility. There are no strong competing methods for disposing of this rubble since it is agent contaminated. The hot gas method is not suitable for the VX production facility because the building has deteriorated, is of a fairly complex configuration and is relatively large. Incineration is the only practical method of decontamination. There is a significant amount of material requiring disposal.

The asbestos may require special handling. Asbestos is categorized as either friable or non-friable. Friable asbestos tends to break into fibers or particles when it is heated. Non-friable asbestos tends to maintain its

form when heated. Non-friable asbestos such as transite (an asbestos siding) may be incinerated as-is. Friable asbestos must be placed in vented containers. The containers ensure that the asbestos fibers do not escape into the atmosphere. The vents prevent the containers from exploding due to pressure buildup. The agent is thermally destroyed inside the container (Blades, 1990). The permitting process for incinerating Step III equipment may be somewhat difficult because of the asbestos. Other than that, the primary contaminant is VX, for which the chemical demilitarization plant will be permitted.

B.9.3 Contaminated Material Recovered from Landfills Undergoing Remedial Action

There are a number of landfills at Newport. The Night Soil Pits were originally used as a depository for waste from privies. Subsequently, the pits were used as disposal pits for decontaminated solid waste from the VX manufacturing process. Most recently, the pits have been used for the disposal of rubble and other burned materials resulting from the razing of the RDX manufacturing facility (USATHAMA, 1979). It is estimated that the Night Soil Pits contain 5,500 cubic yards of material (Mason and Hanger, July, 1990).

If it is determined that the Night Soil Pits require excavation, the solid material could be effectively incinerated in the Metal Parts Furnace (MPF). Incineration would ensure XXXXX decontamination for the VX waste, and would eliminate the possibility of RDX contamination on the building rubble. Permitting for the VX waste may be rather straightforward since the chemical demilitarization facility would already have a permit to incinerate VX. Permitting for the RDX building rubble may be somewhat more difficult since this is a different contaminant than the one for which the plant will receive a permit. The soil in the landfill is not especially well suited for incineration in the MPF. Soil generally requires agitation during incineration to guarantee even heating and the MPF, as designed, has no method for stirring the soil. Soils are generally incinerated in a rotary kiln-type furnace such as a deactivation furnace. Newport is not scheduled to have a deactivation furnace because it has only bulk containers of VX to destroy. If a deactivation furnace or other rotary kiln is brought to Newport, the technical feasibility of incinerating the soil from the Night Soil Pits should be re-evaluated. Another alternative is to modify the MPF to agitate the soil, perhaps using a special tray with a stirring mechanism.

The Decontaminated Waste Burial Ground contains several Burial Areas. Burial Area 1 contains decontaminated pipes, valves, gas masks, gloves, drums and sample bottles. Area 2 contains decontaminated asbestos and nitrobody contaminated gaskets from TNT. Area 3 contains sulfur wastes from TNT. Area 4 contains decontaminated wastes from the VX production

facility (including some munitions that were filled, leaked, were decontaminated and then buried), building destruction rubble, and asbestos insulation from the Heavy Water process towers. Pit A contains a 300 gallon tank containing organophosphorous compounds. The total volume of the Decontaminated Waste Burial Ground is estimated at 8,000 cubic yards (Mason and Hanger, July, 1990).

If it is determined that the Decontaminated Waste Burial Ground should be excavated, much of the material could be easily incinerated in the MPF. The asbestos might require special handling. If the asbestos is friable, or tends to break into fibers upon heating, the asbestos must be placed in vented drums prior to incineration. If the asbestos is non-friable, it could be placed in the MPF directly. Incineration of the asbestos and nitrobody contamination would require new or modified permits, which may not be straightforward to obtain since the contaminants are not included in the original chemical demilitarization permits. It may be easier to obtain permits for the VX waste since the chemical demilitarization facility is already permitted to incinerate VX. The organophosphorous compound could be incinerated in the Liquid Incinerator (LIC) if it is still in a liquid form. The tank itself would need to be cut into smaller pieces to fit into the MPF. New or modified permits would be required for incineration of the organophosphorous compound since the contaminant is not included in the original chemical demilitarization permit. As discussed previously, the soil in the Decontaminated Waste Burial Ground requires agitation during incineration to ensure even heating. Since there is no deactivation furnace scheduled for construction in the Newport complex, the MPF would require modification to efficiently incinerate soil. It might be easier to incinerate the soil in another rotary kiln, such as the portable types especially designed for soil incineration. Because of the potential for agent contamination, there are no strong competing methods to cleanup of this soil. If modifications are made to the MPF to permit soil incineration, other soils such as the Night Soil Pits may become prime candidates for feedstock for the chemical demilitarization facility.

Recovered items from the Decontaminated Waste Burial Ground are another candidate waste that could be disposed of or decontaminated in the chemical demilitarization facility at Newport. This includes a wide variety of items, including asbestos, that are potentially VX or TNT contaminated. The chemical demilitarization facility can probably handle these items, but there may be technical difficulties because of the variety of items to be incinerated. Permitting may also be somewhat tricky since there may unknown contaminants in the material. At a minimum, VX, TNT and asbestos would have to be considered. There is a slight possibility that this landfill will be remediated prior to the availability of the chemical demilitarization facility for future use. The quantity of items in this landfill is moderate.

Several holding and settling ponds may require remediation. The Chemical Plant Waste Settling Basin & Sludge Basin (Facility No. 30031/30025 aka K-9 ponds) is a concrete basin coated with sludge and containing liquid. It was used as a settling pond for decontaminant streams which exited the VX production plant. It is estimated to contain 2,200 cubic yards of concrete, 50 cubic yards of sludge and 1,250 cubic yards of soil that would be excavated with the concrete (Mason and Hanger, July, 1990). The sludge possibly could be incinerated in the MPF, although some modifications would be required to handle sludge rather than solid material. As with soil, the sludge would require agitation to ensure even heating. Modifications to handle the high liquid content in the sludge might be required for the MPF and the pollution abatement system (PAS). The concrete could be incinerated easily. The soil requires agitation, as mentioned previously, and therefore requires a modified MPF. Permitting might be difficult since it is likely the contaminants are different from those identified in the chemical demilitarization permits. The basin is easily accessible, so obtaining representative samples should be straightforward.

The Gypsum Sludge Basin contains about 90,000 cubic yards of soil and sludge, possibly contaminated with trace amounts of nitrobody residue (Mason and Hanger, July, 1990). The Pollution Control Center Retention Pond contains about 20,000 cubic yards of soil and gypsum sludge contaminated with nitrobodies (Mason and Hanger, July, 1990). These sludges could possibly be incinerated in the MPF, but modifications to the furnace probably would be required. As with soil, agitation to ensure even heating is required. Permitting would not be simple, since the contaminants are different than those already included in the chemical demilitarization facility permit.

The sludges from the VX settling basins and nitrobody waste ponds are also potential feedstocks for the future use of the chemical demilitarization facility. The sludges probably contain fairly high concentrations of VX by-product wastes from the VX settling basins and fairly high concentrations of nitrobody from the Red Water Ash Basin and Pollution

Control Center Retention Pond. While there is probably no agent contamination, there are probably many types of hazardous chemicals in the sludges. Sludges are not well suited for the metal parts furnace (MPF). Like soils, they require agitation to ensure even heating. In addition, the concentrations of hazardous materials are much higher in sludges than in soils. Finally, the liquid content of the sludge may cause technical problems in the furnace and pollution abatement system. The permitting process for these sludges may be somewhat difficult because of the variety of chemicals that may be involved. However, the sludges are easily accessible so sampling could be performed. It is fairly certain that the sludges will exist when the chemical demilitarization facility is available for future use because no strong competing method for their disposal has been identified. A fairly large quantity of sludge requires disposal.

The Closed Sanitary Landfill was operated from 1970 to 1977. Several explosive compounds were detected in three downgradient wells installed there as part of a remedial investigation conducted by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) in 1988. Further investigation is ongoing to determine if decontamination is required.

B.9.4 Soils Contaminated with Hazardous Substances

The TNT burning ground contains about 8,500 cubic yards of nitrobody contaminated soil (Mason and Hanger, July, 1990). The RDX burning ground contains about 5,000 cubic yards of explosives contaminated soil (Mason and Hanger, July, 1990). The Red Water Ash Basin contains about 80,000 cubic yards of soil containing nitrobody residue (Mason and Hanger, July, 1990). As discussed previously, the MPF is not well suited to incinerate soil without modifications to ensure even heating. If this soil must be decontaminated, it might be more efficient to use a rotary kiln, perhaps a portable one designed for soil incineration.

B.9.5 Stored Agent-Contaminated Waste

There is a "boneyard" of material inside the fence surrounding the eight large bulk storage tanks for VX. This area includes 55 gallon drums of VX contaminated material such as protective clothing, sand blasting sand, etc., various scrap items from the process and at least 28 empty but sealed ton containers marked X. There are two additional warehouses in the chemical plant area that house X or XXX items that are candidates for incineration. In general, this material could be incinerated in the MPF with little modification. Most of the material was contaminated with VX rather than other contaminants, so the permits may be easier to obtain.

A small, old VX decontamination furnace is a candidate for decontamination. It may be contaminated on the outside and thus require decontamination to the XXXXX level by being cut into pieces and fed into the MPF. The permitting process should be relatively straightforward since the contaminant is agent VX.

B.9.6 Hazardous and Toxic Waste

The Toxic Chemical laboratory generates quantities of solid waste, including charcoal adsorption and high efficiency particulate (HEPA) filters that are at a XXX level of contamination (Mason and Hanger, June, 1990). These wastes could be processed through the MPF, perhaps with some modifications to the PAS. The toxic incinerator and toxic sump tanks will require disposal after air monitoring operations are no longer required. These could probably be incinerated in the MPF, although some modifications may be required. Permitting may be a problem, depending on the toxic chemicals that were used in the laboratory.

Several PCB items require disposal. Some of these are agent contaminated as well as PCB contaminated (Mason and Hanger, June, 1990). The TSCA regulations that govern PCBs are very complex. Depending on a number of factors (including whether the items are stored for reuse or disposal), TSCA may require that these items be disposed of prior to the availability of the chemical demilitarization facility. A separate, detailed study of how best to dispose of the agent contaminated PCB items should be conducted. The conflicting regulatory jurisdictions of TSCA for PCBs and RCRA for agent contaminated items need to be resolved. TSCA may require these items to be treated prior to the availability of the chemical demilitarization facility but RCRA and Army regulations may not permit these items to leave government control until they are at a XXXXX level. Resolution of this problem is beyond the scope of this report.

From a technical standpoint, if the items are available, they could be treated in the chemical demilitarization facility. Agent contaminated items would first be chemically decontaminated to a XXX level. PCB filled items would then be drained. The metal parts would be treated in the MPF to ensure destruction of residual PCBs. It may be somewhat difficult to obtain proper permitting to incinerate residual PCBs in the MPF because the MPF operating temperature is not as high as EPA desires. This might be compensated for by increasing the residence time. The drained PCB oil could be incinerated in the LIC. If the oil is too thick, it could be thinned with clean oil before incineration in the LIC. Therefore, although permitting may be complex, it should be possible to dispose of PCB contaminated items in the chemical demilitarization facility.

B.10 SMALL BURIAL SITES

At a variety of locations, small amounts of buried chemical munitions or chemical agent/chemical agent breakdown product-contaminated soil are known to exist. These are:

1. Ft. Benning, Georgia
2. Yuma Proving Ground, Arizona
3. Memphis Defense Depot, Memphis, Tennessee
4. Hawthorne Army Ammunition Plant, Hawthorne, Nevada

If contamination is confirmed at any or all of these locations, the area in question can be excavated, neutralized, if necessary, and shipped to a CSDP facility. In the cases of Ft. Benning, Georgia or the Memphis Defense Depot where small numbers of intact Chemical Agent Identification Sets (CAIS) may be found, these may also be safely overpacked and shipped to a CSDP site. Recommendations for transporting these recovered items are as follows:

From	To
Ft. Benning	Anniston
Yuma Proving Ground	CAMDS
Memphis Defense Depot	Pine Bluff
Hawthorne AAP	CAMDS

12920

APPENDIX C

DEMILITARIZATION TECHNOLOGIES APPLICABLE TO THE 14 CONSOLIDATED FAMILIES

DEMILITARIZATION TECHNOLOGIES APPLICABLE TO THE 14 CONSOLIDATED FAMILIES

C.l DEMILITARIZATION OF OBSOLETE AND UNSERVICEABLE CONVENTIONAL MUNITIONS

The conventional ammunition demilitarization process (other than OB/OD) involves mechanical reduction, explosives removal, and incineration operations. Figures C-l and C-2 are simplified block flow diagrams that conceptualize the relationships between various steps of the overall demilitarization process (Arthur D. Little, 1985).

As can be seen from figure C-l, munition breakdown/mechanical reduction includes separation of fuze, booster, and main charge; exposure of main charge by punching and sawing; removal of explosives by meltout or washout; followed by incineration and environmental control of flue gases in an appropriate PAS. Figure C-2 shows the various steps involved in the demilitarization of the non-lethal agent munitions. These steps include some disassembly, neutralization, recovery, incineration, and pollution abatement of the flue gases. Listed in appendix D are the existing demilitarization technologies, and the associate Ammunition Peculiar Equipment (APE) that are presently available.

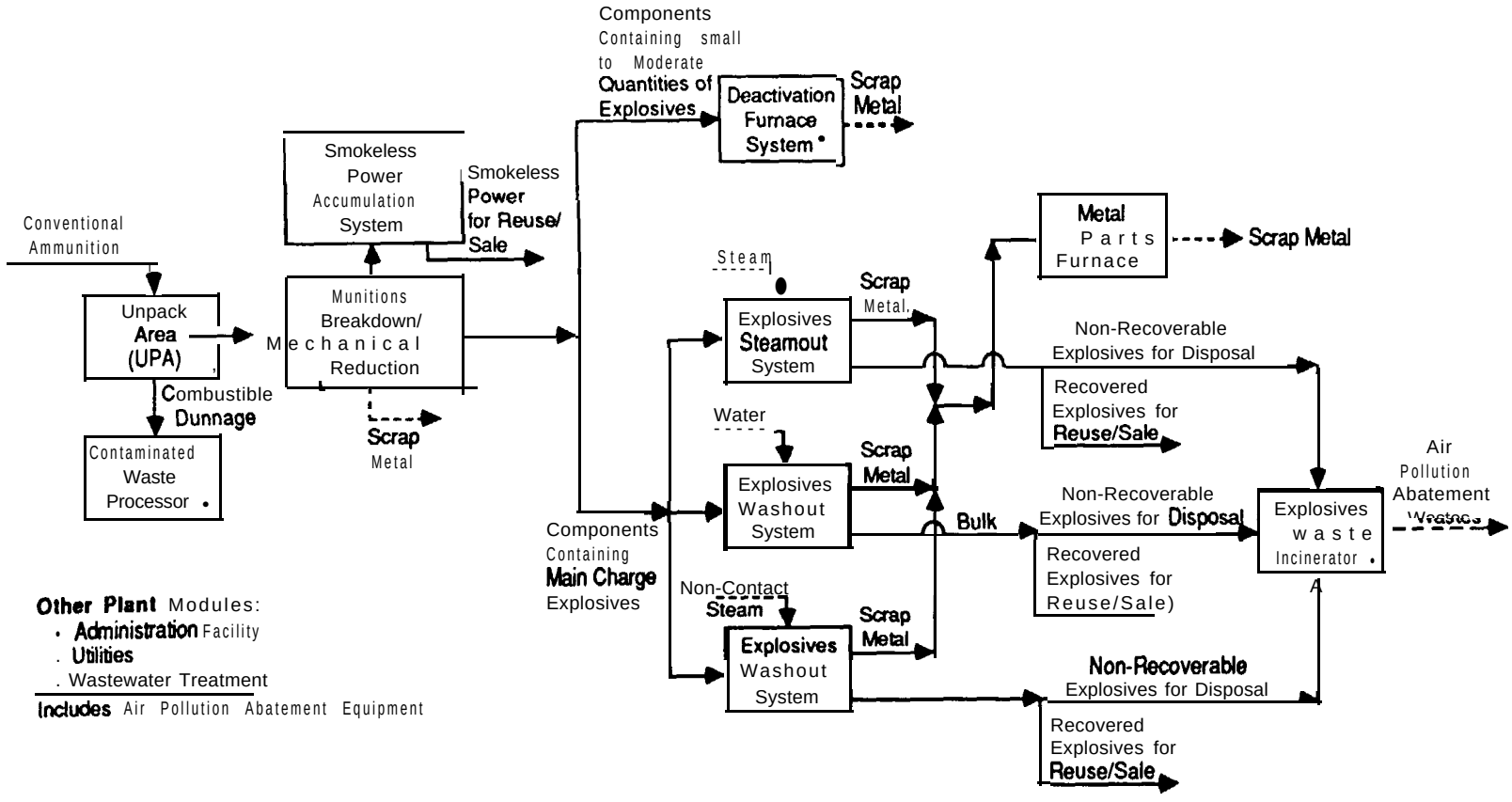
Subsequent to the completion of the lethal chemical munitions test and disposal operations at CAMDS (by September, 1994), at TOCDF (by 1998), and at CCDP (by 1998), these facilities can be modified/retrofitted to demilitarize obsolete and unserviceable conventional munitions stored at TEAD and nearby areas.

C.2 CONSOLIDATED FAMILIES

The following is a listing of the 14 consolidated families and the types of demilitarization assets included in each. Demilitarization Technologies (D.T.) are identified where possible. However, it should be noted that **some** of these technologies identified may **not** be applicable to the demilitarization of some of the items in the subfamilies. Also, some technologies are still in the experimental stage and may not prove to be acceptable.

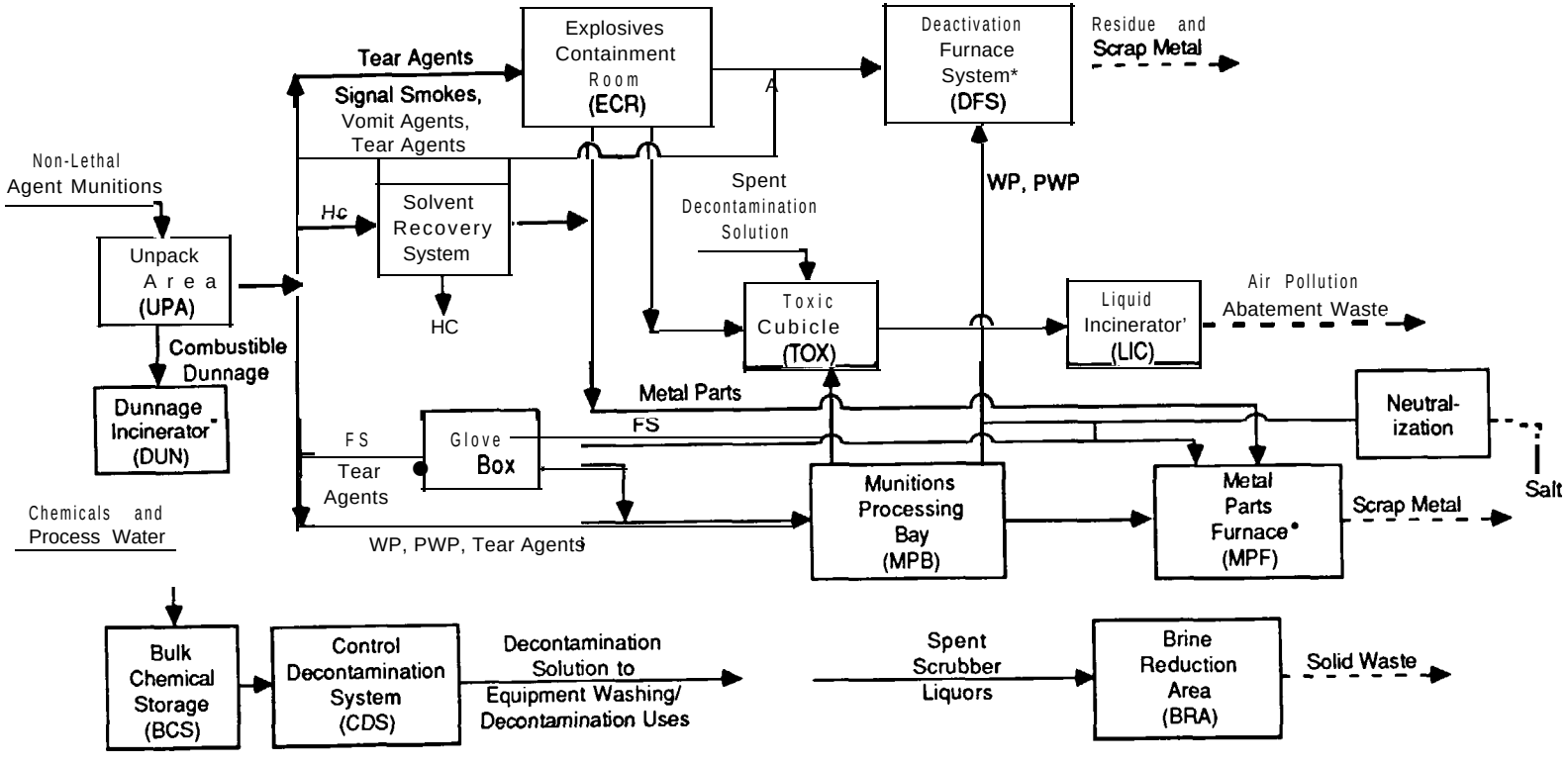
1. Small arms, fuzes, and primers consist of:

   a. Ammunition items 5.56mm through 20mm including small propellant actuated devices.
      (D.T.) No disassembly is needed; use APE 1236 Deactivation Furnace (since this furnace is not refractory lined, it can be used as a



Source: Arthur D. Little, Inc., 1995.

Figure C-I. Conventional Ammunition Demilitarization Process (Excludes Special Categories - i.e., Smokes, Pyrotechnics, etc.)



Other Plant Modules:

- Toxic Maintenance Facility
- Administration Facility
- Utilities
- Miscellaneous Items

Includes Air Pollution Abatement Equipment

Source: Arthur D. Little, Inc.. 1995.

Figure C-2. Non-Lethal Agent Munitions Demilitarization Process

popping furnace). To comply with RCRA, the APE 1236 is being upgraded with an afterburner, a dust collector (cyclone), and a bag house; it will also be a completely shrouded system.

b. 20mm munitions filled with tetryl and incendiary increments.

(D.T.) Same as item la above.

c. Depleted uranium (DU) projectiles.

d. Fuzes used on artillery projectiles and containing small explosive detonators and boosters.

(D.T.) Same as item la.

e. Small tracer composition filled items.

(D.T.) Same as item la.

f. Fuzes, primers

(D.T.) Same as item la.

2. Smokes and dyes consist of:

a. Small rocket warheads loaded with plasticized white phosphorus (PUP).

(D.T.) Disassemble and remove explosive components; incinerate metals in a modified APE 1236 that has been upgraded to include mist eliminators; convert P_2O_5 to H_3PO_4 in WP plant.

b. 57mm through 4.2-inch items which are white phosphorus (WP) filled.

(D.T.) Same as item 2a.

c. 3-inch items filled with colored dyes.

(D.T.) Dye composition could be a problem (possible organic carcinogens). To comply with RCRA, the APE 1236 and PAS equipment require modifications/upgrades.

d. 4.2-inch items filled with sulphur trioxide chlorosulfonic acid (FS, smoke).

(D.T.) Disassemble and remove filler; neutralize acidic filler with a lime slurry; resulting salts may be RCRA wastes. Neutralization technology is available, but U.S. Army has no capability. FS smokes can also be incinerated in an APE 1236.

e. Small WP filled munitions.

(D.T.) Same as item 2a.

f. Hexacholorethane (HC, white smoke) filled hand grenades.

g. Smoke (dye) mix filled hand grenades.

(D.T.) May be able to use upgraded/modified APE 1236 to incinerate.

h. 105mm ammunition with colored smoke projectiles.

(D.T.) These items need disassembly; may be able to use upgraded/modified APE 1236.

i. 3.5 and 2.75-inch rocket warheads WP filled,

(D.T.) Same as item 2a.

j. Bulk packed smoke (FS).

(D.T.) Same as item 2d.

k. Various sized smoke pots filled with HC.

(D.T.) Development work is being done to recover hexachloro-ethane and metals from HC smoke pots; use fluidized bed incinerators (FBI) with appropriate upgrade/modifications.

1. Not used.

m. Various sized smoke pots filled with petroleum base type chemical fog oil.

(D.T.) Use of an industrial boiler incinerator with appropriate upgrade/modifications is being investigated by a current USATHAMA program.

n. Chemical dye marine markers

(D.T.) These are organic dyes; same as item 2c.

o. Items with color burst filler ranging in size from 3 to S-inch.

(D.T.) These items may have metals; to comply with RCRA, the APE 1236 and PAS equipment require modifications/upgrades.

p. Light metal cased signals of various sizes filled with colored smoke and illuminating mixes.

(D.T.) May be able to use upgraded/mofified APE 1236.

3. Pyrotechnics consist of:

a. 3 to 5-inch illuminating and pyrotechnic mix filled items.

(D.T..) This pyrotechnic mix could be solid material; once disassembled, incinerate in a modified/upgraded APE 1236.

b. Multi-sized pyrotechnic mixture filled munitions including some with masking dyes.

(D.T.) Disassembly is a problem; dye may be a problem; once separated, incineration is applicable; use upgraded/modified APE 1236.

c. 60 and 81mm illumination munitions with pyrotechnics and aluminum mix filler.

(D.T.) Same as item 3b.

d. Various sized aircraft and surface flares filled with pyrotechnic, aluminum and magnesium mix.

(D.T.) Same as item 3b.

e. Photofinish cartridges filled with a pyrotechnic mixture.

(D.T.) Disassembly is not a problem; these items are filled with a mixture of Al and $Ba(NO_3)_2$ powder; incinerate in upgraded/modified APE 1236.

4. HE loaded projectiles (except yellow "D") consist of:

a. 20 to 40mm ammunition with HE compositions.

(D.T.) If no OB/OD, Disassemble; Incinerate metals in a modified/upgraded APE 1236; Incinerate propellant in modified/upgraded EWI.

b. TNT loaded projectiles ranging in size from 155mm to 8-inch plus small rocket warheads.

(D.T.) Disassemble (just lift the plug/fuze); melt out TNT, Incinerate TNT in upgraded/modified EWI or re-use TNT; use modified/upgraded APE 1236 for metals.

c. 105mm submunition loaded projectiles.

(D.T.) Disassembly is currently being designed, may be only fuse removal is needed; once disassembled incinerate submunitions in modified/upgraded EWI and APE 1236.

d. 90 to 105mm TNT and comp B filled items.

(D.T.) Open munition, and melt out explosives. Incinerate explosives/metals in modified/upgraded EWI and APE 1236 respectively.

e. 40mm to 4.2-inch items filled with comp. B.

(D.T.) Same as item 4d.

f. Comp B filled small rocket warheads.

(D.T.) Same as item 4d.

g. 3 to 5-inch ccmp A-3 filled items.

(D.T.) Use high pressure water jet to remove the nonxneltabie explosives; incinerate explosives/metals in modified/upgraded EWI and APE 1236, respectively.

h. 5-inch and 155mm projectiles, comp B loaded and equipped with rocket motors.

(D.T.) Disassemble in APE equipment; melt out comp. B explosives; incinerate explosives/casings in modified/upgraded EWI and APE 1236 respectively.

i. Comp B filled bursting and boostering devices.

(D.T.) Disassemble (this is a very diverse family); size reduce in a shearing machine up to 1/2 size; incinerate in upgraded/modified APE 1236 (limited to 600 grams of confined explosives at PBA).

j. 40mm TNT and incendiary composition loaded munitions with multi-fuzing capability.

(D.T.) Disassemble in APE equipment; incinerate primer and propellant in a modified/upgraded EWI; incinerate fuze in a modified/upgraded APE 1236.

k. 3 to 6-inch comp A-3 filled items.

(D.T.) Same as item 4g.

1. Not used.

m. 3-inch to 105mm comp B and TNT filled projectiles.

(D.T.) Same as item 4d; (use hot water melt out).

n. Comp B filled 81mm mortar projectiles.

(D.T.) Same as item 4m.

5. Rockets and missiles consist of:

a. Medium to large warheads filled with cyclotol.

(D.T.) Disassemble; steam out cyclotol, TNT comes out as a liquid and RDX comes out as a slurry; incinerate explosives in a upgraded/modified EWI, incinerate metals in upgraded/modified EWI or APE 1236 or CBI.

b. 5-inch rocket warheads with pyrotechnic filler.

(D.T.) Disassembly is a problem for this large family (62 items); once disassembled and Al is recovered, incinerate in a modified/upgraded APE 1236 (Al could burn very hot and it would damage incinerator). There may be a problem with metal oxide particles, filler could pose a RCRA problem.

c. Rocket motors for 2.75 through 5-inch rockets.

(D.T.) If no OB/OD, disassemble, size reduce and shear (could be very costly); once disassembled, incinerate in upgraded/modified EWI and/or APE 1236.

d. Comp. B loaded rockets.

(D.T.) Disassemble; melt out composition B explosives (hot water); incinerate explosives/metal in a modified/upgraded EWI and APE 1236 respectively; Rocket motors need some disassembly prior to incineration.

e. 2.75-inch assembled rockets with comp B filled warheads and ballistic rocket motors.

(D.T.) Same as item 5d.

f. 2.75, 3, and 5-inch rockets with inert loaded projectiles containing dyes and black powder charges.

(D.T.) Limited disassembly is available; incinerate black powder charges in a modified/upgraded EWI; dyes may or may not be carcinogen, maybe can use upgraded/modified APE 1236.

6. Bombs, torpedoes, depth charges, and CBUs consist of:

a. Submunition loaded bombs.

(D.T.) APE are under development to disassemble these items; once disassembled, incinerate in a modified/upgraded APE 1236.

b. Bombs filled with tritonal.

(D.T.) Disassemble; steam out to remove explosives, incinerate explosive material in upgraded/modified EWI; incinerate metal in upgraded/modified APE 1236 (PAS upgrade need a cyclone to remove particulates).

c. Comp. H6 filled bombs and warheads.

(D.T.) Steam out explosives in the form of liquid/slurry; incinerate explosives/metals in modified/upgraded EWI/APE 1236 respectively.

d. HBX-3 filled warhead type munitions for rockets and torpedoes.

(D.T.) Same as item 6c. (Note: these items could be steamed out at WADF).

e. Underwater munitions filled with HBX-1.

(D.T.) These items have a lot of explosives (RDX, TNT, WAX) and are large; steam out/wash out at WADF; incinerate in upgraded/modified EWI.

f. Large underwater munitions filled with TNT.

(D.T.) Open and disassemble; these depth charges are like 55 gallon drums. Similar to item 6e

7. Riot control agents consist of:

a. 0-chlorobenzalmalononitrile (CS) filled hand grenades.

(D.T.) Certain amount of disassembly is required (punching). Incinerate in upgraded/modified APE 1236.

b. Chloroacetophenone (CN) and adamsite (DM) filled grenades.

(D.T.) Same as item 7a. However, arsenic removal may be a problem (PBA personnel).

c. Bulk packed CN.

(D.T.) No disassembly is required. Incinerate in a FBI equipped with appropriate PAS.

d. Bulk packed DM.

(D.T.)

e. Bulk packed CS.

(D.T.) No disassembly is required, just remove plastic bag. Incinerate in a FBI equipped with appropriate PAS.

8. Bulk explosives consist of:

a. Bulk TNT.

(D.T.) No disassembly is required, incinerate in an upgraded/ modified EWI (similar to APE 1236 upgrade).

b. Bulk composition B.

(D.T.) Same as item 8a.

c. Bulk explosive D.

(D.T.) May be able to use upgraded/modified EWI.

d. Bulk packed military dynamite.

(D.T.) Need size reduction and exposure of dynamite. Incinerate in an upgraded/modified EWI.

e. Bulk packed explosive detonating cord filled with PETN and other explosive mixes.

(D.T.) No disassembly is required; it contains plastic coatings and could cause explosives buildup. May be able to use upgraded/ modified EWI.

f. Bulk packed composition A.

(D.T.) These items are usually packed in a cardboard box; incinerate in an upgraded/modified EWI.

g. Bulk packed composition H-6.

(D.T.) Same as item 8f.

9. Grenades and mines consist of:

a. TNT and composition B filled hand grenades.

(D.T.) Diasassembly is required, remove fuze and punch using APE. Incinerate in an upgraded/modified APE 1236.

b. Antipersonnel mines filled with composition B.

(D.T.) Just punch; incinerate in an upgraded/modified APE 1236.

c. Antitank mines filled with composition B.

(D.T.) These items contain about 20 pounds of explosives; remove cap, meltout explosives, and incinerate in an upgraded/modified EWI and MPF (flashing furnace for metals).

d. Thermite loaded munitions.

(D.T.) Disassembly is needed, however, no present capability is available. After disassembly, the material (ferric oxide and aluminum) could be separated and recovered for reuse.

10. Navy gun ammunition (explosive D) consists of:

a. 3 through 8-inch projectiles filled with explosive D.

(D.T.) No disassembly is needed, usually can stand out projectile on its base and washout to remove explosive D. (WADF has this capability). Incinerate slurry in a rotary type furnace (refractory-lined) which is equipped with an afterburner (2200°F). WADF has this kind of rotary kiln.

b. Heavy metal projectiles filled with explosive D.

(D.T.) Same as item 10a.

11. Projectiles special function consist of:

a. 40 through 152mm "fixed" ammunition requiring disassembly and breakdown.

(D.T.) Disassembly is available (vertical pull-up machine). Incinerate propellant in an upgraded/modified EWI.

b. Depleted uranium (DU) items.

(D.T.) Currently, these items are not in the inventory.

c. 152mm items with TNT filler and combustible cartridge cases.

(D.T.) These are practice rounds. Same as item lla.

d. 3 or 5-inch projectiles with chaff fillers and black powder expelling charge.

(D.T.) Some disassembly is required. Nothing is needed to be done to chaff fillers. Incinerate black powder in an upgraded/ modified EWI.

e. 90 through 120mm munitions equipped with inert loaded projectiles with tracers.

(D.T.) Disassemble and remove cartridge cover, may need to remove tracer. Some of these items contain tungeston carbide. Incinerate propellant in an upgraded/modified EWI.

12. Propellant charges consist of:

a. 3 to 8-inch propelling charges.

(D.T.) These items are generally in bags. Just open bag and incinerate propellant in an upgraded/modified EWI.

b. 3 through 5-inch munitions generally inert but equipped with tracer.

(D.T.) Disassemble, remove cartridge. Incinerate propellant in an upgraded/modified EWI.

c. Black powder loaded blank and relating charges.

(D.T.) Disassemble with APE; incinerate black powder in an upgraded/modified EWI and incinerate blanks in an upgraded/modified APE 1236.

d. Bulk packed propellants, time blasting fuze, black powder, and miscellaneous other propellants.

(D.T.) This category has a lot of different items; usually does not need disassembly. Incinerate in an upgraded/modified EWI.

13 Inert consists of inert loaded items.

(D.T.) This is a catch-all type of a family. Dissassembly is needed, remove cartridge case. Incinerate propellant in an upgraded/modified EWI.

14 Items which cannot be homogeneously grouped.

These are nonhomogenous items. Presently there is no capability to dispose of them.

15 No family items (Misc.).

APPENDIX D

DEMILITARIZATION TECHNOLOGY OF CONVENTIONAL MUNITIONS AND AMMUNITION PECULIAR EQUIPMENT

D.1 DEMILITARIZATION TECHNOLOGY OF CONVENTIONAL MUNITIONS

The inventory of obsolete and unusable conventional munitions are grouped into 14 consolidated families (each family is divided into subfamilies) by the Army Defense Ammunition Center and School (USADACS). Existing and emerging technologies as well as ammunition peculiar equipment that would be applicable for the demilitarization of conventional ammunitions (excluding open burning/open detonation) are summarized below (USADACS, Vol. II and III, 1990):

Existing Technologies

1. Washout:

a. Hot water APE 1300, used to remove binary explosives from munitions.
Applications: Bombs, projectiles, mines, and rocket warheads.
Capacity; Approximately 1400 pounds/hour.
Development status; There are 14 systems installed; however, only two are currently operational.

b. High pressure (waterjet) • 10,000 psig, used to cut/remove propellant from munitions.
Application: Propellants containing AP, HMX, and Catocene.
Capacity: Approximately 1000 pounds/hour.
Development status: Currently the facility is undergoing renovation, Thiokol Corporation proposes to process Minuteman and Caster motors.

c. High pressure (water jet), used to remove propellant.
Application: Minuteman second stage missile motors.
Capacity: One missile motor/l6 hours of 1000 pounds of propellant/hour.
Development status: The facility is currently operating (The Aerojet Solid Propulsion Company).

d. High pressure (water jet), used to remove two types of nonmeltable explosives (A-3 and Explosive D).
Application: Explosive A-3 and explosive D from medium and major caliber gun ammunition items.
Canacitv: One large projectile at a time.
Development status: The equipment at WADF is in layway.

2. Meltout

a. Autoclave, used to remove and recover meltable main charge explosives.
Application: Small to moderate size items (gun ammunition, rocket warheads, depth charges, mortar cartridges).
Canacitv: Varies, based on item size.
DeveloDment status; The equipment at WADF is in layway.

b. Autoclave, used to meltout explosives.
Application: Projectiles and bombs up to 500 pounds.
Caoacitv: 90mm projectiles up to 500 pound bombs.
Development status: The autoclaves at Ravenna Arsenal Inc., Ravenna, OH are operational (12 out of 16).

c. Steam out, used to remove/reuse explosives.
Application: Explosive filled items which have been cast with a TNT-based explosive (i.e., bombs, warheads, mines, torpedoes, and projectiles).
Caoacitv; 4000 pounds of reclaimed explosives/8 hours for large items and 1500 pounds/8 hours for small items.
Development status: Crane Army Ammunition Activity (CAAA), Crane IN, has successfully reclaimed reused explosives and hardware.

d. Steam out, used at WADF to remove and recover cast-loaded explosives.
Application: Large ammunition items (bombs, underwater mines, and other large items).
Capacity: 7900 pounds of TNT-type/S hours.
Development status: Equipment at WADF is in layway.

3. Reclamation

a. Solvation (Class 1.3 propellant), is a propellant thermal processor system used to recover about 95 percent of the AP in Class 1.3 propellant.
Application: 1.3 propellant, needs RCRA permit to process contaminated wastes, chlorinated solvents, AP waste water, and hazardous and toxic solid and liquid organics.
Canacitv; 3,000,000 pounds of propellant/year, can be scaled up to 10,000,000 pounds/year.
Development status: Currently ready at Aerojet Central Waste Management Group (Sacremento, CA).

b. White phosphorus to H_3PO_4 conversion.
Aoolication; WP filled munitions.
Caoacitv; 11520 pounds of WP/day converted to 48,000 pounds of 75 percent concentration H_3PO_4 in a 24 hour period.
Development status; Full-scale operation at U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Crane Army Ammunition Activity (CAAA), Crane, IN.

4. Controlled Incineration

a. Deactivation furnace - APE 1236.
Application; Small arms ammunitions, primers,fuzes, boosters and detonators; to flush 75mm through 120mm projectiles after washout of explosive charge; to deactivate drained chemical bombs, rockets, grenades, and other miscellaneous items.

Capacity; Varied, based on item and rotation speed.
Development status; Fully operational, being upgraded to comply with the environmental laws. The upgrade of 14 APE 1236 has been funded.

b. Deactivation Furnace - modified APE 1236.
Application; Grenades, fuzes, hardware (shredded) from pyrotechnics, WP, riot, HC, and colored smoke munitions, and small explosives items (PBA has a self-imposed restriction not to exceed 600 grains (7000 grains per pound) of confined explosives per section in their furnace).
Canacitv: Varied feed rates. As an example: 254-330 grenades/hour.
Development status: PBA is currently processing a hydro-sonic scrubbing system to comply with RCRA.

c. Rotary Furnace System APE 2210. One of the two furnaces at WADF is used to deactivate small items equipped with lead projectiles and the other furnace is used to deactivate large detonating items equipped with non-lead projectiles.
Application; Small arms ammunition, primer, fuzes, boosters, and detonators.
Caoacitv; The rotation speeds and feed rates for upgraded systems have not been established yet.
Development status: The PAS is being upgraded to meet current RCRA requirements.

d. Explosive Waste Incinerator (similar to APE 1236) with different feed mechanism.

ADDlication; Bulk enrgetic material disposal only.
CaDacitv; 2.5 pounds/container of Composition B or 300 pounds/hour.
Development status; At present, there are several incinerators available for use, however, there are no funds to upgrade them.

e. Contaminated Waste Processor. The CWP is a car bottom incinerator which has a moveable hearth and there are two sizes.
ADDlication; Waste material that has been lightly contaminated with energetic materials.
Capacity: The small unit has 300 pounds/hour throughput rate and the large unit has a 600 pound/hour throughput rate.
Development status; 6 CWPs are currently in operation.

f. Static Incinerator, used at PBA and it is a CBI with a central afterburner.
ADDlication: Flash large metal parts (can accomodate at least two 4' x 4' x 4' pallets of material) and smoke pots.
CaDacitv; To be determined.
Development status: The system was installed at PBA and is being upgraded with a hydro-sonic scrubber.

g. Flashing Furnace System, used at WADF to heat moderate size processed ammunition items.
Application: To decontaminate metal parts from residual energetic material by heat flashing.
CaDacitv; Sequentially can process four skids of metal parts with discharge rate of one skid every 75 minutes.
DeveloDment status: The system is operational.

h. Static Firing of Large Rocket Motors (LRM)

Application: Pershing 1A and II Solid Rocket Motors.
CaDacitv; Six motors/day of the Pershing IA, less than six motors/day of the Pershing II.
DeveloDment status; Longhorn Army Ammunition plant at Marshall TX is using two of six test firing stands. Static firing is performed by the Thiokol Corporation.

i. Rotary Kiln and refractory lined, used at WADF and is equipped with an afterburner.
ADDlication: Burn explosive materials in a slurry form, process pink water.
Capacity: 550 pounds of energetic material/hour/incinerator.
DeveloDment status; Two rotary kilns are operational at WADF.

j. Rotary Kiln, The Environment Systems Company, Eldorado, AR, operates a Hazardous Waste Disposal Facility on a commercial basis. They operate a Fixed System and a modular transportable system which is equipped with a PAS.

Application; To process PCBs contaminated waste and treatment of shredded solids.
Capacity; 3700 pounds/hour of PCBs or 120,000,000 pounds/year of mixed wastes.
Development status: The facility is operational on a 24-hours/day, 7 days/week basis.

k. Chain Grate Incinerator (CGI), used for dunnage and can accept a full pallet of material (4 ft^3).

Application: Scrap metal, dunnage, contaminated packing material, and munitions hardware.
Capacity; Unknown.
Development status; PBA is processing a hydro-sonic scrubber to comply with RCRA.

1. Not used.

m. Air Curtain Pit Burner (ACPB), used at PBA and it is 20 feet long and 13 feet deep.

Application; Size reduction.
Capacity: ~-10 tons/hour of mixed material.
Development status; Available and can be purchased commercially.

n. Fluidized Bed Incinerator (FBI), used at PBA and the bed media is 8 feet, expanded height, of silica sand.

Application: Smokes and dyes in liquid, slurry and in solid form (solids not to exceed l-inch in diameter in particle size). No metal parts are to be processed in FBI.
Capacity; Varied feed rates. (e.g., 300 pounds/hour of Riot Agent CS or 3 gallons/minute decon solution and water).
Development status: PBA is currently procuring a hydro-sonic scrubbing system to comply with RCRA.

o. Circulating Bed Cornbuster used to thermally treat hazardous waste, developed by Ogden Environmental Services, Inc. It is an evolution of the FBI technology.

Application: PCB contaminated soil, various petroleum hydrocarbons. It can also process solids, sludges and liquids.
Caoacitv: Maximum 100-150 tons/day with a 10-20 percent moisture content.

5. Disassembly

a. Waterjet Abrasive Cutting used to cut remotely mild steel 3/4" thick of munitions.

Application: All munitions that can be rendered safe by severing activation device (fuze) from explosives. Such as 105mm projectile.
Caoacitv: Unknown.
DeveloDment status; The Office of the Program Manager for Ammunitions Logistics, Picatinny Arsenal, NJ is currently optimizing the design.

b. Waterjet Abrasive Cutting uses active high pressure water up to 55,000 psi.

Aoolication: To cut a variety of nonmetallic materials. In order to cut metallic or hard materials, add abrasives such as garnet or aluminum oxide to the water jet.
Caoacitv; Varies.
DeveloDment status: A wide assortment of equipment is available off the shelf. The Flow International Corporation, Kent, WA is a world leader in ultra-high pressure water jets.

6. Electrochemical Reduction - Lead Azide Process, used to eliminate the immediate threat of initiation of the explosive.

Aoolication; Lead azide or other fillers that contain a metal that can be dissolved in a electrolyte and electrolyticly plated out.
Capacity: 25 pounds/hour.
DeveloDment status: This process was proven at Iowa Army Ammunitions plant and Savanna Army Depot.

7. Chemical Conversion - FS disposal, used to dispose of fillers by neutralization.

Application: Any acidic or basic chemical filler such as bulk FS smoke mixture.
Caoacitv; Varies.

Development status: Development complete.

8. Detonation Chamber. This is a 6-foot diameter steel sphere similar to the bangbox.

Application: Confined detonation of explosives; 25 pounds in vacuum and 100 pounds/hour when a heat sink (coke) is added in the sphere.
Capacity: Two shoots/day.
Development status: Operational at The Systems, Science, and Software (S-cubed), Green Farm Test Site, La Jolla, CA.

D.2 AMMUNITION PECULIAR EQUIPMENT

Ammunition Peculiar Equipment associated with conventional demilitarization is designed and built to accomplish a specific task such as breakdown, disassembly, or defuzing. The following is a list of some of this equipment (USADACS, Vol. III, 1990):

- APE 2001M1 20mm Breakdown Machine is used to break apart 20mm cartridges and separate the components.
- APE 7033 Navy 20mm Disassembly Machine is used to separate Navy 20mm projectiles from the cartridge case and dump the propellant.
- APE 1028 Vacuum Collection System was developed to convey propellant from maintenance operations to a powder collection building.
- APE 1055M2 Fire Control Panel is designed to provide a safe and convenient control of detonation operations from a single panel controlling seven separate blasting areas.
- APE 2170 Cartridge Case Cutoff Machine is used to cut combustible cartridge cases to separate them from 152mm projectiles.
- APE 1208 Vertical Debanding Machine is used to remove rotating bands from 37mm through 106mm projectiles.
- APE 1212M1 Debanding Machine 120mm through 280mm Projectiles is used to remove the rotating bands from 120mm through 280mm projectiles.
- APE 1042M3 Debanding Machine was developed to remove rotating bands from 57mm through 155mm projectiles.
- APE 1061 Dust and TNT Collector is used to collect air entrained TNT dusts.
- APE 2175 Projectile Saw Machine is used to saw high explosive loaded projectiles for demil ranging in size from 75mm to 120mm.
- APE 2169 Windshield Cap Removal and Continuity Test Equipment is used to perform two operations on two 152mm projectiles or cartridges at the same time. The machine removes the windshield cap and power supply from a projectile or cartridge.

- APE 2196 Small Items Shear Machine is used to punch holes in explosive items to facilitate better control of demil in the APE 1236 deactivation furnace.

- APE 1300M1 Explosive Washout Plant is used to wash explosives out of bombs, projectiles, mines, and warheads, and to reclaim the explosives.

- APE 1328 Explosive Disposal Trailer was designed to safely transport explosive wastes generated in the Explosive Washout Plant, APE 1300, to the burning grounds for disposal.

- APE 2219 Demilitarization of Ml80 Demolition Kit Tool Set is designed for specific rocket motor disassembly operations.

- APE 2160 M605 Mine Fuze Assembly and Disassembly Machine is used to assemble and torque and to disassemble the loading assembly from the head assembly of M605 mine fuzes.

- APE 2153 Centering Band Cutter is used to cut the plastic centering band from M392A2 (L 36A1) 105mm APDS-T projectiles.

- APE 1099 Hand Operated Eight Round Declipper is used to remove caliber .30 and 7.62mm cartridges from eight round clips by hand operation.

- APE 7066 8"/55 and 16"/50 Projectile Defuzing Machine is used to remove base fuzes, nose fuzes, and an auxiliary adapter, from 8"/55 and 16"/50 Navy projectiles.

- APE 1202M1 Hand Grenade Defuzing Machine is used to remove fuzes from hand grenades in a shielded operation.

- APE 1011M5 Backout Depriming Machine was designed to mechanically *remove* screw-type primers from cartridge cases.

- APE 1925M1: M118 and 4.2" M335 Disassembly Equipment is used to push the base from the 155mm: M118 illuminating projectile and 4.2-inch mortar allowing removal of the parachute and illuminating canister for renovation or inspection.

- APE 2099 3.5 Inch Rocket, WP Disassembly Machine is used to remotely disassemble 3.5 inch White Phosphorus rockets with an automatic or emergency dump chute.

- APE 1043 Deep Cavity Pneumatic Drill was developed to drill explosives from the nose end of artillery projectiles to a predetermined depth.

- APE 1504 Stuck Supplementary Charge Drill is used to remove stuck supplementary charges from 155mm, 4.2", 175mm, and 8-inch projectiles.

- APE 2040 Ignition Cartridge Removal Fixture is used to remove ignition cartridges from Ml49 and Ml70 fin assemblies of M374 series HE and M375 series smoke 81mm mortar ammunition.

- APE 1148 Primer Removal and Insertion Fixture is used to assemble or disassemble M32, M34, or M71 screw type primers from the fin assemblies of 60mm and 81mm mortar ammunition by hand operation.

- APE 2140 20mm Link-Delink Machine is used to link or delink 20mm cartridges with M12, M14, or Ml7 links.

- APE 2197 Deprime Machine is used to remove screw-type primers from Navy 3"/50 through 8-inch and Army 105mm and 120mm cartridge cases prior to cartridge case salvage and remove press primers form cases to be reused.

- APE 1224 Shape Charge Munitions Disassembly Machine is used to disassemble for modification, renovation, or demilitarization, the projectile (with shaped charge) of 75mm through 105mm HEAT cartridges.

- APE 1210 155mm M116, 4.5" WHD RKT Diasassembly Machine is used to remove the base plate from 155mm M116 HC smoke projectiles and the warhead from 4.5" rocket.

- APE 1118M2 Fuze Disassembly Machine is used to remove the booster assembly, from bomb, artillery, and mortar fuzes.

- APE 2156 Hand Grenade Defuzing Machine is used to remove grenade fuzes at a high production rate.

- APE 7040 Medium Caliber Defuze-Deplug Machine is designed to remove fuzes, plugs, and adapters from the nose or base of medium caliber projectiles in a remote operation that can permit loading of projectiles onto the machine manually or robotically.

- APE 1106M1 Prime and Deprime Machine is used to deprime 37mm through 106mm cartridge cases with screw and press type primers prior to cartridge case salvage.

- APE 2203 Prime-Deprime, Screw Type Primer Machine mechanically removes and assembles screw type primers from cartridge cases.

- APE 1215M1 Rocket Disassembly Machine is used to disassemble 3.5-inch and 66mm rockets.

- APE 1206 Three-spindle Disassembly Machine is used for screw type disassembly operations such as removing boosters from fuzes.

- APE 1153M1 Vertical Disassembly Machine is used to disassemble fuzes from cartridges.

- APE 1222 Ignition Cartridge and Primer Remover is used to remove M32 and M34 percussion primers and M5A1 and M8 ignition cartridges from 81mm, M43A1 mortar cartridges and 60mm, M49A2 cartridges.

- APE 1240 Motor from Warhead Separator is used to remove warheads from rocket motor on 115mm: M55 and 4.5-inch: M32 rockets.

- APE 7023M1 Navy Projectile Vise is used to hold 3"/50, 5", and 6" projectiles while performing various assembly and disassembly operations,

- APE 1247 Pneumatic Fuze Wrench is used to assemble and disassemble standard contour artillery fuzes from artillery projectiles.

DCN 5860
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APPENDIX E

CALCULATIONS

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APPENDIX E

CALCULATIONS

E.1 FEED RATES

Non-stockpile chemical munitions cannot be processed at the design rates for the stockpile because this inventory is likely to contain non-standard sizes and identification of the contents will delay processing. For the purpose of estimating operating costs, we assumed that non-stockpile munitions would be processed at plants using "base line" (i.e., JACADS) technology *at* a rate of 4 items/hour. Since *the* CIDP can handle a variety of different sizes with less difficulty, we assumed a rate of 20 items/hour for that process.

The processing rates for other feed materials was estimated from the furnace capacities at each facility. The calculations of furnace system capacities are based on the information given in tables E-l and E-2. The results of the calculations of feed rate are given in table E-3. The feed rate of each type of material at each facility is summarized in table E-4 and fuel consumption is summarized in table E-5.

E.1.1 Deactivation Furnace System (DFS)

Burner capacity estimated from the design combustion gas flow rate, assuming natural gas fuel and 100 percent excess air:

$$CH_4 + 4\ O2 + 15.04\ N2 \rightarrow CO2 + 2\ H20 + 15.04\ N2 + 2\ 02$$

$$\text{At JACADS, kiln burner capacity} = \frac{35.600\ ft^3/min}{20.04\ \text{mole gas/mole } CH_4} \times \frac{520°F}{2260°F}$$

$$\times \frac{60\ \text{min/hr} \times 16\ \text{lb/mole } CH_4 \times 23.861\ \text{Btu/lb}}{379\ ft^3/\text{mole}} = 24.7 \times 10^6\ \text{Btu/hr}$$

$$\text{At TEAD, kiln capacity} = \frac{36.500\ ft^3/min}{20.04\ \text{mole gas/mole } CH_4} \times \frac{520°F}{2260°F} \times \frac{16\ \text{lb/mole CH4}}{379\ ft^3/\text{mole}}$$

$$\times \frac{12.3\ \text{psia}}{14.73\ \text{psia}} \times 60\ \text{min/hr} \times 23{,}861\ \text{Btu/lb} = 21.2 \times 10^6\ \text{Btu/hr}$$

'Similarly, the afterburner capacity is calculated to be 10.9 X 10^6 Btu/hr and 16.5 X 10^6 Btu/hr for JACADS and TEAD, respectively.

Table E-l. Design Information Used to Calculate Feed Rates

	APE1236	CAMDS	CSDP/ TEAD	JACADS	CIDP
Atmospheric pressure, psia	14.7	12.3	12.3	14.7	12.3
A. Deactivation Furnace System					
(Rotary kiln)					
Internal diameter, ft	2.5	3.63	4.75	5	6
Length, ft	20	30	30	30	70
Design feed rate, rockets/hr			40	46.1	
Expected feed rate, rockets/hour		25		38[b]	
Explosives feed rate, lb/hr			120		
Small arms feed rate, lb/hr	1000[c]				
Smokes/dyes feed rate, lb/hr	1000[c]				
Combustion gas, 1,000 ACFM			36.5	35.6	
Exit temperature, °F			1800	1800	
(Afterburner)					
Combustion gas, 1000 ACFM			76.3	55.9	
Exit temp., °F			2200	2000	
B. Lisuid Incinerator					
(Both primary and secondary)					
Burner capacity, MMBtu/hr			21a	20	
GB incineration rate, lb/hr		300	875[a]	1050	
Decon solution rate, lb/hr		760	2000a	2400	
C. Metal Parts Furnace					
(Primary)					
Burner capacity, MMBtu/hr			14.8	14.8	
Feed, empty ton containers/hr			1.72	1.72	
(Secondary)					
Burner capacity, MMBtu/hr			8.48	8.48	
D. Dunnage Furnace					
(Primary)					
Burner capacity, MMBtu/hr			2.3	2.3	
Target Feed rate, wood, lb/hr			833	1000	
(Secondary)					
Burner capacity, MMBtu/hr			1.2	1.2	

[a]TEAD only. The LIC design values at all CSDP plants other than TEAD are the same as for JACADS.
[b]Maximum feed rate achieved to date at JACADS.
[c]Approximate rate; varies with type of munition.

Table E-2. Other Information Used in Calculations

Rocket components:	Pounds
Propellant	19.3
Explosive (Comp.B)	3.2
Total	57
Empty ton container	1,600

	Heating Value. Btu/lb
Natural gas (HHV)	23,861
GB	10,073
Propellant	1,760
Explosive Comp. B	5,265
Wood	8,600
Xylenes	18,450
Tricholorethane	2,880
DS2	15,700

Table E-3. **Feed Rates for Each Furnace**

	Feed Rates (lb/hr)										
					Agent			Solvent			
	Propellant	Explosive	Small Arms	Smokes & Dyes	Cont. Metal	Soil[a]	Sludge[b]	Xylenes	DS2[c]	TCE[d]	Wood
CAMDS											
DFS	720	92	1450	3160		1000	350				
LIC								160	190	760	
MPF											
TDI					1400	815	290			300	
JACADS											
DFS	1100	126	2000	6000		2700	950				
MPF					2750	800					
DUN											1000
CSDP at TEAD											
DFS	950	120	1900	5420		2300	815				
LIC								480	560	2000	
MPF					2750	800	570				
DUN											833
CSDP at Other Sites											
DFS	950	120	1900	5420		2300	815				
LIC								570	670	2400	
MPF					2750	800	570				
DUN											1000
CIDP											
DFS	1320	152	2400	20160		5200	3690				

[a]5 percent moisture content.
[b]50 percent moisture content.
[c]DS2 is a solution containing 70 percent amine, 28 percent glycol, and 2 percent NaOH.
[d]Trichloroethane.

Table E-4. Feed Rates Used for Cost Calculations

Feedstock	Furnace	Feed Rate (lb/hour) CAMDS	JACADS	CSDP	CIDP
Conventional Munitions					
Small Arms	DFS	1450		1900	2400
Smokes & Dyes	DFS	3160		5420	20160
Large Munitions	DFS/MPF	920[a]		1200b	1520[c]
Bulk Propellant	DFS	720		950	1320
Bulk Explosive	DFS	92		120	152
Agent Contaminated					
Soil	DFS	1000		2300	10400
Soil	MPF	407		800	
Metal	MPF	1400		2750	
Hazardous Contaminated					
Soil	DFS	1000	2700	2300	10400
Soil	MPF	407	800	800	
Sludge	DFS	350		815	3690
Sludge	MPF	145		285	
Solvents					
Xylenes	LIC	160		570d	
DS2	LIC	190		670[e]	
TCE	LIC	760		2400[f]	
Dunnage					
Non-hazardous wastes	DUN	300	1000	1000[g]	
		Feed Rate (munitions/hour)			
Non-stockpile chemical munitions	All	4		4	20

"Feed rate ranges from 370 to 2300 lb/hr.
[b]Feed rate ranges from 480 to 3000 lb/hr.
[c]Feed rate ranges from 610 to 3800 lb/hr.
[d]The rate at TEAD is 960 lb/hr and the rate at UMDA and NAAP is 1140.
[e]The rate at TEAD is 1120 lb/hr and the rate at UMDA and NAAP is 1340.
[f]The rate at TEAD is 4000 lb/hr and the rate at UMDA and NAAP is 4800.
[g]The rate at TEAD is 833 lb/hr.

Table E-5. Fuel Consumption

	Fuel Consumption (Millions of Btu/day)
CAMDS	
DFS	470 - 560[a]
LIC	45 - 170[a]
MPF	560
TDI	80
Boilers	170
CSDP	
DFS	760 - 900a
LIC	130 - 500a
MPF	560
DUN	80
Boilers	520
JACADS	
DFS	720 - 850[a]
LIC	90 - 480[a]
MPF	560
DUN	80
Boilers	520
CIDP	
DFS	2450 - 2900[a]
Boilers	520

[a]The lower value is the expected fuel consumption when the furnace is operated at the design feed rate for agent or materials with equivalent heating value. Fuel is cut back when the feed supplies heat. The higher value is the design burner capacity.

Propellant Feed Rate

The feed rate for bulk conventional munitions consisting of propellant was calculated on the basis of the feed rate for rockets, which contain both propellant and explosive, assuming that the rate is limited by the amount of heat evolved in burning the energetic materials.

At JACADS, a feed rate of 38 rockets/hour can be achieved.

Heat evolution = 38 rockets/hr X (19.3 lb propellant/rocket X 1,760 Btu/lb + 3.2 lb Comp. B X 5,265 Btu/lb) = 1,931,000 Btu/hr

$$\text{Propellant feed rate} - \frac{1.931.000 \text{ Btu/hr}}{1,760 \text{ Btu/lb}} - 1,100 \text{ lb/hr}$$

At CSDP, assuming rates are proportional to design rates for rockets,

$$\text{Propellant feed rate} - 1,100 \text{ lb/hr} \times \frac{40 \text{ rockets/hr}}{46.1 \text{ rockets/hr}} - 950 \text{ lb/hr}$$

Assuming rates are proportional to maximum rates achieved,

$$\text{Feed rate at CAMDS} - 1,100 \text{ lb/hr} \times \frac{25 \text{ rockets/hr}}{38 \text{ rockets/hr}} - 720 \text{ lb/hr}$$

Assuming rates are proportional to kiln diameter,

$$\text{Feed rate at CIDP} - 1,100 \text{ lb/hr} \times \frac{6 \text{ ft}}{5 \text{ ft}} - 1,320 \text{ lb/hr}$$

Unconfined Explosives Feed Rate

Feed rate is limited by the amount of explosive allowed in each flight of the kiln. Since the limitation on feed rate is based on the allowable amount of explosive per flight, we would expect the amount allowed to increase in proportion to the distance between the top and the bottom of the kiln, assuming that the height of the flights were proportional to the diameter.

At CSDP, feed rate - 120 lb/hr (given).

At JACADS, feed rate - 120 lb/hr X 5/4.75 - 126 lb/hr.

At CAMDS, feed rate = 120 lb/hr X 3.63/4.75 - 92 lb/hr.

At CIDP, feed rate - 120 lb/hr X 6/4.75 - 152 lb/hr.

These are the feed rates for bulk items consisting of explosives. The feed rate of large conventional munitions containing explosives was calculated on the assumption that the amount of explosive in each munition

would be the rate-limiting factor. There is a large variation in the amount of explosive in these munitions. For a typical munition, the total weight of the munition may be 10 times that of the explosive. We estimate that 90 percent of these munitions will vary from about 4 percent explosive content to about 25 percent. Thus, we have estimated the feed rate for large munitions on the basis of a 10 percent explosive content, with a range from 4 percent to 25 percent.

Small Arms Feed Rate

Assuming that feed rates are proportional to kiln diameter,

At APE 1236, feed rate = 1,000 lb/hr (given).

At CSDP, feed rate - 1,000 X 4.75/2.5 - 1900 lb/hr.

At JACADS, feed rate - 1,000 lb/hr X 5/2.5 - 2000 lb/hr.

At CAMDS, feed rate = 1,000 lb/hr X 3.63/2.5 - 1450 lb/hr.

At CIDP, feed rate = 1,000 lb/hr X 6/2.5 = 2400 lb/hr.

Smokes and Dyes Feed Rate

Since the limit on feed rates for smokes and dyes is the heat evolved in their destruction, we expect the feed rates to be proportional to the kiln volume.

At APE 1236, feed rate = 1,000 lb/hr (given).

At CSDP, feed rate = $1{,}000 \times \frac{4.75^2 \times 30}{2.5^2 \times 20} = 5{,}420$ lb/hr.

At JACADS, feed rate - $1{,}000 \text{ lb/hr} \times \frac{5^2 \times 30}{2.5^2 \times 20}$ - 6,000 lb/hr.

At CAMDS, feed rate - $1{,}000 \text{ lb/hr} \times \frac{3.63^2 \times 30}{2.5^2 \times 20}$ - 3,160 lb/hr.

At CIDP, feed rate - $1{,}000 \text{ lb/hr} \times \frac{6^2 \times 70}{2.5^2}$ - 20,160 lb/hr.

Soil Feed Rate

An 8' diameter (excluding refractory) X 30' kiln with 12 " thick refractory can volatilize contaminants from 7,900 lb/hr of soil (5 percent

moisture content) at 1600°F (Brunner, 1988, p. 223). Assuming that the rate is proportional to the kiln volume (using the inside diameter) and that 9" thick refractory is installed in the kilns:

At CSDP, feed rate = 7,900 lb/hr X $\frac{(4.75 - 1.5)^2}{(8 - 2)^2}$ = 2,300 lb/hr.

At JACADS, feed rate = 7,900 lb/hr X $\frac{(5 - 1.5)^2}{(8 - 2)^2}$ = 2,700 lb/hr.

At CAMDS, feed rate = 7,900 lb/hr X $\frac{(3.63 - 1.5)^2}{(8 - 2)^2}$ = 1,000 lb/hr.

At CIDP, feed rate = 7,900 lb/hr X $\frac{(6 - 1.5)^2 \text{ X } 70}{(8 - 2)^2 \text{ X } 30}$ = 10,400 lb/hr.

(This assumes that the rotation speed of the large diameter CIDP kiln can be increased to take advantage of its length.) Note also that 9" thick refractory may not be an optimum amount. A detailed analysis must be performed to balance the loss of fuel efficiency caused by reducing the refractory and the loss of throughput caused by increasing the refractory. Another concern is that the temperature may not be able to be maintained hot enough without sufficient refractory. Again, it requires a detailed study to determine the appropriate amount of refractory. As a bound, if we assume that no refractory is needed and that the fuel consumption doubles because of the reduction in fuel efficiency, the O&M costs for soils are roughly half those given in table E-14.

Sludge Feed Rate

An 8' diam. X 30' kiln with 12" thick refractory can volatilize contaminants from 2,800 lb/hr of sludge (50 percent moisture) at 1600°F (extrapolated from chart in Brunner, 1988, p. 223). The rates calculated earlier for soil containing 5 percent moisture are multiplied by 2,800/7,900 to obtain the following feed rates:

Location of DFS	Feed Rate (lb/hr) Soil	Sludge
CSDP	2,300	815
JACADS	2,700	950
CAMDS	1,000	350
CIDP	10,400	3,690

As with soils, the 9" refractory may not be the optimum value. For a bounding analysis, we can assume that no refractory is required and that fuel consumption is doubled because of the reduction in fuel efficiency. This makes the O&M costs approximately half of those shown in table E-14.

E.1.2 Liquid Incinerator

For solvents with a high heating value, the feed rate is assumed to be inversely proportional to the heat of combustion, using the design rate for GB as a basis. For solvents with a low heating value, the maximum rate is assumed not to exceed the design rate for addition of decon solution.

Xylenes Feed Rate

GB feed rates: 875 $\frac{lb}{hr}$, 1,050 $\frac{lb}{hr}$, 300 $\frac{lb}{hr}$ for TEAD, CSDP, and CAMDS, respectively.

$$\text{Feed Rate} = \frac{10.073}{18,450} \times 875 \text{ lb/hr} = 480 \text{ lb/hr at TEAD CSDP}$$

$$\times 1,050 \text{ lb/hr} = 570 \text{ lb/hr at other CSDP sites}$$

$$\times 300 \text{ lb/hr} = 160 \text{ lb/hr at CAMDS}$$

DS2 Feed Rate

$$\text{Feed Rate} = \frac{10,073}{15,700} \times 875 \text{ lb/hr} = 560 \text{ lb/hr at TEAD CSDP}$$

$$\times 1,050 \text{ lb/hr} = 670 \text{ lb/hr at other CSDP sites}$$

$$\times 300 \text{ lb/hr} = 190 \text{ lb/hr at CAMDS}$$

Trichloroethane Feed Rate

Feed Rate = 2,000 lb/hr (decon solution rate) at TEAD CSDP
2,400 lb/hr at other CSDP sites
760 lb/hr at CAMDS

E.1.3 Metal Parts Furnace

Agent Contaminated Metal Feed Rate

At JACADS and CSDP,
Feed Rate = 1.72 containers/hr X 1,600 lb/container = 2750 lb/hr

At CAMDS,
Feed Rate = 1,400 lb/hr (Niskala, Nov. 1990).

Soil Feed Rate

At JACADS and CSDP, the two factors that affect the soil feed rate are (1) the relative burner capacities of the DFS and MPF and (2) the fact that the soil will have to be put through the MPF twice to compensate for the

lack of mixing in the MPF. Therefore, we calculate the capacity of MPF as directly proportional to the burner capacity, based on the capacity of the CSDP kiln, and then divide by two to account for feeding the soil through the MPF twice.

At JACADS and CSDP,

$$\text{Feed Rate} = \frac{14.8 \times 10^6 \text{ Btu/hr}}{21.2 \times 10^6 \text{ Btu/hr}} \times 2{,}300 \text{ lb/hr} \times 1/2 = 800 \text{ lb/hr}$$

At CAMDS, assume capacity for handling soil is proportional to the capacity for handling metal parts in the CAMDS and CSDP metal parts furnaces.

At CAMDS,

$$\text{Feed Rate} = 800 \text{ lb/hr soil (at CSDP)} \times \frac{1{,}400 \text{ lb metal/hr (at CAMDS)}}{2{,}750 \text{ lb metal/hr (at CSDP)}}$$

$$= 407 \text{ lb/hr}$$

Sludge Feed Rate

The calculations for sludge are performed similarly to those for soil.

At JACADS and CSDP,

$$\text{Feed Rate} = \frac{14.8 \times 10^6 \text{ Btu/hr}}{21.2 \times 10^6 \text{ Btu/hr}} \times 815 \text{ lb/hr} \times 1/2 = 285 \text{ lb/hr}$$

At CAMDS,

$$\text{Feed Rate} = 285 \text{ lb/hr (at CSDP)} \times \frac{407 \text{ lb/hr soil (at CAMDS)}}{800 \text{ lb/hr soil (at CSDP)}} = 145 \text{ lb/hr}$$

E.1.4 Dunnage Incinerator

Assume feed rate of 1,000 lb/hr for JACADS.

Assume feed rate of 1,000 lb/hr for CSDP.

Assume feed rate of 300 lb/hr for CAMDS.

E.2 OPERATING AND MAINTENANCE COST

Operating and maintenance (O&M) cost includes the cost of fuel (section E.2.1), labor cost (section E.2.2), supplies and chemicals (section E.2.3), and utilities (section E.2.4). Each of these costs are given for the CSDP, CIDP and JACADS facilities in terms of S/ton of feed for each type of feed material or, in the case of chemcial munitions, in terms of $/munition. O&M cost for CAMDS could not be calculated in detail because the necessary

information was not available. The cost of operating the CAMDS facility is given only in terms of the total O&M cost for each type of feed material (section E.2.5).

E.2.1 Cost of Fuel

The cost of fuel per unit of feed material was calculated using the feed rates given in table E-4 and the fuel consumption rates given in table E-5 (these costs are presented in table E-6). The cost of fuel was assumed to be $4.00/million Btu. The current (1989) price for natural gas at the eight CONUS sites ranges from approximately $2.64/million Btu at Tooele to $4.68 at Anniston. The median price, adjusted to FY 1991 values, is about $4.00/million Btu.

The fuel consumption is the sum of the fuel used in the furnace(s) required for each operation plus the fuel used in the boilers. The fuel requirement for the boilers is based on the amount of steam required by the BRA evaporator and dryers, assuming an 85 percent boiler efficiency.

$$\text{Cost of fuel} = \frac{\text{Fuel consumption (millions of Btu/day)} \times \$4/\text{million Btu}}{\text{Feed rate (lb/hr)} \times 24\ \text{hr/day} \times 5 \times 10^{-4}\ \text{ton/lb}}$$

$$= \$/\text{ton of feed}$$

In the case of the LIC and the DFS, it was assumed that the maximum fuel rate is used 10 percent of the time (e.g., during start-up) and the lower rate 90 percent of the time for feed materials with high heating value (agent, energetic material, xylenes, or DS2). The maximum fuel rate was used for materials with low heating value (TCE, soil, or sludge). The results are given in table E-6.

E.2.2 Cost of Labor

Labor requirements for the operation of the CSDP plants and JACADS were based on the staffing plan for the TEAD plant prepared by PM Cml Demil (Thomas, 1990). We assumed that the staff required to operate the plant when destroying non-stockpile chemical munitions would be the same as that required by the staffing plan. The staffing required for other "future use" operations was estimated by reducing the number of personnel as appropriate. The results of these estimates *are* given in table E-7. We would expect that the number of QA/QC personnel could be reduced when processing conventional munitions, and reduced even further (to one inspector per shift and a supervisor) when processing other materials, such as hazardous substances or soil suspected of being contaminated with agent. Similarly, fewer safety and environmental personnel would be required for these operations. No surety technicians would be required for non-agent operations. The number of plant operators could be reduced

Table E-6. Cost of Fuel

Feedstock	Furnace	Fuel Cost ($/Ton of Feed) CAMDS	JACADS	CSDP	CIDP
Conventional Munitions					
Small Arms	DFS	160		240	450
Smokes & Dyes	DFS	70		85	55
Large Munitions	DFS/MPF	460[a]		540[b]	710[c]
Bulk Propellant	DFS	320		480	820
Bulk Explosive	DFS	2520		3800	7150
Agent Contaminated					
Soil	DFS	240		210	110
Soil	MPF			460	
Metal	MPF			130	
Hazardous Contaminated					
Soil	DFS	240	170	210	110
Soil	MPF		460[d]	460	
Sludge	DFS	700		580	310
Sludge	MPF			1260	
Solvents					
Xylenes	LIC	480		410[e]	
DS2	LIC	410		350[f]	
TCE	LIC	150		140[g]	
Dunnage					
Non-hazardous wastes	DUN		10	10	
		Fuel Cost ($/Munition)			
Non-stockpile chemical munitions	All	60		90	30

[a]Fuel cost ranges from $180 to $1130/ton.
[b]Fuel cost ranges from $210 to $1340/ton.
[c]Fuel cost ranges from $290 to $1760/ton.
[d]If DFS and MPF are both used, cost is $300/ton.
[e]Fuel cost at TEAD is $490/ton.
[f]Fuel cost at TEAD is $420/ton.
[g]Fuel cost at TEAD is $170/ton.

Table E-7. Staffing for CSDP Plants

Personnel	Staffing for a Three-Shift 'Operation/ Estimated Requirements for Future Use: Chemical Munitions[a]	Agent Contaminated Items	Conventional Munitions	Other Feed Materials
Program Management	8	4	4	4
QA/QC	29	4	17	4
Safety	23	1	11	1
Environmental	4	1	1	1
Surety	3	3	0	0
Service Support management	4	1	1	1
Accounting/ payroll	6	1	1	1
Procurement	5	1	1	1
Administrative support	3	1	1	1
Plant management	8	5	5	5
Plant operations	144	36	65	24
Maintenance	72	22	42	22
Supply	9	1	1	1
Documentation Control	12	1	1	1
Lab management	2	2	2	2
Lab QC	11	4	0	0
Lab monitoring	33	15	0	0
Lab analytical	45	3	3	3
Lab data process	6	3	3	3
Engineering management	1	1	1	1
Engineering	8	3	3	3
Training	8	2	2	2
Total	444	115	165	81

[a]Source: TOCDF Staffing for Rocket Processing (Thomas, 1990)

from 144 to 65 and the number of maintenance personnel from 72 to 42 when processing conventional munitions because not all the equipment used for agent operations would be in use. The number of operators and maintenance personnel required for other feed materials could be further reduced to 22 because the disassembly machinery, which requires a large amount of operator and maintenance attention, would not be in use. Because fewer numbers of workers are required for non-agent operations, the number of management and support personnel can also be reduced.

The cost of labor per unit of feed material was calculated using the feed rates given in table E-4 and the total labor requirement given in table E-7. Costs were computed using $35/hour for an average labor cost when destroying chemical munitions and $40/hour ($70/hour at JACADS) when feeding other materials. The cost of labor was calculated for 2080 hours/year and the plant was assumed to operate for 6240 hours/year with an operating factor of 85 percent. The average labor cost is higher for feeds other than chemical munitions because the number of management and other higher-cost staff cannot be reduced proportionately to the overall staff reductions.

It was assumed that the chemical demilitarization facilities will operate on a three shift per day basis. This assumption seems sensible for two reasons. First, the plants will operate on a three shift basis for their primary mission so this mode of operation will simply be a continuation of the existing operating mode. Second, the added cost and processing time for operating on a one shift per day basis is substantial. Clearly, the processing time will be increased by at least a factor of three. There will probably be additional downtime of the furnaces due to the cyclic operation so the processing time may be extended even further. Some impacts on cost due to one shift versus three shift operation are as follows:

1. There may be additional maintenance costs due to the possible increase in furnace downtime.

2. The number of management and administrative staff cannot be reduced by a factor of three since most of these staff were assumed to work only one shift even when the plant operates three shifts daily.

3. There will be an increase in the proportion of higher paid staff; this tends to increase the average labor rate. However, the non-management labor rate will decrease because of the elimination of shift premiums. Therefore, the overall effect on the average labor rate is unknown.

It is estimated that the overall increase in total O&M costs due to one shift operation will be between 25 and 50 percent. This is based entirely on labor cost increases due to impact (2) above. It was assumed that there were no additional maintenance costs, and that the average labor rate stayed constant due to the offsetting effects discussed in impact (3). It was assumed that plant operations, maintenance and QA/QC staff would be reduced by a factor of 3 and all other staff would remain the same as for a three shift operation. This results in a staff 50 to 65 percent the size of the three shift staff. This reduced staff will have to work at least three times as long, resulting in a total labor cost 1.5 to 2 times higher for a one shift operation than for a three shift operation. This results in an increase in total O&M costs of 25 to 50 percent. Therefore, it is assumed that the chemical demilitarization facilities will operate on a three shift per day basis when processing future feedstocks.

At TEAD, UMDA and NAAP, there are two LICs. The LIC at TEAD has a lower capacity than LICs at other locations due to the effect of altitude. The cost per ton of solvents takes account of the different capacities at these plants.

Since it is expected that dunnage will be burned only if a plant is being used for another purpose, there is no additional labor cost for disposal of dunnage.

The results of these calculations are given in table E-8.

E.2.3 Cost of Supplies and Chemicals

Supplies and chemicals include the following: repair parts needed for equipment maintenance, operating supplies and materials such as protective clothing needed by personnel, and chemicals. The yearly cost of each of these categories of supplies and chemicals was estimated as described below. The cost per unit of feed material was calculated on the basis of 260 operating days per year with an 85 percent operating factor, using the hourly feed rates given in table E-4. The results are given in table E-9.

Repair Parts

The annual cost of repair parts was estimated to be 5 percent of the original cost of the equipment at a demilitarization plant. For this purpose, $60 million was used for the equipment cost at the bulk-only plants (APG and NAAP) and $100 million at the other plants. Thus, the annual cost of repair parts is $3 million at APG and NAAP, and $5 million at the other CSDP plants and JACADS.

Table E-8. Labor Costs

Feedstock	Furnace	Labor Cost (Thousands of Dollars/Ton of Feed) JACADS	CSDP	CIDP
Conventional Munitions				
Small Arms	DFS		2.7	2.2
Smokes & Dyes	DFS		1.0	0.3
Large Munitions	DFS/MPF		4.3[a]	4.5[b]
Bulk Propellant	DFS		5.4	5.1
Bulk Explosive	DFS		43.1	44.6
Agent Contaminated				
Soil	DFS		1.6	0.3
Soil	MPF		4.5	
Metal	MPF		1.3	
Hazardous Contaminated				
Soil	DFS	1.6[c]	1.1	0.2
Soil	MPF	3.2[c]	3.2	
Sludge	DFS		3.1	0.7
Sludge	MPF		a.9	
Solvents				
Xylenes	LIC		4.5[d]	
DS2	LIC		3.8[e]	
TCE	LIC		1.1[f]	
		Labor Cost (Thousands of Dollars/ Munition		
Non-stockpile chemical munitions			1.5	0.3

[a]Cost ranges from 1.8 to 10.8 thousand dollars/ton.
[b]Cost ranges from 1.8 to 11.1 thousand dollars/ton.
[c]If both DFS and MPF are used simultaneously, cost is 2.0 thousand dollars/ton.
[d]Cost in thousands of dollars/ton is 2.5 at TEAD and 2.1 at UMDA and NAAP.
[e]Cost in thousands of dollars/ton is 2.2 at TEAD and 1.8 at UMDA and NAAP.
[f]Cost in thousands of dollars/ton is 0.6 at TEAD and 0.5 at UMDA and NAAP.

Table E-9. Cost of Supplies, Material, Repair Parts and Chemicals

Feedstock	Furnace	Cost (Thousands of Dollars/Ton of Feed) JACADS	CSDP	CIDP
Conventional Munitions				
Small Arms	DFS		1.9	1.5
Smokes 6 Dyes	DFS		0.7	0.2
Large Munitions	DFS/MPF		3.0[a]	2.3[b]
Bulk Propellant	DFS		3.7	2.7
Bulk Explosive	DFS		29.5	2
Agent Contaminated				
Soil	DFS		1.4	0.3
Soil	MPF		4.0	
Metal	MPF		1.2[c]	
Hazardous Contaminated				
Soil	DFS	1.2	1.4	0.3
Soil	MPF	2.0[d]	4.0[e]	
Sludge	DFS		3.9	0.9
Sludge	MPF		11.2[f]	
Solvents				
Xylenes	LIC		5.6[g]	
DS2	LIC		4.7[h]	
TCE	LIC		1.3[i]	
		Cost (Thousands of Dollars/ Munition)		
Non-stockpile chemical munitions			0.6	0.1

[a]Cost ranges from 1.2 to 7.4 thousand dollars/ton.
[b]Cost ranges from 0.9 to 5.8 thousand dollars/ton.
[c]Cost in thousands of dollars/ton is 0.8 at APG and NAAP.
[d]If both DFS and MPF are used, cost is 1.4 thousand dollars/ton.
[e]Cost in thousands of dollars/ton is 2.6 at APG and NAAP.
[f]Cost in thousands of dollars/ton is 7.2 at APG and NAAP
[g]Cost in thousands of dollars/ton is 3.3 at TEAD and 2.8 at UMDA and NAAP.
[h]Cost in thousands of dollars/ton is 2.8 at TEAD and 2.4 at UMDA and NAAP.
[i]Cost in thousands of dollars/ton is 0.8 at TEAD and 0.7 at UMDA and NAAP.

Operating Supplies and Materials

Two types of supplies and materials were considered: Demilitarization Protective Ensembles (DPE), used only for chemical agent operations; and other supplies and materials.

The annual cost of providing DPE has been estimated by the Army to be about $2 million at plants other than bulk-only plants (Gottschalk, 1990). We used this value for the cost of DPE during operations involving non-stockpile chemical munitions. We do not expect DPE to be used when thermally treating contaminated soil or items such as ton containers that have been decontaminated to the XXX level. The annual cost of other supplies and materials was estimated to be $7,500 for each person whose job requires frequent entry to the plant or laboratory operating area (Gottschalk, 1990). The estimated numbers of personnel in this category are given in table E-10. The combined cost of supplies and materials is given in table E-11.

Chemicals

The annual cost of chemicals has been estimated by the Army to be about $2 million at bulk-only plants (APG and NAAP) and $3 million at the other plants (Gottschalk, 1990). Most of these chemicals are those used in the operation of the pollution abatement equipment. In the absence of precise estimates of the amounts of chemicals needed for the various future use operations, we used this value for the cost of chemicals.

E.2.4 Cost of Utilities

Utilities include electric power and water, the major cost being power. The annual cost of utilities, adjusted to FY91 dollars, has been estimated by the Army to be about $1.7 million for bulk-only plants and $3.5 million for the other plants (Gottschalk, 1990). The cost per unit of feed material was calculated on the basis of 260 operating days per year with an 85 percent operating factor, using the hourly feed rates given in table E-4. The results are given in table E-12.

E.2.5 O&M Cost of CAMDS Operation

The Army has estimated that each furnace at CAMDS could be operated for $840/hour (Payeur, 1990). This value includes all of the O&M costs. The cost per unit of feed material was calculated on the basis of this hourly cost and the feed rates given in table E-4, assuming an 85 percent operating factor, The results are given in table E-13.

Table E-10. Personnel Whose Jobs Require Entry Into Operating and Laboratory Areas

Personnel	Chemical Munitions	Agent Contaminated Items	Conventional Munitions	Other Feed Materials
QA/QC	24	3	12	3
Safety	20	1	9	1
Plant Operations	144	36	65	24
Maintenance	69	21	40	21
Laboratory	89	22	3	3
Total	346	83	129	52

Table E-11. Combined Cost of Supplies and Materials

	Cost (Thousands of Dollars/year)			
Supplies and Materials	Chemical Munitions	Agent Contaminated Items	Conventional Munitions	Other Feed Materials
DPE	2000			
Other supplies	2600[a]	620	970	390
Total	4600	620	970	390

(a): $7500 \times 346 \times \frac{1}{1000}$

Table E-12. Cost of Utilities

Feedstock	Furnace	Cost (Thousands of Dollars/Ton of Feed) JACADS	CSDP	CIDP
Conventional Munitions				
Small Arms	DFS		0.7	0.6
Smokes & Dyes	DFS		0.2	0.1
Large Munitions	DFS/MPF		1.1[a]	0.9[b]
Bulk Propellant	DFS		1.4	1.0
Bulk Explosive	DFS		11.0	a.7
Agent Contaminated				
Soil	DFS		0.6	0.1
Soil	MPF		1.6	
Metal	MPF		0.5[c]	
Hazardous Contaminated				
Soil	DFS	0.5	0.6	0.1
Soil	MPF	1.6[d]	1.6[e]	
Sludge	DFS		1.6	0.4
Sludge	MPF		4.6[f]	
Solvents				
Xylenes	LIC		2.3[g]	
DS2	LIC		2.0[h]	
TCE	LIC		0.5[i]	
		Cost (Thousands of Dollars/ Munition)		
Non-stockpile chemical munitions	All		0.2	<0.1

[a]Cost ranges from 0.4 to 2.7 thousand dollars/ton.
[b]Cost ranges from 0.3 to 2.2 thousand dollars/ton.
[c]Cost in thousands of dollars/ton is 0.2 at APG and NAAP.
[d]If both DFS and MPF are used simultaneously, cost is 0.6 thousand dollars/ton.
[e]Cost in thousands of dollars/ton is 0.8 at APG and NAAP.
[f]Cost in thousands of dollars/ton is 2.2 at APG and NAAP.
[g]Cost in thousands of dollars/ton is 1.4 at TEAD and 1.2 at UMDA and NAAP.
[h]Cost in thousands of dollars/ton is 1.2 at TEAD and 1.0 at UMDA and NAAP.
[i]Cost in thousands of dollars/ton is 0.3 at TEAD, UMDA and NAAP.

Table E-13. O&M Cost for CAMDS

Feedstock	Furnace	Cost (Thousands of Dollars/Ton of Feed)
Conventional Munitions		
Small Arms	DFS	1.4
Smokes & Dyes	DFS	0.6
Large Munitions	DFS/MPF	4.3[a]
Bulk Propellant	DFS	2.7
Bulk Explosive	DFS	21.5
Agent Contaminated		
Soil	DFS	2.0
Soil	MPF	4.9
Metal	MPF	1.4
Hazardous Contaminated		
Soil	DFS	2.0
Soil	MPF	4.9
Sludge	DFS	5.6
Sludge	MPF	13.6
Solvents		
Xylenes	LIC	12.4
DS2	LIC	10.4
TCE	LIC	2.6
		(Thousands of Dollars/ Munition)
Non-stockpile chemical munitions	All	0.2

[a]Cost ranges from 1.7 to 10.7 thousand dollars/ton.

E.2.6 O&M Cost for VX-Filled Ton Containers

The feed rate for empty ton containers is 1.72 ton containers/hour. The feed rate of VX-filled ton containers is limited by the time needed to process the VX through the LIC. The feed rate is 0.88 ton containers/hour. For the CSDP plants, the cost of running two furnaces is almost equal to the cost of running one furnace. Therefore, for the APG plant, the O&M cost for processing a filled ton container can be estimated by scaling the cost to account for the reduced feed rate. The weight of the VX ton container should be treated as if it were empty (1600 lbs/ton container).

VX-filled ton container O&M cost = 2.4 x (1.72/0.88) = 4.7

E.2.7 Total O&M Costs for all Facilities

The total O&M Costs for all of the chemical demilitarization facilities are given in table E-14. The costs at CAMDS are lower than at the other facilities because at CAMDS each furnace/PAS system is operated separately. For example, the DFS could be disposing of small arms while the LIC was incinerating a solvent. While simultaneous processing can also be carried out at the CSDP plants, increased monitoring and perhaps, permit modifications would be required.

E.3 FIXED COSTS

Fixed costs are those that are incurred one time during the campaign to use the demilitarization plants for other uses when the disposal of the chemical stockpile has been completed. These costs include the cost of modifications and additions and the cost of obtaining the necessary operating permits.

Fixed costs include only the cost of modifications and additions to the demilitarization plants to permit future uses. The initial construction cost of the facility is a sunk cost that is incurred to complete the primary mission, regardless of any potential future use of the facility. Therefore, only incremental costs are estimated for potential future uses of the chemical demilitarization facilities. For similar reasons, the permitting costs include only those costs above the primary mission permitting costs. Therefore, in those cases where it is possible to modify the existing permits, only the cost for the permit modification is included.

Table E-14. Total O&M Cost

Feedstock	Cost (Thousands of Dollars/Ton of Feed) CAMDS	JACADS	CSDP	CIDP
Conventional Munitions				
Small Arms	1.4		5.5	4.8
Smokes & Dyes	0.6		2	0.7
Large Munitions	4.3[a]		8.9[b]	8.4[c]
Bulk Propellant	2.7		11.0	9.6
Bulk Explosive	21.5		57.9	83.8
Agent Contaminated				
Soil (DFS)	2.0		3.8	0.7
Soil (MPF)	4.9		10.5	
Metal	1.4		3.1[d]	
VX filled ton container			4.7 (APG only)	
Hazardous Contaminated				
Soil (DFS)	2.0	3.5[e]	3.3	0.7
Soil (MPF)	4.9	7.3[e]	9.3[f]	
Sludge	5.6		9.3	2.3
Sludge	13.6		26.08	
Solvents				
Xylenes	12.4		12.3[h]	
DS2	10.4		10.5[i]	
TCE	2.6		2.1[j]	
	Cost (Thousands of Dollars/ Munition			
Non-stockpile chemical munitions	0.2		2.4	0.4

[a]Cost ranges from 1.7 to 10.7 thousands dollars/ton.
[b]Cost ranges from 3.6 to 22.2 thousand dollars/ton.
[c]Cost ranges from 3.3 to 20.9 thousand dollars/ton.
[d]Cost in thousands of dollars/ton is 2.4 at APG and NAAP.
[e]If both DFS and MPF are used simultaneously, cost is 4.3 thousand dollars/ton.
[f]Cost in thousands of dollars/ton is 6.8 at APG and NAAP.
[g]Cost in thousands of dollars/ton is 19.0 at APG and NAAP.
[h]Cost in thousands of dollars/ton is 7.7 at TEAD and 6.5 at UMDA and NAAP.
[i]Cost in thousands of dollars/ton is 6.6 at TEAD and 5.6 at UMDA and NAAP.
[j]Cost in thousands of dollars/ton is 1.9 at TEAD and 1.7 at UMDA and NAAP.

E.3.1 Modifications and Additions

In the absence of design information, dependable cost estimates of equipment modifications and additions are not possible. Since these one-time costs are, in most cases, as little as one percent of the O&M costs over a lo-year period, our estimates are adequate for the purposes of this study.

Installation of a Washout Facility for Conventional Munitions

This modification includes washout/meltout equipment, piping, holding tanks, charcoal filters, and a building to house the equipment. The building must include separation walls. This modification is expected to cost between two million and four million dollars based on replacement costs for existing facilities. (Zajicek and Ansell, 1990).

Additions or Modifications to Existing Disassembly Equipment

It is not possible to identify the types of disassembly devices that might be needed to supplement the existing equipment if conventional munitions are to be processed. However, a rough estimate may be made on the basis of the cost of the equipment designed to disassemble chemical stockpile items. Disassembly machines for agent-containing munitions (e.g, mine machine, rocket shear machine, projectile/mortar disassembly machine, or multipurpose demilitarization machine) are expected to cost from about $100,000 to $300,000 each, not including installation cost. We would expect that equipment designed for conventional munitions need not be as sophisticated as these machines. For estimating purposes, it was assumed that three or more disassembly devices could be installed for $1 million and that this number of machines would be adequate to handle most of the inventory of conventional munitions that requires disassembly prior to disposal.*

Modifications to the DFS or MPF Feed System

Some feed system modifications will be required to feed soil and sludge to the DFS or MPF. Soil will require conveyors and weighing equipment. Sludge will require tanks, pumps, and piping. The estimated costs of these modifications are less than $100,000 for the CSDP and CAMDS facilities. Because of the increased size of the CIDP DFS, the modifications are estimated to cost $100,000 for the CIDP facility.

'There are thousands of different types and configurations of conventional munitions and depending on the adaptibility of the various disassembly machines, this may be a low estimate of the cost of equipment required for disassembly of conventional munitions.

Modifications to the DFS Kiln

It is likely that refractory will need to be added to the DFS to process soil and sludge. This modification is estimated to cost $100,000 (Niskala, November 1, 1990) for the CAMDS and CSDP facilities. Because of the larger size of the CIDP DFS, the refractory is estimated to cost $300,000 for the CIDP. (The surface area of the CIDP DFS is about 3 times that of the CSDP DFS.)

Modifications to the LIC Feed System

The LIC feed system may need to be modified to handle solvents. These modifications may include nozzles, piping, pumps and tanks. This modification is expected to cost no more than $100,000 since it is similar to the modifications required for processing sludge through the DFS or MPF.

Additions to the Pollution Abatement System

The Army expects to upgrade the APE 1236 systems for $1.5 to $2.5 million, depending on the location and the amount of site preparation work required. These revisions include not only additions to the PAS but shrouds for the kiln. Thus, in our judgment, the PAS at a chemical demilitarization facility could be upgraded for one to two million dollars.

An upgraded mist eliminator may be required for processing some hazardous wastes. The mist eliminator is estimated to cost between $100,000 and $250,000 (Niskala, 1990).

Decontamination of the Facility Prior to Future Use

Another fixed cost is the cost of decontaminating the chemical demilitarization facility after the primary mission is complete but before any future uses. This cost was not calculated because decontamination will be required regardless of whether the facility is used for another purpose or is dismantled and disposed of.

E.3.2 Permitting Costs

Permitting costs are assumed to consist of two parts: documentation costs for the permit application and trial burn costs. The trial burn cost is estimated to be $530,000 (CRDEC-CR-039, 1990). The application prepration cost ranges from $225,000 (CRDEC-CR-039,1990) to $650,000 (based on information from Roger Argus, 1990). The $650,000 is calculated by assuming it will take a mid-level manager up to 3 years at $150,000/year and an assistant up to 2 years at $100,000/year to complete the application. The application preparation costs are somewhat site specific because some sites have more rigorous state requirements than others. The

$650,000 figure is assumed to be applicable for sites with difficult state requirements. The $225,000 figure is assumed to be applicable for sites with no additional state requirements. A cost of $450,000 is assumed for sites that fall in-between these extremes. The following table summarizes the application preparation costs by site. Note that Newport is listed in the lowest cost category. This is based on the historical attitude of Indiana towards permitting. It is possible that the public opposition at Newport could influence the state legislature to adopt more stringent regulations. However, at this time, the legislature has not done so. Therefore, while all of these numbers are subject to change (and in general, primarily toward more expensive permitting), the situation at Newport may be one of the most likely to change. To reflect the likely higher cost at Newport, a cost of $250,000 was used.

Site	Permittine: Cost
Tooele	$450,000
Johnston Island	$450,000
Aberdeen	$650,000
Lexington/Blue Grass	$650,000
Anniston	$225,000
Pine Bluff	$225,000
Pueblo	$450,000
Umatilla	$450,000
Newport	$250,000

The time required for permitting ranges from about 18 months to about 3 years. In all cases except perhaps CAMDS, the permitting theoretically could be completed before the demilitarization facilities will be available for future use. The current official date for the availability of CAMDS is September, 1994, so even in that case, the permitting could be complete before the facility is available. Therefore, no delay costs due to permitting delays will be calculated in permitting costs.

E.4 COST OF ALTERNATIVE PROCESSES

Note that these costs are based on the most current information available. No attempt was made to escalate the costs into the future because it is unknown which costs will escalate faster than inflation. If all costs escalate at the same rate, the conclusions drawn from the escalated costs will be the same as those drawn from the current costs.

E.4.1 Conventional Munitions

The two methods generally used to destroy conventional munitions are washout/meltout of the explosives followed by incineration in an upgraded APE 1236, upgraded EWI or open burning/open detonation (OB/OD). The

washout/meltout costs are the same whether the munitions are later incinerated in an upgraded APE 1236 or in a demilitarization facility, so they will not be addressed here. The costs for incinerating various types of conventional munitions in an upgraded APE 1236 or EWI are shown in table E-15. These costs are based on CAMDS DFS hourly O&M costs and APE 1236 or EWI feedrates. The CAMDS DFS is of a similar configuration to the upgraded APE 1236 and EWI (including PAS upgrade); thus the hourly O&M costs should be similar.

CAMDS hourly O&M cost = $840/hour
APE 1236 feedrate for small arms and smokes = 1,000 lb/hour
Assume 85 percent operating factor.

$$\frac{\$840}{hr} \times \frac{1\ hr}{1{,}000\ lb} \times \frac{1}{0.85} \times \frac{2.000\ lb}{ton} = \$1{,}980/ton \text{ APE 1236 small arms and smokes}$$

CAMDS hourly O&M cost = $840/hour
EWI feedrate for explosives = 300 lb/hour
Assume 85 percent operating factor.

$$\frac{\$840}{hr} \times \frac{1\ hr}{300\ lb} \times \frac{1}{0.85} \times \frac{2.000\ lb}{ton} = \$6{,}590/ton \text{ EWI bulk explosives}$$

Assume the ratio for CAMDS explosives to propellant is the same for EWI explosives to propellant.
CAMDS propellant feedrate = 720 lb/hour
CAMDS explosive feedrate = 92 lb/hour

$6,590/ton x (92/720) = $840/ton EWI bulk propellant.

The cost for OB/OD is also shown in table E-15. It is taken from a briefing on the Ammunition Demilitarization Program given on June 14, 1990.

E.4.2 Hazardous Contaminated Soil and Sludges

Hazardous contaminated soil is either incinerated to destroy the hazardous material or landfilled in a hazardous landfill. Using hazardous landfills is becoming more and more difficult because of the increasing regulatory restrictions that apply. Therefore, the costs given for landfilling in table E-15 may be lower than what will be encountered when the demilitarization facilities are available for other uses. In fact, use of hazardous landfills for contaminated soils may not be a viable alternative at all by then because of regulatory restrictions. Soil incinerators vary greatly in size, and the cost per ton is highly dependent on the incinerator size. The demilitarization facility incinerators are very small compared to most soil incinerators, and therefore have a high O&M cost.

Table E-15. Unit Cost Estimates for Alternative Processes

Feedstock	Alternative Process	Cost ($1000/Ton)	Comments	Source
Small Arms	APE 1236	2	Approximate	CAMDS $/hour APE 1236 Eeedrate
Smokes and Dyes	APE 1236	2	Approximate	CAMDS $/hour APE 1236 feedrate
Large Munitions	OB/OD	0.8		14 June '90 Briefing
Bulk Propellant	EWI	0.8	Approximate	CAMDS $/hour EWI feedrate
Bulk Explosive	EWI	6.6	Approximate	CAMDS $/hour EWT feedrate
Hazardous Contaminated Soil	Landfill	0.2-0.3	Landfill restrictions may apply	CRDEC-CR 039
	Incineration	0.2-1.5	Dependent on incinerator size	EPA/625 /9-88/008
Hazardous Contaminated Sludges	Incineration	3	Rotary Kiln	Hawkins, 1991
	Landfill	0.2-0.3	Landfill restrictions may apply	CRDEC-CR 039
Solvents				
General	Incineration	0.2-0.5	Liquid injection incinerator	EPA/625 /O-88/008
DS2	Incineration	1.0	Through DRMS	Beam, 1990

Table E-15. Unit Cost Estimates for Alternative Process (Concluded)

Feedstock	Alternative Process	Cost ($1000/ Ton)	Comments	Source
Buildings	Hot Gas	Equivalent to incineration	Method under development	CRDEC-CR-039
	Incineration	2.0	Cost of pilot plant incineration in Decon/Detox Incinerator	Memo dated 8/15/90
Municipal Waste	Incineration	0.025[a]	Highest cost shown in table 1 of reference	Brunner, 1985
Medical Waste	Incineration	0.5		Vought, 1991

a: Adjusted for inflation to 1991 dollars with factor of 1.2279.

Sludges are usually treated in a rotary kiln and have unit costs as shown in table E-15.

E.4.3 Industrial Wastes

Solvents are generally disposed of in a liquid injection incinerator. The costs are given in table E-15. The cost to dispose of DS2 is somewhat higher than the cost to dispose of other solvents. It is based on the fact that during the period 1 January 89 to 17 September 1990, DRMS disposed of about 65 tons of DS2 for a cost of $1,017/ton (Beam, 1990).

E.4.4 Buildings

Incineration is the only currently accepted method for decontaminating buildings contaminated with agent. The hot gas method is under development and may prove to be feasible for certain buildings by the time the demilitarization facilities are available for future use. The projected costs for the hot gas method is approximately equal to the incineration method. The cost for decontaminating buildings by incineration (including dismantling the equipment) is shown in table E-15. This cost is based on work done to date on the Old Pilot Plant at Edgewood, MD. The incinerator used in this work is a batch-type car-bottom incinerator. It is not very efficient in terms of through-put but the labor costs are far below that required by the demilitarization facility.

E.4.5 Municipal Waste

Municipal waste incinerators are usually many times larger than the demilitarization facility incinerators. The costs per ton, therefore, are many times lower. These costs are shown in table E-15.

E.4.6 Medical Waste

The cost per ton for disposal of medical waste is estimated based on a personal communication with personnel at Memphis Army Depot.

E.5 QUANTITY OF MATERIAL AT EACH SITE

To develop site specific costs, it is necessary to determine the quantity of various materials at each site. Often, the information provided by the sites was somewhat vague regarding quantities. Therefore, assumptions were made to convert this information into quantities that could be used for estimating purposes. Tables E-16 through E-24 show the assumptions and resultant quantities for the most likely feedstocks at each site of a chemical demilitarization plant.

Table E-16. Quantities of Most Likely Feedstocks at Tooele Army Depot and Dugway Proving Ground

Feedstocks	Assumptions
1. "Found on Post" Agent Containing Munitions	
Item — Quantity	
Chemical Agent Identification Sets (CAIS) — 56	
Chemical agent — 25	
Mortar rounds — 49	
105mm projectiles — 3	
155mm projectiles — 11	
6-inch projectiles — 1	
Total Items: 145	
2. Contaminated Material and Soil	
a. Pits (9 of 30 agent contaminated 1,934 acres: 30 pits 580 acres @ 2 ft. depth = 1,160 acre-feet 1,160 acre-feet = 50,529,600 ft^3 = 1,071,467 yd^3 = 1,871,467 tons	30% of acerage (580 acres) associated w/9 pits; for soil, contamination is 2 ft. deep; Revised EPA Hazard Ranking System described in Wusterbarth (1989), "Hazardous Waste Quantity Task: Verification of Hazardous Waste Quantity Divisors," (Unpublished), McLean, VA: The MITRE Corporation.

Table E-16. Quantities of Most Likely Feedstocks at Tooele Army Depot and **Dugway** Proving Ground (Continued)

Feedstocks	Assumptions
b. Open pits North Area	
2 acre-feet = 87,120 ft^3 = 3,227 yd^3 = 3,227 tons	No. of pits unknown; assume a minimum of 1 pit and treat it as a surface impoundment; RCRA surface impoundments (n = 696) are about 1 acre (min, mode, & median); see Wusterbarth, (1989). Contaminated soil depth assumed 2 ft. as in Revised HRS. 1 ton/yd^3 for soil.
c. Waste burial areas (South Area) 2 acre-feet = 3,227 tons	No. burial areas unknown; assumed at least 1 burial area and treated it as a surface impoundment. Assumptions identical to 2b above.
d. Mustard spill area (South) 2 acre-feet = 3,227 tons	Assumptions identical to 2b above.
e. VX leak area (South) 2 acre-feet = 3,227 tons	Assumptions identical to 2b above.
f. Gravel pit 5.8 acreas @ 2 ft. depth 11.6 acre-feet = 505,296 ft^3 = 18,715 yd^3 = 18,715 tons	2 ft. depth (Revised HRS) 1 ton/yd^3 for soil

Table E-16. Quantities of Most Likely Feedstocks at Tooele Army Depot and **Dugway** Proving Ground (Concluded)

Feedstocks	Assumptions
g. Drainage pond - unlined 20 ft x 70 ft x 10 ft = 14,000 ft^3 = 519 yd^3 = 519 tons	1 ton/yd^3 for soil
h. Empty ton containers 1,024 @ 1,600 lbs. each = 819 tons	Empty ton container weight = 1,600 lb 2,000 lbs/ton
3. **Dugway** Waste	
a. Test range areas @ 5 meters deep 15 of 22 test range areas contaminated. 15 acres @ 16.405 ft = 10,715,760 ft^3 = 396,880 yd^3 = 396,880 tons	5 meters = 16.405 ft assume surface areas comparable to RCRA surface impoundment areas; see assumptions for 2b, i.e., surface area = 1 acre

Table E-17. Quantities of Most Likely Feedstocks at Aberdeen Proving Ground

Feedstocks	Assumptions
1. Nonstockpile Chemical Items	
a. Empty ton containers 2,452 @ 1,600 lbs each = 1,962 tons	Weight of ton containers (empty) = 1,600 lbs. 2,000 lbs/ton
b. Ton containers filled with VX 4 ton containers @ 1,400 lbs each 5,600 lbs = 2.8 tons	Use empty ton container weight
2. Contaminated Buildings and Equipment	
a. Buildings contaminated 30 buildings @ 5,000 tons = 150,000 tons	30 of 251 buildings assumed to be agent-contaminated; based on findings in EAI Corporation (1989) Historical Records Search and Site Survey of Ednewood Area Buildings, Final Report, Abingdon, MD, in which 29 buildings were analyzed in detail. Pilot plant in CRDEC-CR-039 is about 7,500 - 10,000 tons; assume 5,000 tons/building: the report by EAI Corporation showed building sizes are smaller than the pilot plant.
b. Equipment 30 buildings @ 200 tons equip/bldg = 6,000 tons	700 tons/bldg. for the pilot demonstration plant where equipment is likely to have a higher density than other buildings; as noted in 2a above, the buildings are smaller that the pilot ⇒ less volume to situate the equipment. ∴ assume 200 tons/bldg for equipment.

Table E-17. Quantities of Most Likely Feedstocks at Aberdeen Proving Ground (Concluded)

Feedstocks	Assumptions
3. Potentially Contaminated Material and Soil*	
a. Old "O" field equipment and scrap 153,710 yd^3 = 43,039 tons	Density of equipment is assumed to be 50% of the density of a ton container. Density of ton container: 30.1 inch diameter (U.S. Army 1988) ⇒ 0.42 yd. radius. $A = \Pi r^2 = 0.55\ yd^2$ Ton length = 81.5 in = 2.26 yd Volume = 1.24 yd^3 Wt/volume = 1,400 lbs/1.24 yd^3 = 0.56 ton/yd^3 50% of density = 0.28 ton/yd^3
b. Old "O" field soil 95,000 yd^3 = 95,000 tons	1 ton/yd^3 for soil
c. Munitions	Not on ton basis
d. Wheeled vehicle training facility 15,000 yd^3 = 15,000 tons	Assumed to be soil 1 ton/yd^3 for soil

*Estimated volumes of potentially contaminated soil were only available for "O" Field and the wheeled vehicle training facility. There are many more sites at Aberdeen with potentially contaminated soil. Estimates of the potential quantity await further study.

Table E-18. Quantities of Most Likely Feedstocks at Lexington-Bluegrass Army Depot

Feedstocks	Assumptions
1. Potentially Contaminated Soils	
a. Burning ground for 900 rounds of mustard filled munitions 2 acre-feet = 87,120 ft^3 = 3,227 yd^3 = 3,227 tons	Assumed to be similar to a surface impoundment w/surface area = 1 acre. (Wusterbarth, 1989) contaminated soil depth = 2 ft (Revised HRS).

Table E-19. Quantities of Most Likely Feedstocks at Anniston Army Depot and Redstone Arsenal

Feedstocks	Assumptions
1. Potentially Contaminated Soil	
a. Munitions burial ground 2 acre-feet = 3,227 tons	Assumed to be similar to a surface impoundment w/surface area = 1 acre. (Wusterbarth, 1989) contaminated soil depth = 2 ft (Revised HRS).

Table E-20. Quantities of Most Likely Feedstocks at Pine Bluff Arsenal

Feedstocks	Assumptions
1. Munitions Recovered from Burial Sites "Found on Post"	
Item — Quantity	
Mortar Rounds — 726	
150mm Traktor Rockets — 477	
Empty Drums — 6	
Total Items: 1,209	
2. Former Storage	
a. Ton containers 4,000 @ 1,600 lbs = 3,200 tons	Assumed empty wt./empty container = 1,600 lbs.
3. Agent-Contaminated Material and Soil Recovered from Landfills	
a. Full drums 43 drums = 10.8 tons	4 drums/ton (Revised HRS)

Table E-21. Quantities of Most Likely Feedstocks at Pueblo Depot Activity and Rocky Mountain Arsenal

Feedstocks	Assumptions
1. Nonstockpile Chemical Items	
a. "Empty" one-ton containers 4,300 @ 1,600 lbs. each = 3,440 tons	Wt/empty container = 1,600 lbs
2. Potentially Agent Contaminated Buildings	
a. Building structure 250,000 yd^3 = 6,750,000 ft^3 = 675,000,000 lbs = 337,500 tons	Assumed concrete with density 100 lbs/ft^3
b. Production equipment 6,800 yd^3 = 1,904 tons	Density of equipment assumed to be same as in old "O" field at APG, i.e., 50% of density of ton container = 0.28 ton/yd^3
c. Piping 15 miles = 79,200 ft = 855,360 lbs = 428 tons	Assumed average 4-inch Schedule 40 piping ⇒ 10.8 lbs/ft 5,280 ft/mile 2,000 lbs/ton
4. Potentially Contaminated Material & Soil	
a. Chemical munitions burial ground (1) 2 acre-feet = 3,227 tons	Assumed similar to a surface impoundment; 1 acre surface area, 2 ft. depth for contaminated soil (Wusterbarth, 1989).
b. Mustard disposal area (1) 2 acre-feet = 3,227 tons	Assumed similar to a surface impoundment; 1 acre surface area; 2 ft. depth for contaminated soil (Wusterbarth, 1989).

Table E-21. Quantities of Most Likely Feedstocks at Pueblo Depot Activity and Rocky Mountain Arsenal (Concluded)

Feedstocks	Assumptions
c. Equipment from burial grounds 500 yd^3 = 140 tons	Density of equipment assumed to be same as in old "O" field, i.e., 50% of density of ton container = 0.28 ton/yd^3

Table E-22. Quantities of Most Likely Feedstocks at Umatilla Depot Activity

Feedstocks	Assumptions
1. Nonstockpile Chemical Items	
2. Potentially Contaminated Buildings	
a. Buildings = 5,000 tons	Assume 1 small lab. Pilot plant in CRDEC-CR-039 is about 7,500 - 10,000 tons; assume 5,000 tons per building: EAI Corporation (1989) Historical Records Search and Site Survey of Edgewood Area Buildings, Final Report, cited buildings of this size at APG.
3. Potentially Contaminated Material and Soil	
a. Mustard Storage Area (1) 2 acre-feet = 3,227 tons	Assumed similar to a surface impoundment; 1 acre surface area, 2 ft. depth for contaminated soil (Wusterbarth, 1989).
b. Agent-contaminated septic tanks 1 @ 1,400 lbs. = 0.7 ton	Assumed minimum of one; assumed similar in size to a ton container (empty).
c. Remote munitions disassembly area (1) 2 acre-feet = 3,227 tons	Assumed similar to surface impoundment; 1 acre surface area, 2 ft. depth for contaminated soil (Wusterbarth, 1989).
d. Decon & solution disposal areas 2 acre-feet = 3,227 tons	Same assumptions as 3a and 3c.

Table E-23. Quantities of Most Likely Feedstocks at Newport Army Ammunition Plant

Feedstocks	Assumptions
1. Old Chemical Agent Production Facilities	
a. Production e uipment 6,100 yd^3 = 1,708 tons	Density of equipment assumed to be same as in old "O" field at APG, i.e., 50% of density of ton container = 0.28 ton/yd^3.
b. Steel Debris 5,100 yd = 137,700 ft3 = 67,473,000 lbs = 33.737 tons	Density of steel is 490 lbs/ft^3 2,000 lbs/ton
c. Concrete debris 2,900 yd^3 = 78,300 ft^3 = 7,830,000 lbs. 3,915 tons	Density of concrete is 100 $lbs./ft.^3$.
2. Potentially Contaminated Material Recovered from Landfills	
a. Night Soil Pits 5,500 yd^3 = 5,500 tons	1 ton/yd^3 for soil
b. Waste Burial Ground 8,000 yd^3 = 8,000 tons	1 ton/yd^3 for soil
c. K-9 pond concrete 2,200 yd^3 = 220,000 lbs. = 110 tons	Density of concrete = 100 lbs/ft^3 2,000 lbs/ton

Table E-23. Quantities of Most Likely Feedstocks at Newport Army Ammunition Plant (Concluded)

Feedstocks	Assumptions
d. K-9 pond sludge 25 yd^3 soil = 25 tons soil 25 yd^3 water = 675 ft^3 = 40,500 lbs = 20 tons	Sludge composition is 50% soil and 50% water; density of water = 60 lbs/ft^3 1 ton/yd^3 for soil 2,000 lbs/ton
sludge tonnage = 25 + 20 = 45 tons	
e. K-9 pond soil 1,250 yd^3 = 1,250 tons	1 ton/yd^3 for soil
3. Stored Potentially Agent Contaminated Waste	
a. Empty sealed ton containers 26 @ 1,600 lbs = 20.8 tons	2,000 lbs/ton 1,600 lbs/ton empty container

Table E-24. Quantities of Most Likely Feedstocks at Johnston Island

Feedstocks	Assumptions
1. Hazardous Coral	
a. 55 gallon drums agent orange contaminated material 85 drums = 21.25 tons	4 drums/ton (Revised HRS)
6,000 - 18,000 yd^3 Herbicide Orange contaminated coral = 6,000 - 18,000 tons	1 ton/yd^3
2. Potentially Agent Contaminated Items	
a. Empty ton containers 264 @ 1,600 lbs each = 211 tons	Empty ton container weight = 1,600 lbs / 2,000 lbs/ton

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GLOSSARY

ABCDF	Aberdeen Chemical Demilitarization Facility
AC	Hydrogen Cyanide
ADA	Ammunition Detonation Area
ADS	Agent Destruction System (CAMDS)
AIDS	Acquired Immune Deficiency Syndrome
AMSMC	U.S. Army Armament, Munitions, and Chemical Command
ANAD	Anniston Army Depot, Alabama
APE	Ammunition Peculiar Equipment
APG	Aberdeen Proving Ground, Maryland
AQCR	Air Quality Control Region
ARAR	Applicable, or Relevent and Appropriate Regulation
BACT	Best Available Control Technology
BAT	Best Available Economically Achievable Technology
BCT	Best Conventional Technology
BDS	Bulk Drain Station
BZ	Incapacitating agent 3-quinuclidinyl benzilate
CAA	Clean Air Act of 1955
CAIS	Chemical Agent Identification Sets
CAMDS	Chemical Agent Munitions Disposal System
CBU	Cluster Bomb Unit
CDF	Chemical Disposal Facility
CDS	Central Decontamination System
CERCLA	The Comprehensive Environmental Repsonse, Compensation, and Liability Act of 1980
CG	Phosgene
CIDP	Cryofracture/Incineration Demonstration Plant
CK	Cyanogen Chloride
CN	Lachrymator chloroacetophenone
Comp B	Compostion B, mixture of explosives RDX and TNT
CON-US	Continental United States
cs	Lachrymator 0-chlorobenzylidene malonitrile
CSDP	Chemical Stockpile Disposal Program
CSM	Chemical Surety Material
CWA	Clean Water Act of 1977
DAS	Data Acquisition System
DATS	Drill and Transfer System
DERA	Defense Environmental Restoration Account
DFS	Deactivation Furnace System
DM	Vomiting Agent Adamsite
DOD	Department of Defense

DOT	Department of Transportation
DRE	Destruction Removal Efficiency
DRMO	Defense Reutilization and Marketing Office
DRMS	Defense Reutilization and Marketing Services
DUN	Dunnage Incinerator
EA	Environmental Assessment
ECC	Explosion Containment Cubicle
ECR	Explosion Containment Room
EIS	Environmental Impact Statement
EOD	Explosive Ordnance Detachment
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act of 1986
EWI	Explosive Waste Incinerator
Explosive D	Ammonium Picrate
FBI	Fluidized Bed Incinerator
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act of 1972
FS	Smoke Mixture of SO3 and Chlorosulfonic Acid
FWDA	Fort Wyngate Depot Activity
GAO	General Accounting Office
GOCO	Government Owned and Contractor Operated
GOGO	Government Owned and Government Operated
gr/DSCF	grains/dry standard cubic foot
HC	Smoke Mixture of Al, AnO, and Hexachloroethane
HCl	Hydrogen Chloride
HE	High Explosive
HMTA	Hazardous Materials Transportation Act of 1975
IR	Installation Restoration
IRP	Installation Restoration Program
JACADS	Johnston Atoll Chemical Agent Disposal System
LAER	Lowest Achievable Emission Rate
LBAD	Lexington/Bluegrass Army Depot, Kentucky

LIC	Liquid Incinerator (CSDP)
LIN	Liquid Incinerator (BZ)
MAAP	McAlister Army Ammunition Plant
MDM	Multipurpose Demilitarization Machine
MHA	Munitions Holding Area
MIN	Mine Machine
MPF	Metal Parts Furnace
MTC	Munition Test Chamber
NAAP	Newport Army Ammunition Plant, Indiana
NAAQS	National Ambient Air Quality Standards
NADA	Navajo Depot Activity
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Eliminations System
NSPS	New Source Performance Stnadards
OB	Open Burning
OD	Open Detonation
OSHA	Occupational Safety and Health Act
OVT	Operational Verification Test
PAS	Pollution Abatement System
PBA	Pine Bluff Arsenal, Arkansas
PCP	Polychlorinated Phenol
PEP	Propellant, Explosive and Pyrotechnic Materials
PETN	Explosive Pentaerythritol Tetranitrate
PIC	Products of Incomplete Combustion
PMD	Projectile/Mortar Disassembly Machine
PM Cml Demil	Program Manager for Chemical Demilitarization
PMP	Potential Migration Pathways
POHC	Principal Organic Hazardous Constituents
POL	Petroleum, Oils and Lubricants
PSD	Prevention of Significant Deterioration
PUDA	Pueblo Depot Activity, Colorado
PWP	Plasticized White Phosphorous
QT	Quench Tower
RCRA	Resource Conservation and Recovery Act
RDS	Rocket Drain Station

RDT&E	Army Research, Development, Test and Evaluation
RDX	Explosive Cyclotrimethylenetrinitramine
RRAD	Red River Army Depot
RSM	Rocket Shear Machine
SARA	Superfund Amendments and Reauthorization Act of 1986
TCE	Trichloroethylene
TEAD	Tooele Army Depot, Utah
TECOM	Test and Evaluation Command
TNT	Explosive Trinitrotoluene
TOX-BRA	Toxic Cubicle Area-Brine Reduction Area
TSCA	Toxic Substances Control Act of 1976
UMDA	Umatilla Depot Activity, Oregon
UPA	Unpack Area
U.S.	United States
U.S.S.R.	Union of the Soviet Socialist Republics
VS	Venturi Scrubber
WARS	Worldwide Ammunition Reporting System
WP	White Phosphorous
WWII	World War II

☆U.S. GOVERNMENT PRINTING OFFICE:1991 -281 -507/ 40101

Enclosure 2:

DESERET CHEMCIAL DEPOT, UTAH.

PROPOSED REPORT LANGUAGE

The original Department of Defense (DoD) recommendation is to close Deseret Chemical Depot at the conclusion of its current chemical munitions disposal mission, which is slated to be completed in calendar year 2012. The recommendation also notes that, under existing federal law (50 USC 1521, as amended by Public Law 106-65, Sec. 141(b)(1)(A)), the incinerator at Deseret Chemical Depot must be torn-down at the conclusion of the chemical mission.

Deseret Chemical Depot's incinerator is the largest full-scale plant constructed by the Department of the Army under its Chemical Demilitarization Program, and Deseret will ultimately be responsible for having successfully de-milled nearly 60% of the United State's stockpile of obsolete chemical munitions. The total cost of designing, building, permitting, and equipping the Deseret facility represents nearly $1 billion in prior taxpayer investment.

Each of the Army incinerators, including Deseret, are operating pursuant to agreements between the Department of the Army and the Governors of the respective states where the facilities are located. In echoing current federal law, those agreements invariably call for the dismantling of the incinerators once their chemical missions are completed.

The Commission notes that, at the direction of the Congress, the Department of the Army contracted with the MITRE Corporation in 1991 to complete a study on alternative uses for these incinerator facilities. This study validated the technical feasibility of converting the existing incinerators for various other uses, including conventional munitions disposal. While this study is over 14 years old, there is nothing to indicate that the engineering studies undertaken on alternative uses, including conventional de-milling activities, are no longer valid. The Commission further takes note that there is a growing backlog of obsolete conventional munitions and energetics within the Army and other services requiring disposal. Increasingly strict environmental regulations governing open-air destruction of these materials are contributing to the growing backlog of conventional materials, and may require more environmentally-sensitive methods of disposal such as incineration and scrubbed emissions; capabilities which the existing Deseret facility already provides.

Finally, the Commission notes that there is significant support within the State of Utah and the Utah Congressional Delegation for converting the Deseret Chemical Depot incinerator to conventional munitions disposal; a current mission at adjacent Tooele Army Depot. Under the most optimistic of scenarios, it will take the Army until the year 2012 for the existing Deseret Chemical mission to be completed. Given all of these facts, it would seem reasonable to provide the Congress flexibility over the next seven years to

re-examine use of the Deseret incinerator facility to provide a means of disposing of conventional munitions and energetics once its chemical mission is completed.

RECOMMENDATION: The Commission directs that the DoD recommendation regarding the Deseret Chemical Depot, Utah, be modified as follows:

The Deseret Chemical Munitions Disposal Facility shall be allowed to remain open beyond the year 2012 and not dismantled, contingent upon the following conditions being met by no later than December 31, 2011:

(1) The Congress repeals or modifies existing federal law requiring dismantling of the Deseret Chemical Depot incinerator facility, to allow for modification and use of the facility for conventional munitions and energetics disposal activities only, and;

(2) The Governor of the State of Utah consents through a new Memorandum of Agreement with the U.S.Army and/or the Secretary of Defense, to follow-on uses of the Deseret facility for conventional munitions and energetics disposal.

Should these two requirements not be met by the deadline, the Commission directs that the original DoD recommendation requiring the closure, dismantling, and excess property transfer to Tooele Army Depot, of Deseret Chemical Depot facilities, be carried out as contained in the original 2005 DoD recommendation.