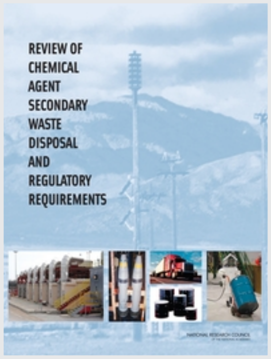

Review of Chemical Agent Secondary Waste Disposal and Regulatory Requirements

DETAILS

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REVIEW OF CHEMICAL AGENT SECONDARY WASTE DISPOSAL AND REGULATORY REQUIREMENTS

Committee on Review of Chemical Agent Secondary Waste Disposal
and Regulatory Requirements

Board on Army Science and Technology

Division on Engineering and Physical Sciences

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Preface

The U.S. Army's Chemical Materials Agency (CMA) is charged with disposing of all chemical munitions and chemical agents in accordance with congressional mandates and in compliance with the Chemical Weapons Convention treaty. In fulfilling part of that mission, the CMA currently operates five facilities to dispose of stockpile munitions and agent. Large quantities of waste result during the disposal operations. This report addresses the challenges of managing these wastes safely and effectively as agent disposal operations proceed. The efficient disposal of the wastes generated as a result of the disposal operations, termed "secondary wastes," can enable a more timely and cost-effective closure of the facilities after agent disposal operations are complete.

This report on the management of these secondary wastes was initiated by the National Research Council (NRC) at the request of the CMA, the agency managing the disposal of chemical weapons. The statement of task for the Committee on Review of Chemical Agent Secondary Waste Disposal and Regulatory Requirements is as follows:

> The NRC will conduct an examination of the environmental, regulatory and permit requirements that chemical agent disposal facilities (CDFs) are subject to, on a federal and state basis, concerning the treatment, storage, and/or handling and shipping of secondary wastes (chemical agent and non-agent related).
>
> The NRC will compare the requirements for CDFs with those to which similar facilities in industry that treat, store, and/or handle and ship secondary wastes are subject, with particular emphasis on industrial best practices.
>
> The comparison with industry practices includes, but is not limited to the following areas:
>
> - the degree of characterization necessary for secondary waste (chemical agent and non-agent) produced during the stockpile disposal and/or storage operations, which is treated on-site or handled and shipped off-site for further treatment or disposal;
> - the number and types of trial burns/compliance tests for chemical stockpile incineration-based disposal facilities and the neutralization-based disposal facility on both a site-by-site basis and programmatically recognizing that the Resource Conservation and Recovery Act has provisions for using prior data;
> - feed-rate restrictions to which chemical agent disposal facilities are subject for post trial burns;
> - the extent and number of health risk assessments deemed necessary;
> - criteria being considered for shipment of agent contaminated wastes for final treatment/disposal;
> - facility closure requirements; and
> - the comparison will address site-specific situations concerning CDFs as well as program-wide considerations of the Chemical Materials Agency with regard to stockpile disposal operations.

As the chair of the committee, I wish to express my appreciation to the committee members for their contributions to the preparation of this report, which included interviewing, visiting, collecting, and analyzing significant information and issues, not only at the disposal sites but also at industrial facilities and state regulatory agencies. The efforts of the writing team leaders, Gary Groenewold, Rebecca Haffenden, and Loren Koller, are particularly appreciated.

The committee in turn is grateful to the CMA, its staff, field offices, and the site contractors for the timely and useful information they provided. The committee also thanks the management and environmental regulatory staff of Dow Chemical Company, E.I. du Pont de Nemours and Company, Clean Harbors Aragonite, Inc., Chemical Waste Management of the Northwest, and the Coalition for Responsible Waste Incineration for their openness in discussing industrial waste management best practices. It also greatly appreciates the support and assistance of the NRC staff who ably assisted the committee in its fact-finding activities and in the production of the report.

The Board on Army Science and Technology (BAST) members listed on page vi were not asked to endorse the committee's conclusions or recommendations, nor did they review the final draft of this report before its release, although board members with appropriate expertise may be nominated to serve as formal members of study committees or as report reviewers. BAST was established in 1982 by the National Academies at the request of the Army. It brings to bear broad military, industrial, and academic scientific, engineering, and management expertise on Army technical challenges and other issues of importance to senior Army leaders. BAST also discusses potential studies of interest; develops and frames study tasks; ensures proper project planning; suggests potential committee members and reviewers for reports produced by fully independent, ad hoc study committees; and convenes meetings to examine strategic issues.

Peter B. Lederman, *Chair*
Committee on Review of Chemical Agent Secondary Waste Disposal and Regulatory Requirements

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's (NRC's) Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Richard A. Conway, Union Carbide Corporation (retired),
Elizabeth M. Drake, Massachusetts Institute of Technology (retired),
Todd A. Kimmell, Argonne National Laboratory,
Nelline K. Kowbel, Malcolm Pirnie, Inc.,
Joann Slama Lighty, University of Utah,
W. Leigh Short, Woodward-Clyde, Inc. (retired),
Calvin C. Willhite, California Environmental Protection Agency, and
Jeffery J. Wong, California Environmental Protection Agency.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by R. Stephen Berry, University of Chicago. Appointed by the NRC, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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Tables, Figures, and Boxes

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Acronyms and Abbreviations

1X	Army designation for agent-contaminated waste
3X	Army designation for potentially agent-contaminated waste
5X	Army designation for agent-free or decontaminated potentially agent-contaminated waste
ABCDF	Aberdeen Chemical Agent Disposal Facility
ACAMS	automatic continuous air monitoring system
ADEM	Alabama Department of Environmental Management
ADEQ	Arkansas Department of Environmental Quality
ANCDF	Anniston Chemical Agent Disposal Facility
ATB	agent trial burn
BRA	brine reduction area
CAA	Clean Air Act
CAC	Citizens Advisory Commission
CDC	Centers for Disease Control and Prevention
CDF	Chemical Agent Disposal Facility
CMA	U.S. Army Chemical Materials Agency
CPT	comprehensive performance test
CRWI	Coalition for Responsible Waste Incineration
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWC	Chemical Weapons Convention
CX	phosgene oximine
DAAMS	depot area air monitoring system
DFS	deactivation furnace system
DOT	U.S. Department of Transportation
DPE	demilitarization protective ensemble
DRE	destruction and removal efficiency
EPA	U.S. Environmental Protection Agency
GA	nerve agent, also known as tabun
GB	nerve agent, also known as sarin
GD	nerve agent, also known as soman
H	sulfur mustard, a blister agent, also known as yperite
HD	distilled mustard, a blister agent
HL	mustard/lewisite mix, a blister agent
HN	nitrogen mustard, a blister agent
HRA	health risk assessment
HT	mustard mixed with bis(2-chloroethylthioethyl) ether, a blister agent
HTT	high-temperature test
IDEM	Indiana Department of Environmental Management

JACADS Johnston Atoll Chemical Agent Disposal System

L liter
LDR land disposal restriction
LIC liquid incinerator

m^3 cubic meter
MACT maximum achievable control technology
mg milligram
MPF metal parts furnace

NaOH sodium hydroxide
NECDF Newport Chemical Agent Disposal Facility
NOC notice of compliance
NRC National Research Council

ODEQ Oregon Department of Environmental Quality

PAS pollution abatement system
PBCDF Pine Bluff Chemical Agent Disposal Facility
PCB polychlorinated biphenyl
PCC permit compliance concentration
PFS pollution abatement system filtration system
POHC principal organic hazardous constituent
ppb part per billion
PPE personal protective equipment

RCRA Resource Conservation and Recovery Act

SDS spent decontamination solution
STB surrogate trial burn
STEL short-term exposure limit
STL short-term limit

T bis(2-chloroethylthioethyl) ether, a chemical sometimes mixed with H
TC ton container
TCLP Toxicity Characteristic Leaching Procedure
TOCDF Tooele Chemical Agent Disposal Facility
TSCA Toxic Substances Control Act
TSDF treatment, storage, and disposal facility

UDEQ Utah Department of Environmental Quality
UMCDF Umatilla Chemical Agent Disposal Facility

VSL vapor screening level
VX nerve agent

WCL waste control limit

Summary

The U.S. Army is currently in the process of disposing of the nation's obsolete stockpile of chemical agents and munitions, which are considered to be hazardous waste. Secondary waste materials are being generated from the processes used to destroy this primary waste at five currently operating chemical agent disposal facilities in the continental United States. Management and disposal of the growing volume of secondary waste has become a major consumer of staff time and effort at these facilities.

This study is concerned only with the wastes that are generated as a result of disposal operations at the four baseline incineration system facilities and one other facility that uses neutralization (hydrolysis) technology as the means of agent destruction. The facilities using incineration are located at Anniston, Alabama; Pine Bluff, Arkansas; Umatilla, Oregon; and Tooele, Utah. These facilities dispose of a variety of chemical munitions as well as bulk agent stocks of the nerve agents sarin (GB) and VX and of mustard, a blister agent. The facility using neutralization technology, located at Newport, Indiana, uses caustic hydrolysis to destroy the VX agent stored there in bulk ton containers. A lesson from the closure of the U.S. Army's first-generation incineration facility, the Johnston Atoll Chemical Agent Disposal System (JACADS), was that the costs and time required for closure were significantly increased because the thousands of tons of secondary waste that had accumulated had to be disposed of. The experience at JACADS clearly showed that it is preferable that secondary wastes should be managed and disposed of concurrently with primary agent disposal operations rather than stored until the end of the agent disposal campaigns.

Secondary wastes may or may not be contaminated with agent residues. Depending on the particular constituents involved and the method of waste generation, these wastes may be classified as hazardous or nonhazardous. Most of the wastes generated during the operation of the disposal process are the same at the various facilities, with some exceptions for the neutralization facility at Newport. Quantities may differ because of the duration of operations and the particular mix of munitions being destroyed. Therefore, many of the challenges concerning waste management and disposal are the same across the program. This study considers all major wastes streams that are generated during agent disposal operations as well as during facility closure. It concentrates on the following major waste streams being generated from the destruction processing of stockpile agent and munitions, including munitions handling:

- Spent activated carbon;
- Brine solutions or brine salts;
- Dunnage, consisting primarily of wooden pallets;
- Metal from munitions or ton containers;
- Plastics, particularly used demilitarization protective equipment; and
- Spent decontamination solutions.

The issues surrounding the effects on closure operations from waste generation and management before and after completion of stockpile disposal operations are also considered.

While the waste streams are essentially the same for all facilities, the way they are managed is not. The chemical agent disposal facilities are all regulated under the Resource Conservation and Recovery Act (RCRA) by the respective state regulatory authorities, and each facility operates under a RCRA permit. These permits were initially negotiated prior to facility construction, when waste types but not quantities were generally known. The permits were therefore modified to a greater or lesser extent as disposal operations proceeded, depending on the local situation. Thus, local regulations and stakeholder concerns play a role in what any facility can do. In three states, for example, the wastes generated from the operation of the chemical agent disposal facility are "listed hazardous wastes," while in the other two states they are not. This has a significant influence on how the wastes can be managed. Listed wastes and wastes derived from listed wastes must be treated as hazardous even if they do not exhibit hazardous characteristics, with the exception that they may be delisted.

Permit conditions will also affect the disposition of waste. For example, in Oregon all waste, with some minor exceptions, must be treated on-site. This significantly inhibits the options for disposal of the wastes off-site. Treatment on-site is limited by the capacity of the metal parts furnace (MPF) and its availability when it is not processing the munitions. Permits at the other locations are not as restrictive as in Oregon, which requires on-site treatment of secondary waste. The detailed differences in operations are discussed in Chapter 3 of the report.

The committee was also asked to evaluate the trial burn practices at the incineration-based facilities and compare them with similar practices in industry. Each Chemical Materials Agency (CMA) incineration facility has several types of incinerators and each has been required, by permit, to carry out a surrogate burn on all of its furnaces after start-up and before feeding any agent. A surrogate trial burn is required to demonstrate the ability of the unit to achieve a 99.9999 percent ("six nines") destruction and removal efficiency and unit operability. They have then been required to carry out a trial burn with each agent. After the trial burn, the feed rates are reduced to 50 percent until the trial burn data have been submitted, and to 75 percent until the data have been accepted. This is a lengthy process.

While industrial practice requires a trial burn and a facility may not operate until the data are accepted, industrial facilities obtain approval to process many different waste streams based on a single trial burn. In special situations, particularly with toxic materials such as polychlorinated biphenyls, both a surrogate burn and a trial burn would be required. RCRA regulations offer the option of allowing the use of data from another facility, under certain conditions, in lieu of a trial burn. However, industry has used this mechanism at only a few sites with similar units. It has been used twice by the CMA for the Tooele, Utah, disposal facility. The CMA should pursue this mechanism with the respective regulatory authorities. The committee believes that chemical agent disposal facilities are treated similarly to industrial facilities with respect to the conduct of trial burns.

The committee's study of site-specific secondary waste practices and requirements focused on the six major waste streams produced by the chemical agent disposal operations. Of the six, brine and brine salts are treated and disposed of off-site during operations at permitted treatment, storage, and disposal facilities. At the Umatilla site, brine solutions are thermally treated to produce a solid salt, which is then shipped off-site to a hazardous waste landfill. However, brine solution may be disposed of off-site if thermal treatment to produce a brine salt impedes the main mission of the agent disposal operation. Brine and brine salts must meet the established waste control limit for off-site disposal—that is, the agent concentration must be below the permit limit for materials containing agent.

Of the five remaining major waste streams, spent activated carbon is being stored at each facility for later disposal. Munitions bodies and other scrap metal are sent to off-site smelters after being thermally treated to a clean condition in the MPF at the four incineration-based facilities. Because on-site secondary waste processing capacity is limited, demilitarization protective ensemble suits are shipped off-site or stored until they can be treated on-site in the MPF when it has an opening in its schedule or at the end of agent destruction operations.

Wood dunnage is separated into that which has not been exposed to agent and that which may have been exposed. This segregation is based on generator knowledge and vapor monitoring. Unexposed dunnage is typically disposed of as ordinary nonhazardous waste. Agent-contaminated dunnage is thermally treated in the MPF as scheduled operations allow or is stored until the end of agent disposal operations, due to limited on-site secondary waste processing capacity.

At the Newport Chemical Agent Disposal Facility (NECDF), instead of the brine solution and furnace slag found at incineration facilities, an aqueous liquid waste stream is generated as a result of the neutralization (chemical breakdown) of the chemical agent VX. Several plans for treating and disposing of Newport hydrolysate have been considered. Most recently, this hydrolysate waste from the first-stage VX neutralization was to be disposed of off-site by chemical and biological treatment in a commercial treatment, storage, and disposal facility (TSDF). Approximately 1.5 million gallons of VX hydrolysate is expected to be generated at NECDF. The disposition of this material has been in dispute and is still under study by the Army.[1] The nature of the final waste stream resulting from a second processing step for the VX hydrolysate has consequently not yet been defined. Many of the other wastes from NECDF are similar to those found at the baseline incineration sites.

The committee found that the regulatory requirements with respect to waste characterization and disposal were similar for industrial facilities and the Army's chemical agent disposal facilities. Minor exceptions are discussed in the body of the report. The main result of the analysis by the committee, as detailed in the findings and recommendations, is that it is both technically feasible and advantageous to dispose of as much waste as possible off-site at approved TSDFs during operations. Also, the mechanism provided for in the Resource Conservation and Recovery Act, which allows data from earlier trial burns conducted in similar incinerators to be used in lieu of conducting an additional trial burn for another disposal facility incinerator, should be utilized to the fullest extent possible. All findings and recommendations are listed in Chapter 5. The most significant appear below.

[1]The disposition of the Newport hydrolysate recently changed. As of May 1, 2007, the Army was shipping Newport hydrolysate to a commercial TSDF incinerator. Since this change occurred after the report was completed but before it was published, the committee is unable to comment.

FINDINGS AND RECOMMENDATIONS

Finding 2-1. An examination of the situation concerning trial burn requirements for incinerators at chemical agent disposal facilities has led to several observations:

- Surrogate trial burns demonstrate that incinerators at chemical agent disposal facilities can operate safely. The requirement to perform surrogate trial burns at these facilities is consistent with the initial start-up procedures followed at commercial hazardous waste incineration facilities.
- In the earlier phases of the Army's Chemical Stockpile Disposal Program, an agent trial burn conducted for each incinerator with each agent to be processed was an appropriate way for disposal facility staff and state regulatory staff to gain operational experience and confidence in the performance of the incinerators.
- As the Chemical Stockpile Disposal Program has matured, there has been only limited use of the data-in-lieu-of regulatory mechanism provided for in the Resource Conservation and Recovery Act. This provision, if applied more extensively to chemical agent disposal facilities, could allow data from other similar incinerators at chemical agent disposal facilities to be used in lieu of conducting additional agent trial burns.

Recommendation 2-1. The Chemical Materials Agency should vigorously pursue the application of the Resource Conservation and Recovery Act provision for using trial burn data from other similar chemical agent disposal facility incinerators in lieu of conducting trial burns for additional agents. This is a reasonable way to proceed now that (1) at least one agent trial burn has occurred for each type of agent in each type of incinerator at all the chemical agent disposal facilities and (2) a surrogate trial burn and an initial agent trial burn have occurred for each incinerator at all sites.

Finding 2-2. The time required to obtain state regulatory approval to proceed to a full feed rate following submission of agent trial burn data for incinerators at chemical agent disposal facilities can be lengthy. This is a consequence of the volume and complexity of the documents filed, as well as limited state regulatory agency resources to review and analyze them.

Recommendation 2-2. The Chemical Materials Agency should seek to provide funding to state authorities for third-party or other support to facilitate the analysis and disposition of trial burn data. This would shorten the time needed to obtain approval for incinerators at chemical agent disposal facilities and allow them to proceed more rapidly to a full processing rate.

Finding 2-5. The committee's examination of how transportation risk assessments for agent-contaminated waste materials are conducted at chemical agent disposal facilities indicated that widely differing models and parameters have been used. A specific problem identified by the committee is that the methodology used for general ton-mile data in transportation risk assessments to achieve a Class 6 ton-mile value is not consistent.

Recommendation 2-5. The Chemical Materials Agency should establish consistent and detailed criteria for conducting whatever transportation risk assessments are required to ensure accuracy and uniformity in the expression of results.

Finding 3-1. In the absence of better techniques for measuring agent concentrations on certain heterogeneous, porous, and permeable materials, indirect measurements leading to conservative classifications of waste materials are being used at chemical agent disposal facilities.

Recommendation 3-1. The Chemical Materials Agency should develop improved analytical techniques for heterogeneous, porous, and permeable materials. Better analytical techniques could enable more exact quantification of agent contamination to meet off-site shipping criteria and help reduce waste remaining on-site at the end of munitions destruction operations.

Finding 3-3. The availability and capacity of equipment for the concurrent treatment of secondary waste during agent disposal operations or changeovers at chemical agent destruction facilities is severely limited in comparison with the capacity available at off-site commercial treatment facilities that could process the waste.

Recommendation 3-3. The committee encourages the CMA to continue the pursuit of off-site shipment and disposal of >1 STL secondary waste. The committee believes this can be done safely in a ramp-up fashion, based on the use of double bags and containerized packing, truck loading restrictions, designated handling and shipping routes, air monitoring at the receiving TSDF, and restrictions on the disposal technique. Appropriate details, including permit modifications, must be worked out in conjunction with the local regulatory agencies and local stakeholders for the practice to be allowed.

Finding 3-4. Contaminated activated carbon from the treatment of several different waste streams is a major waste disposal problem at all chemical agent disposal facility sites. The micronization pretreatment of activated carbon in preparing it to be destroyed by on-site incineration has been shown to be a highly problematic process option.

Recommendation 3-4. The Chemical Materials Agency should select an alternative to on-site micronization followed by incineration for decontamination and/or destruction, and ultimate disposal of contaminated activated carbon. Off-site decontamination, and/or destruction and disposal of contaminated activated carbon should be pursued whenever possible.

Finding 3-5. Some of the mustard agent to be processed at the Tooele Chemical Agent Disposal Facility and the Umatilla Chemical Agent Disposal Facility is mercury-contaminated and will result in some of the activated carbon from the pollution abatement system also being contaminated with mercury. Special treatment may be required or additional challenges may be faced in disposing of this carbon.

Recommendation 3-5. The Chemical Materials Agency should evaluate and select appropriate methods for the treatment and disposal of mercury-contaminated carbon. Mercury-contaminated carbon should not be intermingled with other contaminated carbons during storage.

Finding 3-8. The waste management practices for demilitarization protective ensemble suits and other plastics are limited by the on-site capacity for treatment and, at some sites, by the regulatory restrictions for off-site disposal.

Recommendation 3-8. The Chemical Materials Agency should actively pursue off-site shipment and disposal of waste plastic and personal protective equipment such as demilitarization protective ensemble suits from all sites based on adherence to and enforcement of packing, shipping, monitoring, and treatment restrictions.

Finding 3-9. As of January 2007, over 500,000 gallons of VX hydrolysate generated by the neutralization destruction of bulk nerve agent VX at the Newport Chemical Agent Disposal Facility was being stored in more than 140 intermodal storage containers. It is anticipated that 1.5 million gallons of VX hydrolysate will eventually be generated. Studies by outside government agencies and technical organizations have found that safe, environmentally sound, off-site disposal of VX hydrolysate (such as that proposed by DuPont) is technically feasible.

Recommendation 3-9. The Chemical Materials Agency should evaluate and select an appropriate method to dispose of the VX hydrolysate currently being stored at the Newport, Indiana, site, with preference for off-site disposal.

Finding 3-10. Each chemical agent disposal facility in this study has established open and effective communication channels and has regular dialogue with its Citizens Advisory Commission and other local stakeholders. The input of these stakeholders is also sought by regulatory officials and is an important factor in negotiating permit modifications concerning secondary waste disposal practices.

Recommendation 3-10. The Chemical Materials Agency should continue its support for and emphasis on local stakeholder input and involvement as mission-critical elements when acceptable secondary waste disposal practices are being defined and regulatory permit requirements are negotiated.

Finding 4-1. Closure planning and the time to achieve closure for chemical agent disposal facilities are both very dependent on the extent of waste treatment and disposal that occurs during agent disposal operations—that is, on the degree of concurrent waste minimization that takes place. However, there is only limited treatment capacity for secondary waste during agent disposal operations and changeovers at chemical agent disposal facilities.

Recommendation 4-1. The Chemical Materials Agency should use off-site disposal concurrent with ongoing agent disposal operations wherever possible, practical, and environmentally sound for all secondary and closure wastes generated during operations.

Finding 4-2. An analytical methodology for establishing agent contamination levels in porous wastes generated during closure, such as concrete scrabble, is not available.

Recommendation 4-2. The Chemical Materials Agency should develop appropriate analytical methods for establishing agent levels in porous materials and have them certified at the earliest possible time as a means of minimizing closure costs.

1

Secondary Waste Generation at Chemical Agent Disposal Facilities

INTRODUCTION

Under the direction of the U.S. Army's Chemical Materials Agency (CMA), the nation is engaged in the destruction of its obsolete stockpile of chemical weapons. These materials are considered hazardous waste. The agents and munitions are destroyed using a combination of mechanical, chemical, and thermal processing. The progress made in destroying the stockpile agents and munitions comes with a challenge, however—disposal of secondary wastes from these destruction processes in a safe manner and in compliance with all applicable laws. The laws governing the disposal of these hazardous wastes are dictated primarily by the federal Resource Conservation and Recovery Act (RCRA) but are managed by state regulatory agencies, which sometimes stipulate different levels of performance.

At the Army's request, the National Research Council (NRC) previously examined process technologies and associated requirements to optimize health, safety, and operations at chemical disposal facilities,[1] including issues related to the continuing operability of these facilities (NRC, 2006). An important and growing part of the ongoing operations at the chemical agent disposal facilities is managing the secondary wastes, which can amount to between 2 and 5 pounds per pound of chemical agent destroyed, excluding closure waste.[2]

In June 2006 the CMA asked the NRC to evaluate its practices for managing secondary waste at its chemical agent disposal facilities. This study focuses on the growing volume of secondary waste at each chemical agent disposal facility and the regulatory requirements and best practices for managing these wastes.

Statement of Task

The full statement of task for this study is as follows:

> The NRC will conduct an examination of the environmental, regulatory and permit requirements that chemical agent disposal facilities (CDFs) are subject to, on a federal and state basis, concerning the treatment, storage, and/or handling and shipping of secondary wastes (chemical agent and non-agent related).
>
> The NRC will compare the requirements for CDFs with those to which similar facilities in industry that treat, store, and/or handle and ship secondary wastes are subject, with particular emphasis on industrial best practices.

[1]The NRC's Board on Army Science and Technology has produced many reports on chemical demilitarization over more than a decade. The board's reports on the Army Stockpile Disposal Program can be found at http://www7.nationalacademies.org/bast/Chemical_Stockpile_Demilitarization_Reports.html. The board's reports on the Non-Stockpile Chemical Materiel Project can be found at http://www7.nationalacademies.org/bast/Non_Stockpile_Chemical_Demilitarization_Reports.html. The board's reports on the Assembled Chemical Weapons Alternatives Program can be found at http://www7.nationalacademies.org/bast/Alternative_Technologies_for_Chemical_Weapon_Demilitarization_Reports.html.

[2]This ratio is a committee estimate based on the 31,496 tons of original chemical agent to be destroyed and the estimated quantities of secondary waste discussed in Chapter 3 of this report.

The comparison with industry practices includes, but is not limited to the following areas:

- the degree of characterization necessary for secondary waste (chemical agent and non-agent) produced during the stockpile disposal and/or storage operations, which is treated on-site or handled and shipped off-site for further treatment or disposal;
- the number and types of trial burns/compliance tests for chemical stockpile incineration-based disposal facilities and the neutralization-based disposal facility on both a site-by-site basis and programmatically recognizing that the Resource Conservation and Recovery Act has provisions for using prior data;
- feed-rate restrictions to which chemical agent disposal facilities are subject for post trial burns;
- the extent and number of health risk assessments deemed necessary;
- criteria being considered for shipment of agent contaminated wastes for final treatment/disposal;
- facility closure requirements; and
- the comparison will address site-specific situations concerning CDFs as well as program-wide considerations of the Chemical Materials Agency with regard to stockpile disposal operations.

The membership of the Committee on Review of Chemical Agent Secondary Waste Disposal and Regulatory Requirements included experts in environmental chemistry, hazardous waste management, transportation safety, risk analysis, toxicology, civil engineering, environmental law, chemical process engineering, industrial process technology, environmental management, chemistry, and chemical engineering. Biographical sketches for committee members are presented in Appendix A.

During the course of the study, presentations and written information on secondary waste practices and regulatory requirements were received from a multitude of organizations that included individual Army facilities, Army contractors, industrial facilities, regulatory authorities, and other organizations involved with waste management.

The committee met in Washington, D.C. (August 2006); Tooele, Utah (September 2006); Washington, D.C. (December 2006); Irvine, California (January 2007); and Washington, D.C. (February 2007). In addition to these full committee meetings, small teams of four to six people from the committee also conducted fact-finding site visits to chemical agent disposal facilities in Anniston, Alabama (October 2006); Umatilla, Oregon (November 2006); and Newport, Indiana (November 2006). Visits and discussions on hazardous waste practices also took place at the Clean Harbors Aragonite hazardous waste incineration facility (Aragonite, Utah) and at the Chemical Waste Management of the Northwest, Inc., landfill (Arlington, Oregon). Additional details on the committee's meetings and activities are included in Appendix B.

Representatives from the committee also met with state regulatory officials in Alabama, Indiana, Oregon, and Utah during the site visits. Their discussions centered on state regulatory requirements impacting local facilities and any perceived secondary waste issues for the chemical agent disposal facilities. Committee members also met with representatives from the Confederated Tribes of the Umatilla Indian Reservation, representatives from three local Citizens Advisory Commissions (CACs) in Newport, Tooele, and Umatilla, and other public officials (Anniston) to gauge local public perception of secondary waste practices, regulatory requirements, and any associated issues that might emerge at the disposal facilities.

Organization of the Report

Chapter 1 provides a background overview of the issues surrounding management of secondary waste at chemical agent disposal facilities. The report focuses on the four operating facilities that are based on incineration as the primary destruction technology. It also covers the one other active facility, which uses neutralization (hydrolysis) as the primary destruction technology.[3] Chapter 1 also briefly describes the chemical processes in these chemical agent disposal facilities and the types, sources, and volumes of secondary waste handled. Importantly, Chapter 1 also summarizes federal and state regulatory requirements for managing the hazardous waste from both the Army's facilities and similar industrial facilities, as well as site-specific permits requirements. Key issues and comparisons central to this report are addressed in the two chapters that follow. Chapter 2 addresses trial burns and health risk assessment. It compares the experience of the Army's chemical agent disposal facilities with that of industrial facilities practicing similar technologies. Chapter 3 characterizes the

[3]The terms "neutralization" and "hydrolysis" are often used interchangeably in the literature on chemical agent demilitarization. Hydrolysis is the more appropriate term from a chemical process perspective. Neutralization is more in keeping with the notion of neutralizing and thereby rendering innocuous. It may be found in the literature to refer to hydrolysis in either aqueous or nonaqueous media.

secondary wastes at each site, describes and analyzes practices and permit requirements, and compares these with the situation and practices at industrial sites. Anticipated wastes and waste disposal issues associated with site closure at the end of chemical agent disposal operations are addressed in Chapter 4. Findings and recommendations are presented in Chapter 5.

Throughout the report, specific chemical agent disposal facilities are listed in the alphabetical order of the names of the states where they are located. This parallels the organization of state regulatory considerations throughout the report. The units still in operation began operation in the following order: Tooele, Utah; Anniston, Alabama; Umatilla, Oregon; Pine Bluff, Arkansas; and Newport, Indiana.

CHEMICAL STOCKPILE DISPOSAL PROGRAM

Overview

During the Cold War, the United States produced and stockpiled over 31,000 tons of unitary nerve agents (sarin (GB) and VX) and blister agents (sulfur mustard (H), distilled sulfur mustard (HD), and mixed mustard (HT)). The agents were loaded into individual munitions or stored in bulk containers. They are now obsolete and their use has been banned by the Chemical Weapons Convention (CWC), an international treaty that was ratified by the U.S. Congress in 1997. The Chemical Stockpile Disposal Program began over two decades ago. In 1985, Congress had mandated that the Army institute a sustained program to destroy some elements of the chemical weapons stockpile (Public Law 99-145), and in 1992 it extended this mandate to require the destruction of the entire stockpile (Public Law 102-484). The CWC requires that its signatory nations destroy their entire chemical weapons stockpiles by April 29, 2007. An extension to April 29, 2012, has been granted to the United States, Russia, and several other nations.

The U.S. Army, as the executive agent for the U.S. Department of Defense, selected incineration as the preferred method of stockpile destruction for the first U.S. chemical agent disposal facility. The Johnston Atoll Chemical Agent Disposal System (JACADS) was located on Johnston Island, southwest of Hawaii, operated throughout the 1990s, and has since been demolished. The first disposal facility in the continental United States is the still active Tooele Chemical Agent Disposal Facility (TOCDF) in Tooele, Utah, which began agent destruction operations in 1996. It was followed by incineration facilities at three additional sites: the Anniston Chemical Agent Disposal Facility (ANCDF) in Anniston, Alabama; the Pine Bluff Chemical Agent Disposal Facility (PBCDF) in Pine Bluff, Arkansas; and the Umatilla Chemical Agent Disposal Facility (UMCDF) in Umatilla, Oregon.

In response to public concerns, the Army also developed and implemented chemical neutralization technology as the method of destroying chemical agent at two sites where chemical agents were stored in bulk, and no explosives or propellants had to be destroyed. The sites that have used neutralization technology are the Aberdeen Chemical Agent Disposal Facility (ABCDF) in Aberdeen, Maryland, and the Newport Chemical Agent Disposal Facility (NECDF) in Newport, Indiana. Design and construction plans for neutralization facilities to destroy the stockpiled chemical agent and associated munitions located at Pueblo, Colorado, and Lexington, Kentucky, are currently being developed and are not covered in this report. JACADS and ABCDF have completed their agent destruction campaigns and are also not directly covered in this report.

Operating history and chemical agent disposal progress for each operating chemical agent disposal facility are summarized in Table 1-1. The composition of the chemical weapon stockpile at a particular site, the length of time the facility has been in operation, and the type of agent destruction process used, all influence the type and quantity of secondary waste generated at a facility.

Process Descriptions

Baseline Incineration System

The baseline incineration systems for destroying chemical agent follow the process scheme shown in Figure 1-1. Agent contained in munitions (including rockets) and bulk containers is moved from the stockpile, where it is stored in igloos, to the munitions demilitarization building. The munitions are disassembled and the agent is drained from the munitions in this building. Energetics are also separated from the munitions at this point. Agent, metal parts, and energetics are then sent further for treatment and destruction. The liquid agent is sent to the liquid incinerator (LIC), where it is burned. Metal parts are treated in the metal parts furnace (MPF), where they are treated at high tempera-

TABLE 1-1 Chemical Agent Disposal Facility Start-up History and Progress

Location	Process	Start Date	Agent Type[a]	Share of Local Stockpile Destroyed (%)[b]
TOCDF[c]	Incineration	August 1996	GB, H, HD, HT, VX	59
ANCDF[d]	Incineration	August 2003	GB, HT, HD, VX	27
UMCDF[e]	Incineration	September 2004	GB, HD, VX	24
PBCDF[f]	Incineration	March 2005	GB, HD, HT, VX	11
NECDF[g]	Neutralization	May 2005	VX	43[h]

[a]GB, a nerve agent known as sarin; H, HD, HT, blister or mustard agents; VX, an organophosphate nerve agent.
[b]Site reported agent destruction progress as of February 2007.
[c]TOCDF, Tooele Chemical Agency Disposal Facility.
[d]ANCDF, Anniston Chemical Agent Disposal Facility.
[e]UMCDF, Umatilla Chemical Agent Disposal Facility.
[f]PBCDF, Pine Bluff Chemical Agent Disposal Facility.
[g]NECDF, Newport Chemical Agent Disposal Facility.
[h]Further treatment of the resultant hydrolysate is necessary to meet the requirements of the CWC (NRC, 1998).
SOURCE: Agent destruction status as of February 28, 2007. Available at http://www.cma.army.mil/home.aspx#. Last accessed March 26, 2007.

ture to destroy any remaining agent and ensure that the metal parts meet the waste control limit (WCL) so that they can be shipped off-site. Energetics and metal parts with energetics are conveyed to the deactivation furnace system (DFS), where the energetics are destroyed and the metal parts are treated to meet the WCL. The metal from both the MPF and DFS is scrap metal and is a secondary waste. The gases from the three furnaces are treated in the pollution abatement system filtration system, where particulate and acid gases are removed in a cyclone scrubber and organic contaminants, primarily VOCs,[4] are recovered by activated carbon adsorbers. The scrubber brine is either treated on-site and reduced to a solid in the brine reduction area before off-site disposal, or sent off-site as a brine solution if it meets the WCL. The off-gases, primarily carbon dioxide and water that are products of combustion, pass from the carbon filters to the stack, where they are discharged to the atmosphere. The activated carbon in adsorbers and filters requires periodic replacement. Depending on the source and degree of contamination, the waste carbon from this operation is either shipped off-site or stored on-site for future disposition.

[4]VOCs is a common regulatory and technical term defining a class of "volatile organic compounds."

Newport Neutralization Process

A process block flow diagram for the NECDF VX neutralization process is shown in Figure 1-2. The Newport stockpile of nerve agent VX is stored in bulk ton containers (TCs). These TCs are moved from the stockpile to the TC cleanout area, where the liquid agent is drained from the TC into a holding tank prior to treatment. The liquid is batch treated in the neutralization reactor, where it is mixed with an aqueous sodium hydroxide (NaOH) solution that hydrolyzes the VX into smaller organic molecules. The product of this neutralization, known as hydrolysate, is an aqueous mixture that may separate into two layers: an upper organic layer and a lower aqueous layer. The organic layer, which can make up from 0.5 percent to 5 percent by volume of the hydrolysate (IDEM, 2006), is tested to ensure that the VX has been destroyed and sent to temporary storage for further treatment to meet the requirements of the CWC (NRC, 1998). The vent gases from the process are sent through a series of high-efficiency particulate air filters and activated carbon adsorbers, which capture any remaining particulates and organic contaminants. The spent carbon is a waste that must be managed. The "empty" TCs are rinsed with a caustic decontamination solution to remove any residual liquid and thermally treated to meet the WCL, after which

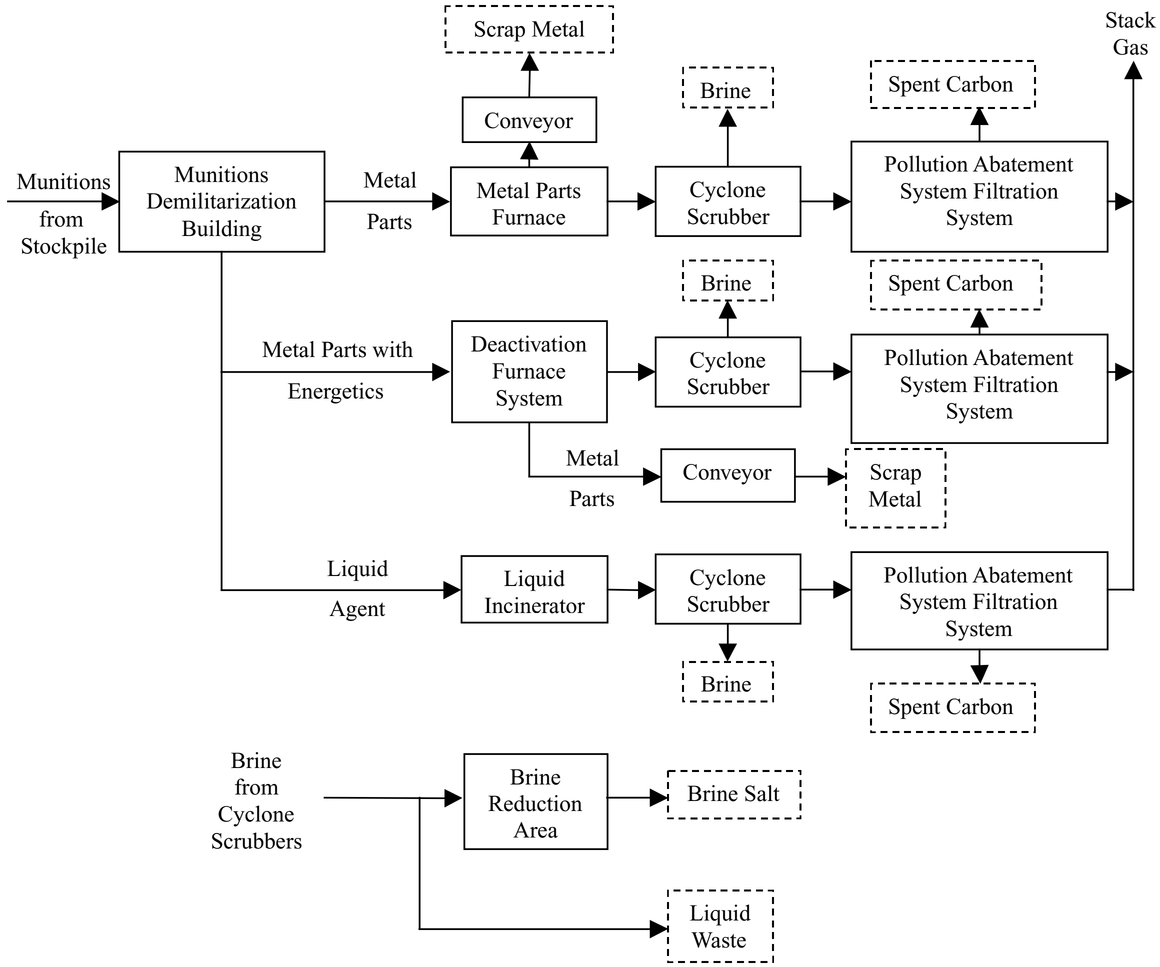

FIGURE 1-1 Baseline incineration system block diagram indicating major secondary waste streams.

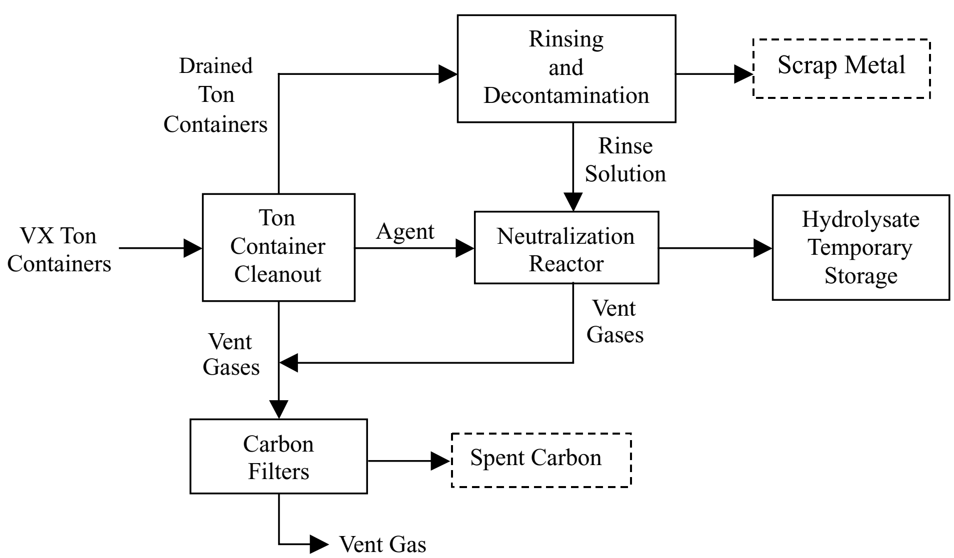

FIGURE 1-2 NECDF neutralization process block diagram indicating major secondary waste streams.

they are sent to smelters as scrap. The liquid rinsate is returned to the neutralization reactor.

SECONDARY WASTE FROM CHEMICAL AGENT DISPOSAL FACILITIES

Types of Secondary Waste

The U.S. Army's chemical agent disposal facilities, like many industrial facilities, produce wastes in the course of plant operations. For the purposes of this report, secondary waste is defined as any waste associated with the storage or destruction of chemical agent. Like other industrial waste, these wastes are either hazardous or nonhazardous. A particular waste is classified into one or the other of these categories by either laboratory analysis or "generator knowledge" of material source, use, and exposure (Box 1-1). The wastes discussed in this report are called "secondary wastes" to distinguish them from the chemical munitions that are being treated and disposed of, which are also wastes, but "primary" ones.

Many of the secondary wastes generated by the chemical agent disposal facilities are classified as hazardous by the federal and state regulatory agencies. This is because these wastes (1) exhibit a hazardous characteristic, (2) are listed as hazardous waste under the state regulatory program, (3) are derived from the treatment of a chemical warfare agent, or (4) are specified as hazardous in the state-issued facility permits. Hazardous wastes may therefore be either listed or characteristic, and some are both listed and characteristic. All hazardous and nonhazardous wastes generated at these facilities must be treated and disposed of in an environmentally safe manner, in accordance with the facility's operating permits and applicable state and federal regulations. Treatment and disposal of secondary wastes is typically done locally, depending on the type of waste. Some hazardous waste can be treated on-site using thermal treatment, combustion, or decontamination technologies, while others must be shipped to off-site permitted treatment, storage, and disposal facilities (TSDFs).

Chemical agent disposal facilities generate the following major categories of secondary wastes over the lifetime of operations:

- Spent activated carbon and spent particulate filter media from the pollution abatement system;
- Brine solutions or brine salts resulting from evaporation of the brine;
- Dunnage, consisting primarily of wooden pallets;
- Scrap metal from munitions or TCs;
- Plastics, particularly used demilitarization protective ensemble (DPE) suits and other personal protective equipment (PPE); and
- Spent decontamination solution.

Figure 1-3 gives a pictorial overview of the main secondary waste streams generated across the five operating chemical agent disposal sites. Other common wastes generated at some or all sites but not covered in detail in this report include the following:

- Cleaning materials;
- Equipment parts from maintenance and repair activities, such as discarded pumps, piping, gaskets, and hoses;
- Heated discharge conveyor ash and debris;

BOX 1-1
Definition of "Generator Knowledge"

"Generator knowledge" is a hazardous waste evaluation method commonly accepted and defined by the EPA and individual states based on some or all of the following information:

1. Facility process flow diagram or narrative description of the process generating the waste (should be used in most cases).
2. Chemical makeup of all ingredients or materials used in the process that generates the waste (should be used in most cases).
3. List of constituents that are known or believed to be by-products or side reactions to the process that produces the waste.
4. Material Safety Data Sheets and/or product labels or substances used in the process that generates the waste.
5. Data obtained from approved methods of sampling and laboratory analysis of waste generated from the same process using the same ingredients/materials.
6. Data obtained from literature regarding waste produced from a similar process using the same ingredients/materials.
7. Documentation of product specifications or input materials and output products.

SOURCE: EPA, 2005.

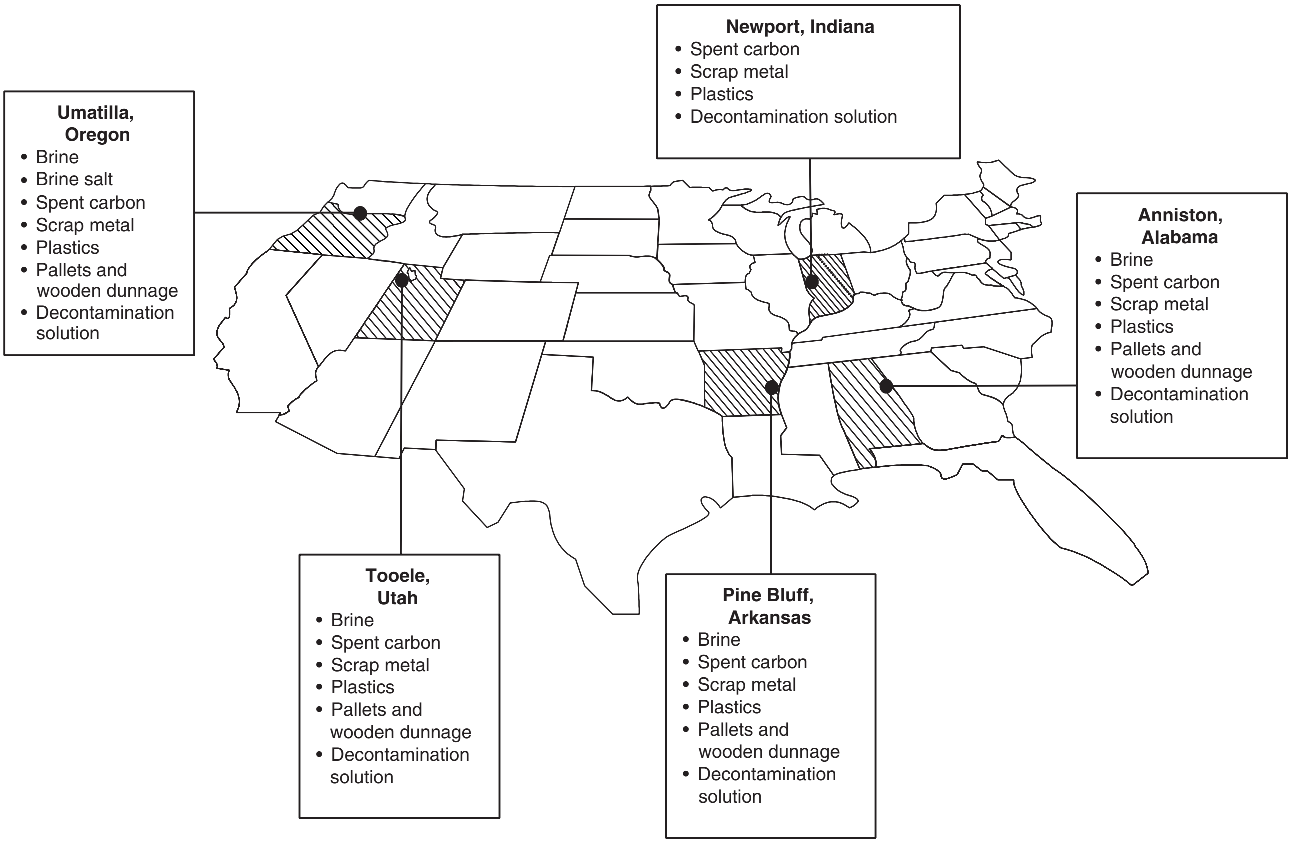

FIGURE 1-3 Major secondary waste distribution across chemical agent disposal facilities.

- Incinerator slag and refractory; and
- Laboratory waste.

These wastes are small in volume compared to the major secondary waste streams listed just above.

Chemical agent disposal facilities using incineration technology will have waste profiles somewhat different from facilities using neutralization technology. Table 1-2 gives a more detailed summary of both major and minor waste streams at chemical agent disposal facilities. The classification of these wastes and the acceptable treatment and disposal options, however, depend on state and federal regulations.

A separate category of waste, closure waste, results from the decontamination and destruction of the facility at the completion of disposal operations. These wastes, which are also classified as either hazardous or nonhazardous, are addressed in Chapter 4.

Sources of Secondary Waste

Direct chemical agent destruction operations as well as indirect or peripheral operations all result in secondary waste. Indirect or peripheral operations critical to chemical agent disposal facilities include laboratory operations, operations associated with protection of personnel or the environment, and operations associated with maintenance of the facility. The links between direct and indirect process operations and secondary waste streams are described next.

Pollution Abatement System Filtration System, Spent Activated Carbon

The pollution abatement system filtration system (PFS) treats all gases that emanate from the process or processing facilities. This includes gases flowing from the chemical processes and ventilation gases from the

TABLE 1-2 Site-Generated Waste Streams

Waste Stream	Description
MPF metal	Metal parts after incineration
MPF residue	MPF maintenance residue
LIC slag	Slag generated in LIC secondary chamber
LIC refractory	Produced during refractory change-out
DFS heated discharge conveyor ash	Produced during incineration of munitions
DFS cyclone residue	Produced during incineration of munitions
DFS refractory	Produced during refractory change-out
Brine salts	Produced during the evaporation of scrubber brine
Brine tank sludge	Produced during the cleanout of tanks that store scrubber brine
Waste citric acid	Generated during the cleaning of the brine reduction evaporators and PAS
Waste hydrochloric acid	Generated during the cleaning of the brine reduction evaporators and PAS
Demister filters	Produced during the change-out of demister filters
Spent decontamination solution (decontamination neutralization solution)	Produced from site decontamination and laboratory operations
Waste acid solution	Generated at the laboratory
Waste organic solvents	Generated at the laboratory
DPE suits	Generated during toxic operations
Wood pallets	Producing during the unpacking of on-site containers and munitions
Spent activated carbon	Produced during the change-out of the carbon filters
Miscellaneous metal parts	Worn-out equipment and parts
Clean-up materials	Miscellaneous materials generated during the decontamination and maintenance of the plant
Spill clean-up materials	Generated during single-substance spill response clean-up
Trash, debris, and PPE	Produced during maintenance activities
Brine reduction area baghouse debris	Produced during maintenance activities
MPF brick	MPF refractory replacement
MPF vacuum ash	Residue removed from MPF burn trays and munitions
Cleaning solutions	Cleaning of sample equipment
PAS solids	Solids collected in PAS filters and removed from quench towers and scrubbers

NOTE: DFS, deactivation furnace system; DPE, demilitarization protective ensemble; LIC, liquid incinerator; MPF, metal parts furnace; PAS, pollution abatement system; and PPE, personal protective equipment.
SOURCE: UDEQ, 2004.

forced air handling for all enclosed buildings on-site. Banks of activated carbon are used to capture and remove any trace-level residual semivolatile organics in the exhaust gases and air streams before release to the environment. The carbon beds are continuously monitored for organic breakthrough between individual trays of carbon, indicating when the trays need to be changed. This happens when the carbon is saturated to a specified practical limit, or is said to be “spent.” The beds containing spent carbon are emptied and refilled with fresh carbon. Spent activated carbon waste streams are generated at chemical agent disposal facilities using either the baseline incineration system or the neutralization process. The spent carbon may be considered hazardous or nonhazardous depending on the organic contaminants adsorbed, but they may also be classified as hazardous as a result of state regulation or site-specific permit conditions. In addition, prefilters, high-efficiency particulate air filters, and demister candles, all containing carbon, are also monitored and replaced as necessary. Spent carbon disposal options depend on contaminant type, contaminant level, and specific facility permit requirements. In at least two facilities, TOCDF and UMCDF, mustard agent containing mercury will be treated and will result in mercury-contaminated spent carbon in the PFS. Any such carbon will require special treatment and disposal techniques.[5]

[5]The TOCDF incineration system does not currently contain a PFS. Until a PFS is installed, TOCDF controls its mercury emissions below permit limits by processing only material low in mercury contamination.

PFS Scrubber Brine

Scrubber brine results from the treatment by the PFS of the process gases coming from the incinerators. Scrubber brine contains water, dissolved salts, suspended solids, and trace amounts of heavy metals. After use, scrubber brine is designated as spent brine and is transferred to storage tanks before off-site shipment to a permitted TSDF. A thermal evaporation system for concentrating the spent brine solution to solid brine salts is used at some sites, while other sites manage this waste as a brine solution. The use of a thermal evaporation brine reduction system may be required by individual site permits.

Spent Decontamination Solution

Decontamination solutions are dilute aqueous solutions of caustic or sodium hypochlorite. These solutions are used to wash (decontaminate) work areas where agent has spilled. They are also used to decontaminate a worker in PPE prior to removing the suit for disposal. Spent decontamination solution (SDS) usually contains very small amounts of the chemical agent breakdown products resulting from hydrolysis of the agent present on the surface being decontaminated. SDS is collected and stored on-site for later disposal either off-site or on-site by incineration.

Metal Parts Furnace Scrap Metal

This scrap metal includes metal munitions casings after the chemical agent has been drained and the casings have been treated in the MPF. Drained bulk containers and metal munition casings and components are treated in the MPF to destroy agent residues. After treatment in the MPF, the metal parts are allowed to cool, vacuumed to remove loose paint flakes and ash residue, and stored temporarily in roll-off bins prior to shipment off-site. Munition bodies and empty TCs are carbon steel and may be recycled by smelting at either a commercial recycling facility or the Rock Island Arsenal,[6] or disposed of at a hazardous waste landfill.

Furnace Ash and Debris

The DFS differs from the MPF in that it is equipped to process drained rockets, mortars, mines, and explosive components from projectiles. This processing leaves behind fiberglass ash and metal debris (aluminum and steel). The ash and debris are collected in bins, allowed to cool, and sampled and analyzed to verify that they are agent free. Once this determination has been made, the wastes are consolidated into larger roll-off bins. The ash and debris are transported to a hazardous waste landfill.

Wood Dunnage

Wood dunnage is the wood packing in and on which the munitions are stored in the munition storage igloos. The wood pallets and packing materials are monitored to verify that there is no agent contamination. This monitoring is done by analyzing the atmosphere in the igloos and in the transport vehicles between the storage area and the processing area. Once this verification occurs, the dunnage is characterized as a nonhazardous waste. This uncontaminated dunnage waste is accumulated in roll-off bins before shipment to an approved industrial waste landfill. Wood that might be contaminated with agent from leaking munitions is classified as hazardous and is disposed of on-site by incineration.

Liquid Incinerator Slag and Refractory

Slag is a molten, glasslike material that forms inside the LICs from the burning of SDS. When cooled to ambient temperature, it forms a solid. Refractory is a bricklike material used to line the inside of the LICs to provide insulation from the heat. As slag accumulates and the refractory gradually corrodes and is replaced, these waste materials are removed from the LIC. Slag and refractory are listed hazardous wastes in some states because they are derived from the chemical demilitarization process. These wastes typically are shipped to a hazardous waste landfill.

Maintenance, Lab, and Monitoring Wastes

A variety of small-volume wastes are generated by maintenance, analytical, and monitoring activities. These primarily consist of discarded glassware, wipe cloths, gloves, plastic, trash, and paint waste, as well as other monitoring materials. Most of these materials

[6]Rock Island Arsenal is the largest government-owned weapons manufacturing arsenal in the United States. It is an active U.S. Army facility and manufactures ordnance and equipment. Some scrap metal is sent to Rock Island from chemical agent demilitarization facilities for smelting and recycling. More information can be found at http://www.ria.army.mil/sites/local/ and http://www.globalsecurity.org/military/facility/rock-island.htm.

have hazardous components; they are also listed hazardous wastes in some states because they are derived from the demilitarization process. These wastes are generally transported off-site to appropriate permitted facilities suited to treatment and disposal of the particular type of waste.

Waste Demilitarization Protective Ensemble Suits

DPE suits are encapsulating, supplied-air PPE worn by personnel required to enter areas where chemical agent liquid or vapors are known to exist. Each suit is decontaminated and monitored for chemical agent vapor before being removed from the worker. Discarded DPE suits are characterized for chemical agent contamination based on generator knowledge and/or chemical agent vapor monitoring results. Waste DPE suits and similar plastic materials are sealed in containers and placed in storage on-site. These materials, depending on the type of waste and the level of contamination, are destroyed in the incinerators at baseline facilities or sent to off-site TSDFs.

Hydrolysate

NECDF is the only operating chemical agent disposal facility using neutralization technology. ABCDF also used neutralization technology to treat mustard agent but has now completed operations. The NECDF neutralization facility generates a dilute caustic process waste stream known as VX hydrolysate, in addition to generating many of the same secondary wastes found at baseline incineration facilities. Hydrolysate is a caustic wastewater containing breakdown products that come from the hydrolysis of the agent. This stream must undergo a second treatment step to meet the requirements of the CWC. Several disposal options for VX hydrolysate have been considered. This stream is not included in the quantities and waste inventory tables cited, but is reported and discussed separately in this report.

Quantities of Secondary Waste

CMA has estimated the types and quantities of secondary wastes projected to be in storage at the end of operations for each of the five chemical agent disposal facilities included in this study (Table 1-3). These quantities include wastes generated during operations but exclude wastes for which an on-site or off-site disposal option is currently available and is being used. Table 1-3 also does not include closure wastes. Several of the smaller individual waste streams cited earlier are combined in this summary for reporting purposes. The total estimated secondary waste stream inventory at the end of operations based on current practices is

TABLE 1-3 Projected Secondary Waste Inventories in Storage Across Sites at End of Operations According to Vapor Screening Levels (tons)[a]

	Total Across All Sites	
Secondary Waste Stream	Above VSLs[b]	Below VSLs
Spent carbon from filters	1,112	869
Containerized combustible solids	301	1,423
Containerized miscellaneous solids	13	140
Containerized DPE/PPE/TAP[c] gear	605	241
Metals	177	76
Subtotal solids	2,208	2,749
Spent decontamination solution	318	0
Miscellaneous liquids	63	13
Subtotal liquids	381	13
Total	2,589	2,762

[a]Site managements' best estimates as of January 2007.
[b]VSL, vapor screening limit, an internal control limit used to clear materials for off-site shipment, discussed in detail in Chapter 5.
[c]TAP gear is protective clothing made mostly of butyl rubber.
SOURCE: Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, December 11, 2006.

projected to be over 5,000 tons (more than 10 million pounds), excluding neutralization hydrolysate. Spent activated carbon represents the largest of these streams and nearly 35 percent of the total nonclosure waste anticipated. The waste streams and special disposal issues at each of the five operating chemical agent disposal facilities are profiled in detail in Chapter 3.

REGULATORY FRAMEWORK AND CONSIDERATIONS

Overview of Federal Resource Conservation and Recovery Act Requirements

The generation, accumulation, treatment, storage, and disposal of hazardous wastes are regulated under RCRA and the Hazardous Solid Waste Amendments of 1984. Wastes derived from the management and destruction of chemical agents and munitions, i.e., "secondary wastes," must be assessed under this authority and, if determined to be hazardous, must be managed under it.

The U.S. Environmental Protection Agency (EPA) authorizes states to regulate hazardous wastes within their borders under RCRA. A state must adopt a program that is no less stringent than the requirements adopted by the EPA (40 CFR 271). All of the states with operating chemical agent disposal facilities, namely, Alabama, Arkansas, Indiana, Oregon, and Utah, have obtained EPA authorization to implement and enforce state requirements for the management of hazardous waste.

Each of these states has adopted the basic EPA hazardous waste management program, including regulations for identification and listing of hazardous wastes; requirements applicable to generators and transporters of hazardous waste; requirements for facilities that treat, store, or dispose of hazardous waste; and restrictions for the land disposal of specific hazardous wastes.

Each state has a program for granting permits for the construction and operation of TSDFs. Permits stipulate the general RCRA requirements in the design, construction, and operation of a TSDF. They also establish appropriate site-specific conditions for all aspects of the hazardous waste management and destruction processes used. Secondary waste from the five chemical agent disposal facilities covered in this report are governed by the TSDF regulations and requirements established in the respective states in which these facilities are located. More recently, the Clean Air Act emission standards have been added to the operating permits for the four baseline incineration facilities, as discussed in additional detail in Chapter 2.

Waste Characteristics and Listing

There are two types of regulated hazardous waste: "characteristic" wastes and "listed" wastes. A solid waste is classified as a characteristic hazardous waste if it exhibits any of the following: ignitability, corrosivity, toxicity, or reactivity. A solid waste is a "listed" hazardous waste if it is specifically listed by the EPA or a state regulatory body based on certain criteria (40 CFR 261.11).

Phosgene is the only chemical agent that is a listed hazardous waste under the federal RCRA program. It is listed as an acute hazardous waste, commercial chemical, or manufacturing chemical intermediate (Hazardous Waste Code[7] P095). Mustard agent is the only chemical agent included as a hazardous constituent under 40 CFR 261.11.[8] Therefore, it can be considered for listing by the EPA or state regulatory authorities but is not currently a federally listed waste.

One of the critical differences between characteristic hazardous wastes and listed hazardous wastes is that, under RCRA regulations, any wastes derived from the treatment, storage, or disposal of a listed hazardous waste (e.g., treatment residues or secondary wastes from storage) are themselves regulated as listed hazardous waste. In addition, any mixture of a solid waste and a listed hazardous waste is then also designated as a listed hazardous waste. The listed hazardous waste designation applies regardless of the actual hazardous characteristics of the waste. Unlike listed hazardous wastes, wastes that exhibit one or more of the RCRA characteristics are not subject to the mixture

[7]A Hazardous Waste Code, consisting of a letter followed by three numbers, is assigned by the EPA or the state regulatory agency to each listed waste. The code is associated with a specific type of listed waste. The F list (e.g., Fxxx) designates particular solid wastes from certain common industrial or manufacturing processes as hazardous. Because the processes producing these wastes can occur in different sectors of industry, the F list wastes are known as wastes from nonspecific sources. The P list (e.g., Pxxx) addresses pure or commercial-grade formulations of certain specific unused acutely hazardous chemicals.

[8]Appendix VIII of 40 CFR 261.11 identifies the universe of hazardous constituents of concern and is used by the EPA primarily to identify wastes that should be considered for listing. It consists of chemicals that have toxic, carcinogenic, mutagenic, or teratogenic effects on humans or other life forms.

or derived-from rules, and once they no longer exhibit the characteristic, they are no longer hazardous wastes and may be managed under the less stringent rules for nonhazardous solid wastes.

Scrap Metal Exclusion

EPA regulations on scrap metal are not straightforward. These regulations provide that all "excluded scrap metal"[9] that is recycled is not a solid waste and, therefore, hazardous waste regulations would not apply (40 CFR 261.4(a)(13)). The regulations go on to state that all other scrap metal sent for recycling/reclamation is a solid waste and therefore is a hazardous waste if it exhibits a characteristic or has become contaminated with a listed waste (40 CFR 261.2(c)). However, a later section exempts from RCRA regulation all hazardous scrap metal if it is sent for recycling/reclamation (40 CFR 261.6(a)(3)(ii)). Therefore, under the federal and most state RCRA regulatory schemes, all scrap metal going to recycling, whether or not it exhibits a characteristic or has become contaminated with a listed waste, is exempt from the hazardous waste regulations. No waste characterization is necessary for material that meets the definition of scrap metal that will be recycled. Scrap metal that is to be disposed rather than recycled, however, is a solid waste and must be characterized and disposed of accordingly.

Maximum Achievable Control Technology Regulation

In October 2005, under authority of the Clean Air Act and RCRA, the EPA issued its final national emission standards for hazardous air pollutants from hazardous waste combustors. The standards require hazardous waste combustors to meet hazardous air pollutant emission standards reflecting the application of maximum achievable controllable technology (MACT). These standards are applicable to any hazardous waste incinerator, including the chemical agent disposal facilities. In some states, separate air permits are issued to hazardous waste incinerators, while in others the RCRA permit requirements are adopted or changed to implement the requirements of the new MACT emissions standards for controlling the following pollutants:

- Dioxins and furans;
- Mercury;
- Semivolatile metals (cadmium and lead);
- Low-volatility metals (arsenic, beryllium, and chromium);
- Particulate matter, as a surrogate for nonmercury metal; and
- Other hazardous air pollutants, including certain metals, hydrogen chloride, chlorine gas, and organic hazardous air pollutants.

Overview of State-Specific Regulatory Requirements

Each state has adopted its own waste characterization regulations. Alabama and Arkansas have generally adopted the federal scheme of regulation for hazardous waste characterization and listing. However, Indiana, Oregon, and Utah have issued additional regulations specifically addressing chemical agents or munitions. The discussion below addresses the general state-specific regulatory requirements for waste characterization and listing in the five affected states. However, each state can include in a permit additional requirements for the management and disposal of specific wastes. These additional requirements are discussed further in Chapter 3.

Alabama

The Alabama Department of Environmental Management (ADEM) has adopted hazardous waste regulations that mirror the federal RCRA program (Alabama Administrative Code Revised 335-14-2). ADEM has not specifically designated chemical agents or chemical munitions as listed hazardous wastes; therefore, under the Alabama RCRA regulatory program, secondary wastes from the treatment or management of chemical agents or munitions must be managed as RCRA hazardous waste only if they exhibit hazardous characteristics.

Arkansas

Similar to the situation in Alabama, the Arkansas Department of Environmental Quality (ADEQ) has promulgated hazardous waste regulations that basically reflect the federal RCRA program (ADEQ Regulation No. 23). ADEQ likewise has not specifically designated chemical agents or munitions as listed hazardous wastes; therefore, under the Arkansas RCRA regulatory

[9]Excluded scrap metal includes processed scrap metal, unprocessed home scrap metal (steel mill scrap), and unprocessed prompt scrap metal (metal fabrication scrap) (40 CFR 261.1 (c)(9), (10), (11), and (12)).

program, secondary wastes from the treatment or management of chemical agents or munitions must be managed as RCRA hazardous waste only if they exhibit hazardous characteristics.

Indiana

The Indiana Department of Environmental Management (IDEM) has also generally adopted the federal RCRA regulations concerning the identification and listing of hazardous waste (329 Indiana Administrative Code 2.1-6-1(b)). However, in addition to the federal list of hazardous wastes, the following wastes are listed hazardous wastes under the IDEM program and have been assigned the Indiana Hazardous Waste Code I001:

- Nerve agents GA, GB, and VX;
- Mustard agents H, HD, HT (60 percent mustard agent and 40 percent T, which is bis(2-chloroethylthioethyl) ether); and
- Lewisite.

Oregon

The Oregon Department of Environmental Quality (ODEQ) has incorporated by reference the federal RCRA regulations for identification and listing of hazardous wastes (Oregon Administrative Rules 340-101-001). In addition to the federally listed acute hazardous wastes, ODEQ regulations include the following as state-specific listed hazardous wastes:

- Blister agents (such as mustard agent) (Hazardous Waste Code P998) and
- Nerve agents (such as GB and VX) (Hazardous Waste Code P999).

Oregon regulations also include the following as additional state-specific listed hazardous wastes from nonspecific sources:

- Residues from demilitarization, treatment, and testing of blister agents (such as mustard agent) (Hazardous Waste Code F998)[10] and
- Residues from demilitarization, treatment, and testing of nerve agents (such as GB and VX) (Hazardous Waste Code F999).

Utah

The Utah Department of Environmental Quality (UDEQ) regulations generally restate the federal RCRA regulations concerning identification and listing of hazardous wastes (Utah Administrative Rules R315-2). Therefore, the UDEQ regulations incorporate by reference the list of acute hazardous wastes and then add the following state-specific listed wastes:

- Nerve, military, and chemical agents (i.e., CX, GA, GB, GD, H, HD, HL, HN-1, HN-2, HN-3, HT, lewisite, T, and VX) (Hazardous Waste Code P999).

The UDEQ regulations also incorporate by reference the federal list of hazardous waste from nonspecific sources and then add the following state-specific listed wastes:

- Residues from demilitarization, treatment, and testing of nerve, military, and chemical agents CX, GA, GB, GD, H, HD, HL, HN-1, HN-2, HN-3, HT, lewisite, T, and VX (Hazardous Waste Code F999).

Overview of Site-Specific Permits

Each chemical agent disposal facility has been issued a RCRA permit under the applicable state regulations. These permits establish the waste characterization requirements, the pertinent sampling/analysis methodologies, waste disposal methods, facility oper-

[10] ODEQ regulations specifically define demilitarization as

> all processes and activities at the Umatilla Chemical Depot and Umatilla Chemical Agent Disposal Facility from February 12, 1997, through ODEQ approval for closure of all permitted treatment, storage and disposal units and facility-wide corrective actions.

Demilitarization residue is defined as

> any solid waste generated by demilitarization processes and activities, except for waste streams generated from processes or activities prior to the introduction of nerve or blister agent into the treatment unit; and waste streams generated from maintenance or operation of non-agent-contaminated process utility systems. (Oregon Administrative Rules 340-100-0010)

ating parameters, and closure requirements for each facility. In addition to reflecting the requirements found in each state's law and regulations, permit provisions also establish specific operating parameters and waste characterization requirements that are not specifically addressed in the general state regulations. A facility must file a modification request to deviate from any of the provisions set forth in its permit. The individual facility permit requirements for specific secondary waste streams are discussed in Chapter 3.

Anniston

ADEM issued a permit (AL3210020027) to the U.S. Department of the Army, Anniston Army Depot; the U.S. Department of the Army, ANCDF Field Office (ANCDF site); and Westinghouse Government Environmental Services Company LLC to operate a hazardous waste storage and treatment facility.

Pine Bluff

The Arkansas Department of Pollution Control and Ecology issued a permit (Permit No. 29-H) to Pine Bluff Arsenal to operate a hazardous waste management facility at Pine Bluff Circle, Jefferson County, Arkansas.

Umatilla

The Oregon Environmental Quality Commission issued a permit (ORQ 000 009 431) to the U.S. Army, as represented by the Umatilla Chemical Depot and the Washington Demilitarization Company, LLC, to operate a hazardous waste treatment and storage chemical demilitarization facility located in Umatilla County in Hermiston, Oregon, off Interstate Hwy-84 at exit 177.

Tooele

The Utah Solid and Hazardous Waste Control Board issued a permit (UT 3213820894) to the Tooele Army Depot to operate a hazardous waste treatment and storage facility located approximately 3 miles south of Tooele, on State Highway 36, in Tooele County, Utah.

Newport

IDEM issued a permit (IN1210022272) to Newport Chemical Depot to operate a hazardous waste facility located in Newport, Indiana.

Comparison of Broad Regulatory Requirements for Chemical Agent Disposal Facilities and Industrial Facilities

Based on the information gathered by the committee, there is little difference in the overarching regulatory requirements at industrial TSDFs and U.S. Army chemical agent disposal facilities.

The transportation, treatment, storage, and disposal of hazardous wastes are regulated under RCRA, the Hazardous Solid Waste Amendments of 1984, and the regulations promulgated thereunder. Wastes derived from the management and destruction of chemical agents and munitions are assessed under this authority and, if determined to be hazardous wastes, must be managed under these regulations. The same regulations and authority apply to hazardous waste from industrial waste facilities. Specific hazardous wastes may be declared "listed hazardous wastes" by federal or state regulations.

In three of the states hosting chemical destruction facilities, the wastes that result from the disposal of agent-containing munitions have been declared listed hazardous wastes by the state. The regulation and management of listed hazardous wastes associated with disposal of agent are similar to the management of listed hazardous wastes from industrial processes.

There are some differences in the specific waste disposal management schemes at the five sites that were reviewed. Most of the differences between the five chemical destruction facilities are due to the different implementation strategies in place in the five different states, particularly permit parameters and requirements. Each state has a program for granting permits for the construction and operation of TSDFs. Permits implement the general RCRA requirements in the design, construction, and operation of a TSDF. They also establish appropriate site-specific conditions for almost every aspect of the hazardous waste management and destruction processes used.

Secondary waste from the five chemical agent disposal facilities covered in this report are governed by the regulations and requirements established in the respective states in which these facilities are located. The same is generally true for industrial facilities located in these states. However, the management of chemical warfare agents and munitions is not directly addressed in the federal or state RCRA programs (e.g., there are no land disposal restrictions established for the warfare agents). This may result in some differences in the management and shipping criteria found in chemical destruction facility permits. The application of these individual state requirements to specific waste streams and a comparison to practices and requirements at similar facilities in industry are provided in Chapters 2 and 3.

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NRC (National Research Council). 1998. Using Supercritical Water Oxidation to Treat Hydrolysate from VX Neutralization. Washington, D.C.: National Academy Press.

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2

Trial Burns, Compliance Testing, and Health Risk Assessments

INTRODUCTION

Hazardous waste combustors, which include incinerators, boilers, and industrial furnaces, are regulated by the U.S. Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), and in some cases, the Toxic Substances Control Act (TSCA). These regulations define an incinerator as an enclosed device that uses controlled flame combustion (40 CFR 260.10). The nomenclature used to describe certain components of the Army's baseline incineration system notwithstanding (e.g., metal parts furnace), the processes at chemical agent disposal facilities using combustion technology are considered hazardous waste incinerators. Consequently, the discussion in this chapter is generally restricted to issues that concern incinerators. Health risk assessments and transportation risk assessments are also discussed.

Properly conducted, incineration effectively destroys (to 99.9999 percent) toxic organic compounds contained in hazardous waste, reducing or eliminating their toxicity. The products of incineration consist primarily of carbon dioxide and water. Depending on the feed composition, small quantities of carbon monoxide, nitrogen oxides (NO_x), HCl, and other products of combustion may form. If combustion is not complete, compounds known as products of incomplete combustion are emitted. Some ash may be carried through the incinerator as small particles along with the gases.

The EPA's principal measure of incinerator performance is destruction and removal efficiency (DRE). The DRE is determined by measuring the amount of a principal organic hazardous constituent (POHC) destroyed in the incineration process. A formula for calculating the DRE of a system's performance is given in Box 2-1. Under RCRA regulations, a DRE of 99.99 percent is required for all wastes other than those identified as presenting significant threats to human health or the environment. In these cases, for example dioxin-containing wastes, a DRE of 99.9999 percent has been established as a requirement. A DRE of 99.9999 percent (also called "six nines") means that one molecule of a POHC is emitted into the air for every one million molecules of a POHC entering the incinerator (EPA, 2000). The RCRA operating permits for all chemical agent disposal facility incinerators specifically require a DRE of 99.9999 percent for agent and agent-contaminated wastes.

BACKGROUND ON REGULATORY REQUIREMENTS FOR TRIAL BURNS

Resource Conservation and Recovery Act

An incinerator regulated under RCRA must conduct a trial burn and submit the trial burn plan or results of a trial burn as part of a permit application for a facility (40 CFR 270.19(b)).[1] Before conducting the trial burn, the facility must submit a trial burn plan that covers all

[1]The RCRA permit life for the chemical agent disposal facilities in this study, once granted, is 10 years, the same length of time that is standard for similar industrial facilities.

BOX 2-1
Definition of Destruction and Removal Efficiency

$$DRE = 100 \times [(\text{Feed rate} - \text{Emission rate}) / \text{Feed rate}]$$

where emission rate is the rate at which the selected POHC exits the process in the exhaust gas stream. The DRE thus focuses on air emissions.

hazardous wastes slated to be treated in the hazardous waste incinerator. Based on the waste analysis data in the trial burn plan, the state regulatory agency will specify the POHCs for which DREs must be calculated during the trial burn. POHCs are selected based on their high concentration in the waste stream to be processed or the greater difficulty of destroying them in comparison to other waste stream constituents. If the unit achieves the required DRE for the POHCs, it is presumed that it will achieve the same or better DRE for all other easier-to-burn organics in the waste streams covered in the trial burn plan. At least one POHC is selected for each waste stream.

After completing the trial burn in accordance with the trial burn plan, a hazardous waste facility submits the results along with all data collected during any trial burn. Based on the results of the trial burn, the state agency sets the incinerator's operating parameters in the final (or modified) RCRA permit. For the purposes of allowing a hazardous waste incinerator to operate following completion of the trial burn, and prior to any final modifications of the permit conditions to reflect the trial burn results, the agency may establish temporary permit conditions. These conditions may include, but are not limited to, setting waste feeds and operating conditions (such as feed rates) that allow operation prior to issuance of the final permit.

The RCRA permits for all baseline system chemical agent disposal facilities prohibit the incineration of any chemical agent or any waste containing chemical agent for which treatment has not been successfully demonstrated through a trial burn. An individual trial burn plan for each different chemical agent must be submitted by the facility's management for each of its incinerators and is considered as a request for a major permit modification. Agent-specific trial burn plans must be approved by the state agency prior to the start of the shakedown period for the respective trial burns. RCRA permit conditions preclude chemical agent disposal facilities from feeding more than one agent at a time into the incinerators. Thus, unlike a commercial treatment, storage, and disposal facility (TSDF), which can obtain approval to process many different waste streams in one trial burn, at the chemical agent disposal facilities, a separate trial burn is conducted for each individual agent.

Under RCRA regulations, performance data from one incinerator can be submitted in lieu of conducting a trial burn on a second incinerator. The permit submittal to accomplish this is similar to that described above and requires the following (40 CFR 270.19(c)):

- A detailed engineering description of the proposed incinerator and the incinerator from which previous trial burn data are being provided,
- An analysis of each waste,
- A detailed description of sampling and monitoring procedures,
- A description of the results of the previous trial burn from which data are being provided,
- Planned procedures for normal and off-normal operating conditions, and
- Any other relevant information.

The Chemical Materials Agency (CMA) and the state regulators have not used the data-in-lieu-of-a-trial-burn mechanism provided for by RCRA, with the exception of twice at the Tooele Chemical Agent Disposal Facility (TOCDF). This resulted from an understandable desire to be conservative in managing risks given the initial lack of experience with baseline system incinerators, and the learning curve needed by both the chemical agent disposal facility staff and the state regulatory staff. Most regulators told the committee they would consider such an approach and, in at least one case, said they anticipated such an approach would be pursued.

Toxic Substances Control Act

The EPA has issued a "national permit" to the U.S. Army's chemical agent disposal facilities that governs the disposal of polychlorinated biphenyls (PCBs) under TSCA. The EPA's regional administrator or the director of the National Program Chemical Division may determine that a trial burn must be conducted based on a submitted trial burn plan. At a minimum, the plan must include:

- Date trial burn is to be conducted;
- Quantity and type of PCBs and PCB items to be incinerated;
- Parameters to be monitored and location of sampling points;
- Sampling frequency and methods and schedules for sample analyses; and
- Name, address, and qualifications of persons who will review analytical results and other pertinent data and who will evaluate the technical effectiveness of the trial burn.

Similar to RCRA, once the trial plan has been approved, a trial burn will be conducted and the results reported to the regional administrator or the director, National Program Chemical Division, for approval. At TOCDF, trial burns were conducted in accordance with RCRA and TSCA protocols for certain M55 rockets. The acceptance criteria for the RCRA trial burn of the liquid incinerators, the deactivation furnace system (DFS), and the metal parts furnace were met. A second test of the DFS destruction efficiency for PCBs showed that emissions levels meet TSCA criteria (NRC, 1999).

Maximum Achievable Control Technology Comprehensive Performance Test Requirements

In October 2005, the EPA issued a final rule updating the RCRA emission standards for hazardous waste incinerators based on maximum achievable control technology (MACT) that is commonly employed under the CAA. Therefore, hazardous waste incinerators are subject to MACT combustion unit performance standards and operating requirements, in addition to RCRA standards.

The general provisions of the MACT standards are contained in CAA regulations (40 CFR 63 Subpart A). Sources of hazardous air pollutants are required to demonstrate compliance with emission limitations by conducting a comprehensive performance test (CPT). If compliance is demonstrated, the facility's management files a notice of compliance (NOC) with the state regulatory body. Sources can use any combination of control technologies to achieve the emission standards.

The MACT rule has more stringent emissions standards than RCRA for dioxins and furans, including a concentration limitation. In addition, if dioxins or furans are in the feed, a 99.9999 percent DRE applies. There are also numeric limitations for particulate matter, hydrocarbons, and carbon monoxide. For HCl and chlorine gas, emissions must not exceed specific concentration limits. Under MACT, there are numerical emission standards for three categories of metals: mercury, low-volatile metals (arsenic, beryllium, and chromium), and semivolatile metals (lead and cadmium). In addition, a DRE of either 99.9999 or 99.99 percent must be achieved for each POHC designated for the proposed waste feed. As with RCRA, POHCs are specified from the list of hazardous air pollutants on the basis of the degree of difficulty of incineration for the organic constituents in the waste stream or streams, and on their concentration or mass in the waste feed (40 CFR 63.1203).

Once a facility successfully completes a CPT that demonstrates compliance with MACT standards and submits an NOC to state regulators, it may operate within guidelines consistent with emissions limits in the facility's current permit. Under the MACT rule, a CPT to demonstrate compliance with MACT standards is required every 5 years—in comparison to a 10-year interval for trial burns under RCRA. In addition, any change in operations or equipment outside the original CPT limits requires a new CPT to be conducted, and operations under the new operating parameters may not commence until CPT results and an NOC have been received by the regulatory authority.

Approximately 30 months after each periodic CPT, less comprehensive confirmatory tests are performed to demonstrate continued compliance with MACT standards by collecting gas samples to determine the presence of any dioxins.

Under the new RCRA/MACT regulations, when a RCRA incinerator facility demonstrates compliance with MACT air emission standards and limitations by conducting a CPT and submitting an NOC, duplicate RCRA emission requirements no longer apply. Nevertheless, the state agency may continue to apply the RCRA permit emission provisions on a case-by-case basis for purposes of information collection. RCRA permit provisions for all other aspects of the combustion unit and the facility are still applicable (40 CFR 270.10(k) and 270.32(b)(2)).

To remove the duplicative air emission/combustion requirements from a RCRA permit prior to its expiration and reissuance, a chemical agent disposal facility would have to request a major RCRA permit modification (see Box 2-2). This may be done after the facility has successfully completed a CPT and submitted an NOC documenting compliance with the MACT standards. The MACT conditions will then be incorporated into the facility's CAA Title 5 air permit. However, any terms or conditions that are more stringent or extensive than the MACT requirements will be retained in the RCRA permit if they are necessary to ensure protection of human health and the environment (EPA, 2006).

At the time this report was prepared, the state agencies had maintained the requirements and operating parameters established in the existing RCRA permits for all of the baseline incineration system chemical agent disposal facilities, rather than modifying the RCRA permits to eliminate the duplicate RCRA emissions standards and issuing a separate or modified permit under the MACT regulations (i.e., CAA Title 5 permit). Therefore, the incinerators at chemical agent disposal facilities currently must meet both the air emissions requirements in the facility RCRA permits, as well as the requirements under the new MACT regulations, whichever are more stringent. The state agencies maintain that they have incorporated the MACT standards into their regulatory schemes in a manner that will not result in duplication of effort or conflicting regulatory requirements by adopting the MACT emission criteria into the RCRA permit in coordination with the state CAA permitting division.

BOX 2-2
RCRA Permit Modification Classification and Public Comment

A RCRA permit may be modified at the discretion of EPA or the authorized state or upon the request of the facility management. There are three classes of permit modifications initiated by the permittee:

- *Class 1 permit modification.* Initiated for routine changes such as upgrading plans and records maintained at the facility.
- *Class 2 permit modification.* Initiated for a technical advancement, a minor process change, changes in the type or quantity of waste managed, or a change necessary to comply with new regulations without substantial change to design specification.
- *Class 3 permit modification.* Initiated for major changes that substantially alter the facility or its operations.

All three classes of modifications require that the permittee send a notice of the modification to all persons on the facility mailing list. Inclusion on a RCRA facility mailing list is typically accomplished by submitting a written request. Class 2 and 3 permit modifications trigger requirements for public notice, solicitation of comments, and, in some cases, a public meeting.

SOURCE: 40 CFR 270.42; 40 CFR 124.

TRIAL BURN PROCEDURES AT CHEMICAL AGENT DISPOSAL FACILITIES

Overview

At chemical agent disposal facilities, the first trial burns performed are those that use surrogate chemicals that are more difficult to destroy than the chemical agent they simulate. These trial burns are called surrogate trial burns (STBs). STBs are subsequently followed by agent trial burns (ATBs) that use actual chemical agent.

Thus, all chemical agent disposal facilities with a baseline system hazardous waste incinerator have completed STBs and ATBs for each agent that has been or is currently being treated.[2] The facility permits have been issued or modified to contain specific air emission limitations and operating parameters based on the results of those STBs and ATBs. Table 2-1 shows the critical pollutant emissions measured during trial burns.

Under RCRA regulations, a trial burn must be conducted prior to initial start-up and whenever a new waste stream or new operating parameter is proposed. The RCRA trial burn plan submitted for regulatory agency approval under either a permit application or permit modification application must contain the following (40 CFR 270.62):

- A detailed description and analysis of each waste,
- A detailed engineering description of the incinerator,
- A detailed description of sampling and monitoring procedures,

[2]As explained in more detail in the following sections, an STB uses a surrogate material to represent the chemical agent or surrogate POHC. The surrogate is a chemical that is more difficult to burn (break the bonds).

TABLE 2-1 Typical Trial Burn Critical Emissions and Performance Standards

Performance Standards	Agent Trial Burn
Minimum DREs for applicable principle organic hazardous constituents	99.9999% (LIC, agent)
	99.9999% (MPF, agent) for heels greater than 5% or 99.99% for heels equal to or less than 5%
	99.99% (DFS, agent)
	99.99% (DFS, agent)
	99.99% (DFS; propellant, explosive, and pyrotechnic feed)
Particulate matter emission limit	0.013 grains/dscf[a] (29.75 mg/dscm[b]) at 7% O_2
Mercury	130 μg/dscm at 7% O_2
Semivolatile metals (Pb, Cd)	230 μg/dscm at 7% O_2
Low-volatility metals (As, Be, Cr)	92 μg/dscm at 7% O_2
Hydrogen chloride/chlorine ($HC1/C1_2$) emission limit	32 ppmv total HC1 and $C1_2$ expressed as HC1 equivalents at 7% O_2
Toxic metals emission limits	At levels determined by the regulatory agency to be protective of human health and the environment
Dioxins and furans TEQ[c]	0.4 ng/dscm at 7% O_2
CO emission limit, 60-min rolling average	100 ppmv at 7% O_2
Emission limits for chemical agents	
GB	0.0003 mg/m^3
H/HD/HT	0.03 mg/m^3
VX	0.0003 mg/m^3

[a]dscf, dry standard cubic foot.
[b]dscm, dry standard cubic meter.
[c]Toxic equivalency quotient (TEQ) is the amount of 2,3,7,8-TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin) with toxicity equivalent to a complex mixture of 210 dioxin and furan isomers with 4 to 8 chlorine atoms found in flue gases. This equivalency is based on the International Toxic Equivalence Factor scheme adopted by the EPA and most countries to simplify the reporting of dioxin emissions.
SOURCE: Adapted from UDEQ, 2001.

- A detailed test schedule and protocol, and
- A description of planned procedures for both normal and off-normal operating conditions.

According to 40 CFR 63.1207(f), a MACT CPT must include

- An analysis of each feed stream, including hazardous waste and other fuels,
- A highly detailed treatment of certain organic hazardous air pollutants,
- A detailed engineering description of the incinerator,
- A detailed description of sampling and monitoring procedures,
- A detailed test schedule and protocol for each hazardous waste,
- A description of planned procedures for both normal and off-normal operating conditions, and
- Additional detailed technical and procedural information.

In general, state agencies may accept RCRA trial burn results for a facility's initial CPT, and the next CPT would be required within 61 months of the date of that RCRA trial burn.

Trial Burn Phases

The following information from the RCRA permit for the Umatilla Chemical Agent Disposal Facility (UMCDF) is based on 40 CFR 264.343(c) and is typical of the permits for other baseline incinerator disposal facility sites. The phases apply to each incinerator at each site, except as noted in the discussion below.

Shakedown Period

A shakedown period is the time during which an incinerator is brought to a state of operational readiness necessary to conduct a trial burn. The shakedown period is initially limited to 720 hours of operating time; if needed, an additional 720 hours can be requested.

Surrogate Trial Burn

Because chemical warfare agents are extremely toxic, incinerator performance must be demonstrated for each incinerator before a chemical agent is introduced. This is accomplished by a trial burn using a surrogate material (surrogate POHC) to represent the chemical agents. Perchloroethylene and monochlorobenzene are two of the surrogate POHCs used at chemical agent disposal facilities. One STB is required per incinerator.

The objectives of the STBs are to

- Establish that the incinerator can process chemicals that are more difficult to destroy than the actual waste chemicals they will process,
- Demonstrate a DRE of 99.9999 percent,
- Verify that the particulate matter emissions do not exceed 0.015 grains per dry standard cubic foot,
- Establish maximum chlorine feed rates while maintaining HCl emissions below permit levels,
- Verify that emission levels of products of incomplete combustion, such as carbon monoxide, do not exceed the specified limit,
- Establish maximum metal feed rates, and
- Establish maximum surrogate feed rates.

The primary regulatory and permit limits with which a facility must comply under RCRA are the POHC DRE and emissions limits for NO_x, HCl, dioxins and furans, metals, particulate matter, and carbon monoxide.

STBs are conducted under three conditions, each requiring three separate test runs. The first condition is a low-temperature test for the purpose of demonstrating that the DRE of two POHCs meets or exceeds 99.9999 percent when they are processed at lower temperatures.

The second condition is a high-temperature test (HTT) using the same POHCs designated for the low-temperature test, plus ethylene glycol and 21 metal oxides to determine metal emissions. The third condition is an HTT using the pollution abatement system filtration system (PFS). Both HTT conditions use the same surrogates and additives, but additional metal oxides are fed in this third condition test to determine the metal removal efficiency of the PFS.

Agent Trial Burn

An agent trial burn (ATB) is conducted prior to processing each new agent at a chemical agent disposal facility. During the ATB, actual chemical agent is burned under the most severe case operating parameters, e.g., maximum feed rates and off-normal operating parameters that will still allow demonstration of the incinerator's compliance with regulations and pertinent permit requirements. If compliance is successfully demonstrated under such nonideal conditions, it is assumed that compliance can be achieved during normal operations.

Post-Trial-Burn Operation

Following an ATB, an incinerator's feed rate is restricted to 50 percent of the feed rate used during the ATB until regulatory approval of the preliminary ATB data is provided. Upon approval, feed rates may be increased to 75 percent of the ATB feed rate. This preliminary approval typically takes approximately 30 days. The facility must await regulatory approval of the final ATB report before moving to 100 percent of the ATB feed rate. This is a lengthy process, and in some instances, the disposal facilities have completed destroying a given chemical agent without ever obtaining final approval for 100 percent feed rate operations.

There are three primary reasons for the lengthy regulatory approval process. First, the ATB reports are very long and complicated and may contain as many as 20,000 pages. The site verifies and validates the documents in detail (ensures that all the data are accurate and consistent) before submitting them to the state regulators. Next, once the report has been submitted, the regulators review it in detail and issue a letter noting any and all deficiencies in the report, essentially constituting a RCRA notice of deficiency. And finally, extensive communications that can take months to complete then ensue between the site and the regulators.[3]

Once an ATB is complete and the trial burn report and data have been submitted to the state, the state's approval of the move to full-rate operations depends on its regulatory staff's experience with and confidence in the operating facility. If a health risk assessment (HRA) is required, still more time will be required to obtain approval to move to the full-rate operations.

[3]Personal communication between Mike Strong, UMCDF Deputy Site Project Manager, and Billy Williams, NRC study director, December 4, 2006.

TABLE 2-2 Completed and Still-Scheduled Trial Burns Across Operating Chemical Agent Disposal Facilities

	LIC 1				LIC 2				DFS					MPF					Totals
Site	STB	GB	VX	H/HD	STB	GB	VX	H/HD	STB	GB	VX	H/HD	TSCA	STB	GB	VX	H/HD	2nd[a]	(C + S)
JACADS[b]		C							C				4C				C	C	8
TOCDF	C	C	D	D	C	C	C	C	C	C	C		2C	C	C	C	S	3C	18
ANCDF	C	C	S	S					C	C	S	S	C	C	C	S	S	C	14
UMCDF	C	C	S	S	C	C	S	S	C	C	S	S	C	C	C	S	S	C	18
PBCDF	C	C	S	S					C	C	C	S	C	C	S	S	S	S	14
																			72

NOTE: ANCDF, Anniston Chemical Agent Disposal Facility; C, completed burns; D, indicates data used in lieu of a trial burn; DFS, deactivation furnace system; GB, a nerve agent, also known as sarin; H, mustard agent, a blistering agent; HD, distilled mustard agent, a blistering agent; JACADS, Johnston Atoll Chemical Agent Disposal System; LIC, liquid incinerator; MPF, metal parts furnace; PBCDF, Pine Bluff Chemical Agent Disposal Facility; S, scheduled burns; STB, surrogate trial burn; TOCDF, Tooele Chemical Agent Disposal Facility; TSCA, Toxic Substances Control Act; UMCDF, Umatilla Chemical Agent Disposal Facility; and VX, an organophosphate nerve agent.

[a]This column is for a second set of waste trial burns to meet new requirements and which are being added through permit modifications.

[b]JACADS requirements were set prior to issuance of the EPA's 1993 Hazardous Waste Combustion Strategy.

SOURCE: Adapted from a chart provided to the committee by the U.S. Army Chemical Materials Agency on August 1, 2006, and updated in January 2007.

CHEMICAL AGENT DISPOSAL FACILITY EXPERIENCE TO DATE WITH TRIAL BURNS

The committee obtained trial burn information for each chemical agent disposal facility. This information is summarized in Table 2-2, which provides the CMA's anticipated trial burn activity and plans as of September 2006. In general, STBs and ATBs for nerve agent GB were the first trial burns to be performed. This is because risk assessments have shown GB munitions pose the greatest risk to the public. The requirements and trial burn experiences for each site are discussed in the sections that follow.

Anniston Trial Burn Experience

Prior to agent operations, STBs were carried out for each of the three furnaces at the Anniston Chemical Agent Disposal Facility (ANCDF): the liquid incinerator (LIC), the deactivation furnace system (DFS), and the metal parts furnace (MPF). GB ATBs were conducted for the LIC and DFS in 2003 and for the MPF in 2005. In 2006, VX ATBs were conducted for the LIC and DFS. A DRE performance test was conducted on the MPF in 2006, and MPF VX ATBs are planned for 2007.[4] After an ATB, the Alabama Department of Environmental Management allows ANCDF to operate at 50 percent of the ATB feed rate for 30-45 days. ANCDF then operates at 75 percent of the ATB feed rate until the trial burn report is reviewed and approved, which takes about 6 months. No special testing is done to support HRAs. Instead, HRAs are conducted with emissions data gathered at the maximum feed rates during the ATBs.

Pine Bluff Trial Burn Experience

STBs were conducted for the three Pine Bluff Chemical Agent Disposal Facility (PBCDF) incinerators: the DFS, the LIC, and the MPF. These were followed by GB ATBs that were conducted between mid-October and early November 2005. VX ATBs are scheduled to occur in April 2008. CMA has negotiated with Arkansas state regulators to include only a DRE test in the VX ATBs. Mustard agent ATBs are currently scheduled to occur between late December 2009 and early January 2010.[5]

Umatilla Trial Burn Experience

STBs were begun in early 2003 and have been completed for the four incinerators at UMCDF: LIC1, LIC2, DFS, and MPF. GB LIC1 shakedown runs began in October 2004, followed by GB ATBs in June and

[4]Tracy Smith, Compliance Engineer, Washington Group International, "ANCDF secondary waste incineration tests," Presentation to the committee on October 16, 2006.

[5]Personal communication between Clara Moraga, PBCDF Deputy Project Manager, and James Myska, NRC staff, December 22, 2006.

July 2005 for LIC1 and the DFS, in March 2006 for the MPF, and in June 2006 for LIC2. The shakedown runs for processing secondary waste in the MPF began in October 2006, and the secondary waste trial burn was completed in January 2007. VX ATBs are anticipated for January 2008.[6]

Tooele Trial Burn Experience

STBs and ATBs for nerve agent GB were conducted on each of the four incinerators at TOCDF (one DFS, one MPF, and two LICs) when the facility started up in the mid-1990s. The STBs were used to demonstrate that the incinerators were operationally ready to begin feeding agent rather than to establish incinerator operating parameters and were required to be conducted only once before GB operations commenced. TOCDF has since conducted separate ATBs for each of the stockpile chemical agents stored at Deseret Chemical Depot.

An ATB was performed on only one of the two LICs when TOCDF began VX destruction operations. The ATB results from LIC2 were used as data in lieu of performing a VX ATB on LIC1. The VX ATBs for LIC2 were performed under two trial burn conditions, high and low temperature, requiring a total of six test runs (three test runs under each condition).

The same LIC ATB permitting approach was used in the mustard agent disposal campaign. The mustard agent ATBs were performed as follows:

- A single condition was used for the LIC ATB for a total of three test runs.
- Two conditions were used for the MPF ATB, three test runs to establish the DRE and three test runs to determine the emissions associated with the incineration of solid agent heels.

An ATB for the DFS was not required for the mustard agent campaign, as no energetics will be fed through the DFS, but a MACT-rule CPT was required for the DFS. After the PFS is installed at TOCDF, a demonstration of its ability to control mercury emissions will be required. This will not be a trial burn in the strict sense because there is no requirement to demonstrate attainment of a required POHC DRE.[7]

[6]UMCDF RCRA/MACT trial burn history (updated October 30, 2006), provided to the committee by CMA, October 31, 2006.

[7]Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, October 17, 2006.

COMPARISON WITH TRIAL BURN EXPERIENCE IN COMMERCIAL INDUSTRY OPERATIONS

Trial burns at both commercial incinerators and the Army's chemical agent disposal facilities are tailored to meet proposed operational requirements at their specific sites, under the applicable regulations governing that site. In response to a committee query, a DuPont and Company environmental manager replied as follows:

> Each incinerator test burn is unique and specific to the regulation being addressed. Each component of the test burn is determined by the test objectives and is unique from sampling requirements to test methods to data reporting, and is in many cases all or in part determined by the specific regulation.[8]

This is also true for trial burns at the U.S. Army's chemical agent disposal facilities.

Table 2-3 shows representative data on industry trial burns, and trial burns at the Johnston Atoll Chemical Agent Disposal System (JACADS) and TOCDF from the 1990s.[9] As can be seen in the table, both the commercial facilities and the chemical agent disposal facilities conducted several trial burns under a variety of operating conditions. When conditions were changed, a new trial burn was conducted. For most of the commercial facilities, trial burns were conducted again after several years. At one company, Waste Technologies Industries, annual performance tests were required over a 4-year period.

At baseline incineration facilities, CMA has conducted separate campaigns to dispose of each chemical agent and munition type because of monitoring and processing constraints. This approach is reflected in the provisions of the site-specific RCRA permits. In all cases, trial burns have been conducted for each agent destruction campaign at each chemical agent disposal facility.

Commercial and industrial incinerators test a range of materials during their trial burns to account for the maximum anticipated feed rates and all the wastes that are slated for incineration in the unit according to the

[8]DuPont response to committee questions about industrial best practices, September 26, 2006. The DuPont Sabine River Works facility practicing incineration technology is located in the state of Texas.

[9]JACADS was the first baseline incineration system disposal facility and was located on Johnston Atoll, approximately 700 miles southwest of Hawaii. Disposal operations at JACADS lasted approximately 10 years and were completed in 2000, after which the facility was closed.

TABLE 2-3 Trial Burn Data for Certain Industrial Facilities and CMA in the 1990s

Organization	Location	Trial Burn Dates	Trial Burn Purpose
Waste Technologies Industries	East Liverpool, Ohio	Annual performance tests in 1997, 1998, 1999, and 2000	
		Quarterly tests in 1994 and 1995	
Safety Kleen	Aragonite, Utah	6/1/2001	Operating limits on all constituents
		5/1/1992	Maximum liquid and direct burn feed rate
		3/1/1992	Maximum sludge feed rate
		3/1/1992	Maximum kiln heat input
Ross Environmental	Grafton, Ohio	10/1/2000	Low-temperature DRE, high solids, air pollution control device detuned
		3/1/1993	Air test, normal operation
		3/1/1992	Trial burn
DuPont Sabine River Works	Orange, Tex.	7/1/2000	Trial risk burn, DRE and metals
		8/1/1990	Trial burn, medium temperature, typical operating parameters
		8/1/1990	Trial burn, maximum temperature/maximum waste
Bayer Corp.	New Martinsville, W.Va.	5/1/1992	Trial burn, maximum liquid feed and ash input
		5/1/1992	Trial burn, maximum heat input
GlaxoSmithKline	Research Triangle Park, N.C.	4/1/1999	Trial burn, high-temperature for liquid mode operation
		4/1/1999	Trial burn, high-temperature for solid mode operation
		8/1/1993	Trial burn, maximum liquid waste feed/maximum heat
		8/1/1992	Trial burn, reduced liquid waste feed
Upjohn	Kalamazoo, Mich.	12/1/1990	Trial burn, part./metals testing, high-solids feed
U.S. Army	Johnston Atoll	3/1/1992	Trial burn, nominal conditions
		4/1/1997	Trial burn, agent GB
		12/1/1990	Trial burn, nominal conditions
		8/1/1992	Steady-state conditions
		2/1/1998	Trial burn, GB
U.S. Army	Tooele, Utah	6/30/1995	Surrogate trial LIC 1
		9/30/2005	Surrogate trial DFS
		1/29/1996	Surrogate trial LIC 2
		6/4/1996	Surrogate trial MPF
		1/7/1997	Trial burn agent GB in DFS
		2/26/1997	Trial burn agent GB in LIC 1
		4/4/1997	Trial burn agent GB in MPF
		8/20/1997	Trial burn agent GB in LIC 2

NOTE: DFS, deactivation furnace system; DRE, destruction and removal efficiency; LIC, liquid incinerator; and MPF, metal parts furnace.
SOURCE: EPA, Undated.

facility's permit application and trial burn plan. Their permits usually require that air pollution control equipment and other operating parameters remain the same during operations as they were during the trial burn.

In contrast, at chemical agent disposal facilities, trial burns have been conducted whenever an operating incinerator is to begin destruction of a different chemical agent. Such a switch requires the chemical agent disposal facility to change and recalibrate the process and ventilation monitors for the new agent; equipment capable of multiagent monitoring is not available at this time. This changeover is a lengthy process, taking many weeks. In other respects, the general conditions governing the need for and conduct of trial burns at commercial incinerators and chemical agent disposal facilities are quite similar.

For both chemical agent disposal facility incinerators and commercial incinerators, a trial burn plan must be submitted and receive regulatory approval prior to conducting the trial burn. A trial burn is then conducted

TABLE 2-4 Comparison of Trial Burn Experience at Industrial Facilities and UMCDF (months)

		UMCDF	
Time Period	CRWI Industrial Experience	Average Experience	Experience Range
Trial burn plan submittal to trial burn start	9 (goal); 17 (actual)	10	3-17
Trial burn plan submittal to end of trial burn	15	8	6-10
End of trial burn to trial burn report submission	3	3	2-3

NOTE: CRWI, Coalition for Responsible Waste Incineration; and UMCDF, Umatilla Chemical Agent Disposal Facility.
SOURCES: Letter from Melvin E. Keener, Executive Director, CRWI, to Donald Arbuckle, Acting Administrator, Office of Information and Regulatory Affairs, Office of Management and Budget, June 7, 1999. Available online at http://www.crwi.org/textfiles/omb.htm; data provided to the committee by UMCDF, October 31, 2006.

and, if it is successful, the disposal facility or the commercial incinerator can proceed over time to full-rate operations. A general notional timeline for the trial burn process at commercial incinerators, obtained from the Coalition for Responsible Waste Incineration (CRWI), suggests the following milestones for the trial burn process:[10]

- Submission of trial burn plan 1 year before the trial burn,
- Approval of trial burn plan by regulators within 9 months of plan submission,
- Conduct trial burn within 6 months of plan approval, and
- Trial burn report to agency within 3 months of trial burn completion.

Given the quantity of data that must be analyzed, regulatory agencies in states with multiple incinerators would in the past have had difficulty approving a trial burn plan for commercial facilities within 9 months. CRWI gives some examples of trial burn proposal approval periods that ranged from 5 to 50 months, with an average of 17 months from submission until regulator approval. These data show that in the 1990s, approval for commercial facility trial burns frequently took longer than the target times established by the regulatory agencies. Table 2-4 compares the experience at UMCDF with that cited in the CRWI data. Industrial incinerator permitting time frames seem similar to those at UMCDF.

[10]Melvin E. Keener, Executive Director, CRWI, letter to Donald Arbuckle, Acting Administrator, Office of Information and Regulatory Affairs, Office of Management and Budget, June 7, 1999. Available at http://www.crwi.org/textfiles/omb.htm.

Based on the committee's information gathering, the use of data in lieu of a trial burn, as allowed under RCRA regulations, has occurred only in industrial operations where similar furnaces are started up at the same location.[11] At one Dow Chemical Co. site, data were used in lieu of trial burns for three identical boilers that burn RCRA hazardous waste. The request to do so was submitted as a part of the trial burn plan for one of the three boilers and was approved by the state regulators. Data from the trial burn for one unit were used in lieu of trial burns for the other two identical units. At three other Dow sites, data in lieu of RCRA trial burns and burns for HRAs (discussed later) have been used for boilers and industrial furnaces regulated under RCRA. Each of the three sites had two identical boilers. These requests were granted by either the state or the EPA region depending on which agency was the lead at the time. Dow does not have any examples of data being used in lieu of trial burns for combustion units that are not colocated.[12]

The committee also found examples where Reilly Chemicals was successful in using data in lieu of trial burns for conducting RCRA certification and compliance on two of three boilers. The three boilers were located at the same facility. Examples of the data presented to make the successful case for data in lieu of trial burns for this commercial facility are provided in a publicly available technical paper (Drake et al., 2000). The company was able to show enough similarity for

[11]Committee sources on data in lieu of trial burns included information from Melvin E. Keener, Executive Director of the CRWI, an industrial group representing 26 companies practicing incineration technology in the United States.

[12]Dow response to committee questions regarding industrial best practices, September 26, 2006. Dow Chemical facilities with incineration, boiler, or industrial furnace technology are located in the states of California, Louisiana, Michigan, and Texas.

three nonidentical units by comparing the process feed streams, the combustion unit design, process operating conditions, process monitoring devices, and maintenance profiles.

In the case of chemical agent disposal facilities, when an incinerator begins destruction of a different agent, the same equipment is used except the monitoring devices are recalibrated for the specific agent. Using the previous operating data on this incinerator in conjunction with operating data from a similar incinerator at the same or another site for the same agent appears to be a proper application of the data in lieu of a trial burn regulatory mechanism available under RCRA. Oregon regulators responsible for UMCDF have said they expected such an approach from the Army.

Considerable time is sometimes required to obtain approval and proceed to full-rate incinerator operations after submission of trial burn results. Because of the size and complexity of the task for trial burn report review and approval, increased resources and specific trial burn and regulatory skills could greatly speed the process. It is an accepted practice to provide funding to a regulatory agency so that it can hire a third party to support regulatory reviews.[13]

Generally, industrial facilities do not ramp up feed rates prior to receiving approval of trial burn results. They proceed to full-rate operations upon receiving regulatory approval. Prior to approval, they continue to operate under their existing permit limitations. On the other hand, the ramp-up provisions found in RCRA permits for all chemical agent disposal facility incinerators allow the chemical agent disposal sites to process the new agent prior to obtaining final approval of the agent trial burn results, something not done in industry.

All commercial TSDFs and all chemical agent disposal facilities must adhere to permit operating parameters, including feed rates, temperatures, and other combustion criteria. In addition, all commercial TSDFs and chemical agent disposal facilities must meet both the RCRA and the MACT air emission limitations. There is little difference in the treatment of commercial TSDFs and chemical agent disposal facilities under MACT. Under the RCRA regulations for trial burns, both TSDFs and chemical agent disposal facilities must conduct trial burns for initial start-up and whenever there is a process change or when a new waste stream or a higher feed limit for a waste contaminant is requested.

Finding 2-1. An examination of the situation concerning trial burn requirements for incinerators at chemical agent disposal facilities has led to several observations:

- Surrogate trial burns demonstrate that incinerators at chemical agent disposal facilities can operate safely. The requirement to perform surrogate trial burns at these facilities is consistent with the initial start-up procedures followed at commercial hazardous waste incineration facilities.
- In the earlier phases of the Army's Chemical Stockpile Disposal Program, an agent trial burn conducted for each incinerator with each agent to be processed was an appropriate way for disposal facility staff and state regulatory staff to gain operational experience and confidence in the performance of the incinerators.
- As the Chemical Stockpile Disposal Program has matured, there has been only limited use of the data-in-lieu-of regulatory mechanism provided for in the Resource Conservation and Recovery Act. This provision, if applied more extensively to chemical agent disposal facilities, could allow data from other similar incinerators at chemical agent disposal facilities to be used in lieu of conducting additional agent trial burns.

Recommendation 2-1. The Chemical Materials Agency should vigorously pursue the application of the Resource Conservation and Recovery Act provision for using trial burn data from other similar chemical agent disposal facility incinerators in lieu of conducting trial burns for additional agents. This is a reasonable way to proceed now that (1) at least one agent trial burn has occurred for each type of agent in each type of incinerator at all the chemical agent disposal facilities and (2) a surrogate trial burn and an initial agent trial burn have occurred for each incinerator at all sites.

Finding 2-2. The time required to obtain state regulatory approval to proceed to a full feed rate following submission of agent trial burn data for incinerators at chemical agent disposal facilities can be lengthy. This

[13] For example, there is a memorandum of understanding (MOU) for direct funding of regulatory review efforts: memorandum from William J.B. Pringle, Chief, Environmental and Monitoring Office, Program Manager for Chemical Demilitarization to John L. Matthews, Utah Office of Planning and Budget, February 23, 1999.

is a consequence of the volume and complexity of the documents filed, as well as limited state regulatory agency resources to review and analyze them.

Recommendation 2-2. The Chemical Materials Agency should seek to provide funding to state authorities for third-party or other support to facilitate the analysis and disposition of trial burn data. This would shorten the time needed to obtain approval for incinerators at chemical agent disposal facilities and allow them to proceed more rapidly to a full processing rate.

HEALTH RISK ASSESSMENTS

HRAs are a means of estimating the potential for an adverse effect on a select population upon exposure to a single chemical or mixture of chemicals. This risk is generally defined as a function of the concentration of chemical(s) to which an individual of known size and specified characteristics is exposed, for a given period of time, via ingestion, inhalation, or dermal contact. HRAs are performed for acute and chronic exposures of both on-site and off-site populations.

Regulatory Basis for Health Risk Assessments

Federal Regulatory Requirements

There is no federal statutory or regulatory requirement to conduct HRAs for hazardous waste incinerators. However, the 2005 final MACT rule added language to the RCRA regulations to provide authority for state permitting agencies to require HRAs on a case-by-case basis and add conditions to RCRA permits based on HRA results (40 CFR 270.10(l) and 270.32(b), respectively). Prior to this change, HRAs could be required by permitting agencies based on the general RCRA "omnibus authority."

State-Specific and Permit-Specific Requirements

The hazardous waste regulations of Alabama, Arkansas, Oregon, and Utah do not require an HRA as a condition for obtaining a RCRA hazardous waste incinerator permit. However, state authorities have required HRAs at each of the chemical agent disposal facilities based on the RCRA omnibus authority. The RCRA permits for ANCDF, PBCDF, UMCDF, and TOCDF all require that an HRA or an HRA addendum be submitted after each trial burn or performance test.

Indiana, as a condition of granting a permit for an incinerator that generates or treats a hazardous waste associated with chemical munitions, by statute, requires proof from the facility that its emissions, alone or in combination with other substances, pose no risk of an acute or chronic human health effect or of adverse environmental effect (Indiana Code 13-22-3-10(a)(2)). However, neither the Indiana Department of Environmental Management regulations nor the Newport Chemical Agent Disposal Facility (NECDF) permit specifically calls for submission of an HRA.[14]

Site-specific HRAs have been performed for the vast majority of commercial hazardous waste incinerators[15] and for all of the chemical agent disposal facilities. The data necessary to conduct an HRA are obtained from trial burns (40 CFR 271.19, 264.342, and 264.343). If an HRA is to be developed prior to trial burns at either industrial facilities or chemical agent disposal facilities, data from comparable facilities or the MACT standards could be used.

The Hazardous Waste Combustion MACT rule states that a site-specific risk assessment is recommended for a specific site if the MACT controls do not sufficiently protect human health. If the MACT standards are sufficiently protective of health and the emissions are below the MACT standards, a new HRA is not typically required.

Chemical Agent Disposal Facility Health Risk Assessments

Because chemical agent disposal facilities are based on one of two general categories of technology, incineration or neutralization (hydrolysis), it is necessary to address the HRAs for these facilities in a manner that recognizes these technological differences.

Incineration-Based Chemical Agent Disposal Facilities

Each incinerator at a chemical agent disposal facility presents a potential source for worker and public

[14]The reader is reminded here that NECDF uses a neutralization (caustic hydrolysis) process to destroy the bulk VX stored at the Newport Chemical Depot. An incinerator is not part of the process.

[15]The committee's information gathering on industrial facilities for this report, including the 26 facilities represented by the CRWI, found only one facility, located in a very remote geographic region and with no significant receptors, that was not required to conduct an HRA.

exposure to the products of incineration. The HRA risk calculations for this type of facility are carried out according to recommended EPA methods. State regulators also strongly influence how HRAs are conducted at chemical agent disposal facilities, which means that HRA requirements for sites using incineration technology can vary from state to state.

Before any incinerator operations begin, an original, or baseline, HRA is conducted.[16] This baseline is then updated upon completion of ATBs for each agent campaign. Only minor differences in risk estimates have been found between baseline HRAs and later updates based on actual emissions data. This is true for all four chemical agent disposal facilities using the Army's incineration technology.

For each potential exposure source, various exposure scenarios and populations are examined. For the HRA for TOCDF, for instance, these included subsistence ranchers, residents, workers, and people engaged in various nearby recreational activities. Potential emissions release into, and transport through, the environment are modeled considering all applicable media, e.g., air, water, and solids, to provide exposure estimates.[17]

Potential chemicals of concern resulting from incineration operations are identified prior to any trial burns, as part of the permitting process. Typically, a few hundred chemicals of concern are identified, but only a small sampling are actually present in incinerator emissions. Since actual emissions data were not initially available from disposal facility sites in the continental United States, data from JACADS operations were used until site-specific emissions data became available. Also, if a given chemical of concern is not detected in site emissions, then it is assumed to be present at the minimum detection limit concentration, whether or not it is actually there.

Finding 2-3. The same requirements concerning health risk assessments apply to chemical agent disposal facilities and industry. Although the currently applicable laws do not specifically require health risk assessments, state regulatory agencies frequently require them under the authority granted to them by either the new Resource Conservation and Recovery Act/Maximum Achievable Control Technology provisions or general omnibus provisions. Requirements concerning health risk assessments are typically expressed in each site's RCRA operating permit provisions.

Neutralization-Based Chemical Agent Disposal Facility

NECDF uses neutralization (hydrolysis) technology instead of incineration. Air emissions were determined to be the only potential source of risk to the surrounding population. The risk assessment approach developed for NECDF concluded that, based on the samples collected, no risk from air emissions exists at this site. Forty-eight chemicals of concern were expected to be present at trace levels. Four sampling events occurred during which none of the chemicals of concern were detected, nor were any volatile organic compounds detected (Rowden et al., 2006).

As NECDF is unique among the operating chemical agent disposal facilities in using neutralization instead of incineration, no monitoring data from a comparable hazardous waste facility were available when the permitting process took place. Pursuant to Indiana Code 13-22-10(a)(2), a risk assessment and air monitoring approach had to be developed in conjunction with the Indiana Department of Environmental Management. The Indiana statute requiring a health and environmental risk assessment for NECDF is similar to the Indiana statute requiring risk assessments for gaseous emissions from a PCB incinerator (Indiana Code 13-22-9) and is based on EPA guidelines for HRAs. A full report on the NECDF risk assessment approach is available (Rowden et al., 2006).

Finding 2-4. The requirements for conducting a health and environmental risk assessment for the Newport Chemical Agent Disposal Facility are similar to the state of Indiana requirements for a risk assessment of gaseous emissions from a commercial PCB incinerator. These requirements, which are similar to EPA guidelines for health risk assessments, are a reasonable approach to assessing the health risk posed by the NECDF.

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[16]As mentioned earlier, if the HRA is to be developed prior to trial burns at either industrial facilities or chemical agent disposal facilities, data from comparable facilities or the MACT standards can used in the risk calculations.

[17]An example full risk assessment protocol including both health and ecological considerations may be found at http://www.hazardouswaste.utah.gov/HWBranch/CDSection/CDS_Risk_Page.htm.

TRANSPORTATION RISK ASSESSMENTS FOR SECONDARY WASTE

U.S. Department of Transportation (DOT) regulations (10 CFR 49) for transporting hazardous materials have been developed over many years and continue to be modified as necessary to protect the public. Adherence to the DOT regulations provides an appropriate level of safety for materials from chemical agent disposal facilities with low levels of agent contamination. DOT regulations do not require or recommend a risk assessment for shippers or carriers of hazardous materials. However, in the case of hazardous waste shipped from chemical agent disposal facilities, a transportation risk analysis can lead to insights for increased risk mitigation commensurate with the levels of residual agent contamination. Risk mitigation considerations include routing to reduce the mileage, population along the route, and/or crash likelihood; additional physical barriers to an uncontrolled release; and control of ambient and/or postaccident environments.

To transport a hazardous waste such as dilute caustic solutions, both commercial facilities and Army chemical agent disposal facilities must comply with DOT regulations, including standards for packaging, marking, placarding, vehicular safety, and driver qualification. Although as just mentioned, no explicit risk assessment or safety plan is required by DOT regulations, in the case of NECDF, Indiana Code 13-22-3-7.5 requires an evaluation of potential transportation risks and a transport safety plan for either VX or the hazardous waste derived from the bulk neutralization of VX, currently interpreted as consisting only of the hydrolysate.

The committee is aware of three transportation risk assessments involving materials from chemical agent disposal facilities:

1. Hydrolysate from NECDF to satisfy National Environmental Policy Act requirements (Zimmerman et al., 2003),
2. Hydrolysate from NECDF to support a transport safety plan (DuPont, 2004), and
3. 1X wastes from the Aberdeen Chemical Agent Disposal Facility to support the decision to ship wastes off-site (Hessian and Myriski, 2005).

Recently, the CMA issued a requirement for sites to perform and document their consideration of transportation risk assessment requirements when evaluating off-site shipping of secondary waste contaminated with more than 1 VSL of agent.[18] The committee did not evaluate the above reports in detail but did note one major transportation risk parameter that showed significant variability: the truck crash rate.

The difference between the crash rates per mile in the first two reports is due to the use of a bounding rate (using general data) in the first report and a carrier-specific rate in the second report. The third report derived a truck crash rate per billion ton-miles, based on Federal Motor Carrier Safety Administration data for the number of commercial vehicle hazmat crashes divided by the number of commercial vehicle ton-miles. The commercial vehicle accident rate per ton-mile value was multiplied first by 0.59 and then by 0.013 to account for the number of ton-miles for for-hire commercial vehicles and for Class 6 poisons, respectively. These adjustments to the accident rate are inappropriate without consideration of the corresponding hazmat crashes, for which no data were used. The total accident scenario probabilities may be conservative (too high), however, when the probabilities of fire occurring, impact forces sufficiently high, etc. are considered. These probabilities do not appear to have been addressed, and the committee did not review the reports at that level of detail.

Finding 2-5. The committee's examination of how transportation risk assessments for agent-contaminated waste materials are conducted at chemical agent disposal facilities indicated that widely differing models and parameters have been used. A specific problem identified by the committee is that the methodology used for general ton-mile data in transportation risk assessments to achieve a Class 6 ton-mile value is not consistent.

Recommendation 2-5. The Chemical Materials Agency should establish consistent and detailed criteria for conducting whatever transportation risk assessments are required to ensure accuracy and uniformity in the expression of results.

Finding 2-6. The state of Indiana requirements for an evaluation of transportation risks and for preparing a

[18] Off-site shipping and commercial treatment of secondary waste contaminated with greater than 1 vapor screening level (VSL) chemical agent. Memorandum from Kevin J. Flamm, Program Manager for the Elimination of Chemical Weapons, February 6, 2006.

transport safety plan for hazardous waste derived from the neutralization and destruction of bulk VX exceed the regulatory requirements for the transportation of hazardous waste by industry.

Recommendation 2-6. The Chemical Materials Agency should continue to perform transportation risk assessments for shipping any secondary wastes from chemical agent disposal facilities with agent contaminant levels >1 VSL, despite the fact that doing so is not a DOT requirement.

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3

Site-Specific Analyses of Major Secondary Waste Issues

Chapter 3 presents a discussion and analysis of the main secondary waste streams generated at each of the four baseline incineration chemical agent disposal facility sites,[1] as well as the waste streams generated at the Newport Chemical Agent Disposal Facility (NECDF) neutralization disposal facility for bulk VX. There are significant similarities among the secondary wastes generated at the four incineration facilities despite some differences in the inventories of specific weapons and chemicals to be disposed of at each facility. There is, however, a difference in the way each facility approaches the management of these wastes, largely because of the regulatory and permitting differences (see Chapter 1). Stakeholder involvement, another highly important part of the regulatory and management process for chemical agent secondary waste at each site, is discussed later in this chapter.

The main waste streams generated at chemical agent disposal facilities and examined in detail in this report with respect to their waste characterization and disposal requirements are as follows:

- Spent activated carbon;
- Brine solutions or brine salts;
- Dunnage, consisting primarily of wooden pallets;
- Metal from munitions or ton containers;
- Plastics, particularly spent personal protective equipment (PPE); and
- Spent decontamination solutions.

Many of these wastes are effectively disposed of during operations. However, current permit requirements and other process limitations have resulted in significant quantities of these wastes accumulating on-site. Hydrolysate from the neutralization of the VX stockpile at Newport, a unique liquid waste stream among the wastes generated at the active chemical agent disposal facility sites, has also accumulated on-site. Specific quantities, issues, and comparisons associated with each of the main waste streams generated at the active disposal facilities are detailed in the remainder of this chapter.

OVERVIEW OF SECONDARY WASTE INVENTORIES

Significant amounts of secondary wastes are generated at each site as a result of operations, and additional quantities of wastes will be generated during closure operations. Closure wastes will be discussed separately in Chapter 4. In Chapter 3, the secondary wastes generated as a result of operations are identified by type, followed by a discussion of the challenges faced by each site.

The secondary wastes at chemical agent disposal facilities were summarized in Chapter 1 and profiled in Table 1-2. Some of them, depending on the site, are disposed of concurrently with the operations to

[1] These are the Anniston Chemical Agent Disposal Facility (ANCDF), the Pine Bluff Chemical Agent Disposal Facility (PBCDF), the Tooele Chemical Agent Disposal Facility (TOCDF), and the Umatilla Chemical Agent Disposal Facility (UMCDF).

TABLE 3-1 Projected Secondary Waste Inventories in Storage at End of Agent Disposal Operations (tons)[a]

Secondary Waste Stream	ANCDF	PBCDF	UMCDF	TOCDF	NECDF	Total Across All Sites
Spent carbon from filters	169	640	761	274	136	1,980
Containerized combustible solids[b]	163	18	1327	199	17	1,724
Containerized miscellaneous solids	96	8	27	3	19	153
Containerized DPE/PPE/TAP gear	157	22	80	535	52	846
Metals[c]	175	15	0	51	12	253
Subtotal solids	760	703	2,195	1,062	236	4,956
Spent decontamination solution[b]	0	0	0	0	318	318
Miscellaneous liquids	8	0	18	40	10	76
Subtotal liquids[d]	8	0	18	40	328	394
Total	768	703	2,213	1,102	564	5,350

NOTE: ANCDF, Anniston Chemical Agent Disposal Facility; DPE, demilitarization protective ensemble; NECDF, Newport Chemical Agent Disposal Facility; PBCDF, Pine Bluff Chemical Agent Disposal Facility; PPE, personal protective equipment; TAP, chemical protective clothing made primarily of butyl rubber; TOCDF, Tooele Chemical Agent Disposal Facility; and UMCDF, Umatilla Chemical Agent Disposal Facility.

[a]Site managements' best estimates as of January 2007.

[b]Excludes solids or liquids treated on-site in metal parts furnace or shipped off-site for treatment and disposal.

[c]Excludes metals to smelter recycle or off-site landfill disposal.

[d]Excludes Newport hydrolysate.

SOURCE: Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, December 11, 2006.

destroy the chemical weapons stockpile. Disposal is either off-site at a permitted treatment, storage, and disposal facility (TSDF) or by treatment on-site when the facilities are not engaged in the primary mission of agent and munitions destruction.

The projected profile and quantities of secondary wastes remaining in inventory at the end of operations at each of the five currently operating chemical agent disposal facilities, based on current disposal practices, are shown in Table 3-1. A profile of secondary wastes currently shipped off-site for treatment and the disposal methods are given in Table 3-2.

GENERAL WASTE CHARACTERIZATION CONSIDERATIONS

Generator knowledge may be used to make a determination that a waste from a chemical agent disposal facility never came into contact with agent and therefore is not agent-contaminated when it is declared a waste. In that case, these secondary wastes are designated not as hazardous wastes but as solid wastes unless they possess some other characteristic of a hazardous waste or are a listed waste.

Where a waste material was in an environment in which contact with chemical agent could have occurred, the waste must be characterized before it may be shipped off-site. Agent-contaminated waste streams may be certified as chemical-agent-free (1) if analysis show levels not greater than or equal to the applicable waste control limits (WCLs) or (2) if the waste has been subjected to thermal treatment at 1000°F for 15 minutes.

Waste Control Limits and Vapor Screening Level

The Resource Conservation and Recovery Act (RCRA) permits for all of the baseline incineration facilities specify a WCL below which a specific waste may be shipped off-site for additional treatment or ultimate disposal.[2] Generally, if the extractive analysis of a waste shows the concentration of agent to be not greater than or, at most, equal to the WCL, the waste is considered nonhazardous for chemical agent and may be disposed of off-site. The WCL is defined as 20 parts per billion (ppb) for GB and VX and 200 ppb

[2]Permitted methods for off-site disposal of secondary waste vary from case-to-case, factoring in environmental considerations such as the potential environmental persistence of waste contaminants. Discussion of degradation rates for trace amounts of chemical agents under a variety of conditions are available in Waysbort et al. (2004), Bartelt-Hunt et al. (2006), and Columbus et al. (2006). Land disposal of hazardous waste is governed by Subtitle C of RCRA (40 CFR Parts 264/265). For landfill requirements, see 40 CFR Parts 264/265, Subpart N.

TABLE 3-2 Treatment and Disposal Methods Used for Secondary Wastes Shipped Off-site During Agent Disposal Operations

Waste Category	Secondary Waste Stream	Primary Off-site Treatment/ Disposal Method	Site				
			ANCDF	PBCDF	UMCDF	TOCDF	NECDF
Containerized solids	Refractory brick, slag, or furnace ash	Stabilization/ landfill	X	X	X	X	
	PAS solids and spent filter media	Landfill		X	X	X	
	Miscellaneous debris	Incineration		X	X		X
Containerized liquids	Laboratory waste	Incineration	X	X	X		X
	Paint-related waste	Incineration	X	X	X	X	X
Bulk solids	Metal	Smelting or landfill	X	X	X	X	X
	Dunnage	Landfill	X		X		
	Brine salt	Landfill			X		
Bulk liquids	Brine liquid	Stabilization/ landfill	X	X		X	
	Decontamination solution	Incineration		X			X

NOTE: ANCDF, Anniston Chemical Agent Disposal Facility; NECDF, Newport Chemical Agent Disposal Facility; PAS, pollution abatement system; PBCDF, Pine Bluff Chemical Agent Disposal Facility; TOCDF, Tooele Chemical Agent Disposal Facility; and UMCDF, Umatilla Chemical Agent Disposal Facility.
SOURCE: Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, December 11, 2006.

for HD at all chemical agent disposal facilities except UMCDF[3] (ADEM, 2006; ADEQ, 2006; ODEQ, 1997; UDEQ, 2004). These values were originally derived from Army chemical agent regulations for workforce drinking water standards.

Most chemical agent disposal facility RCRA permits have adopted the procedures set forth in U.S. Environmental Protection Agency (EPA) Publication SW-846 as the primary analytical methodology for waste stream characterization. However, in cases where there is the potential for the waste to be agent-contaminated, some methodologies used by individual facilities have been specifically approved for certain wastes. For liquid wastes, or wastes that can yield a liquid "leachate," the EPA-approved methodology is the toxicity characteristic leaching procedure (TCLP). Other methodologies may be used if approved by the EPA or the state regulatory agency.

In addition to extractive analysis techniques, other analytical and process metrics are routinely used to characterize and profile the hazard level of chemical agent in secondary waste at chemical agent disposal facilities. These include the short-term exposure limit (STEL), the vapor screening level (VSL), the short-term limit (STL), and the Army's 0, 1X, 3X, and 5X designations for various levels of agent contamination. These metrics are explained briefly below and summarized in Table 3-3.

The STEL is defined as the maximum vapor concentration to which unprotected workers can be exposed for up to 15 minutes (as often as four times in an 8-hour workday) without any adverse health effect. Exposure limits are measured in milligrams of agent per cubic meter of air and are set for each specific agent. STELs and other health-based concentration standards were established by the Army in coordination with the Centers for Disease Control and Prevention (CDC) and are used to establish industrial hygiene guidelines and monitoring standards for worker safety. Monitoring is conducted using equipment capable of measuring the chemical agent level in real time or near real time, ensuring the 15 minutes associated with the STEL is

[3]The UMCDF permit refers to this not as a WCL but as a permit compliance concentration (PCC). The PCCs at UMCDF are slightly lower than the WCLs used at other chemical agent disposal facilities and are discussed later in this chapter and listed in Table 3-8.

TABLE 3-3 Waste Control Limit Screening Criteria for Off-site Management of Chemical Agent Disposal Facility Secondary Waste

Agent Contaminant	Direct Measurement (Extraction)[a] (ppb)	VSL (Vapor Screening Level)[b]	Process Decontamination History[c]
GA, GB	20	1 STL[d] (0.0001 mg/m^3)	5X
VX	20	1 STL (0.00001 mg/m^3)	5X
HD	200	1 STL (0.003 mg/m^3)	5X

[a]Analytical methods defined in site waste analysis plan: ppb, parts per billion by volume (1 molecule in 1 billion).
[b]VSL ≥1 short-term limit (STL) used via permit modification; STL, short-term exposure limit without the time component.
[c]5X, agent-free based on thermal decontamination at 1000°F for 15 minutes. Site-specific permit modifications allow different waste control limits to be used.
[d]STL, short-term limit.
SOURCE: Rob Malone, CMA Task Manager for Closure and Secondary Waste Disposal, "Secondary waste background and management criteria by site," Presentation to the committee, August 2, 2006.

not exceeded. The STL is a concentration typically expressed in terms of milligrams of a specific agent per cubic meter of air. It is similar in numerical value to the exposure limits found in the STEL but without the 15-minute time component.

A VSL is a control limit used to clear materials for off-site shipment based on agent concentration in the atmosphere above the packaged waste materials. A VSL has been incorporated into the RCRA permits for ANCDF and PBCDF for use in characterizing solid waste streams that are not amenable to other analysis methodologies. A VSL is also used at TOCDF and NECDF to group and classify various wastes. The VSL in the PBCDF RCRA permit is currently <1 STEL (ADEQ, 2006). The VSL in the ANCDF RCRA permit is currently established at ≤1 STL (ADEM, 2006).

The Army also uses the designations 0, 1X, 3X, or 5X (defined in Box 3-1) to characterize and classify the agent contamination level of exposed materials. These nonanalytical designations reflect the decontamination treatment a specific waste has received.

Due to the toxicity of the nerve and mustard agents and the hazard and risk associated with them, the Army has developed specific criteria based on the concentration of agent vapors in air to determine the potential for equipment to be agent contaminated. These criteria are covered in detail in an Army policy guidance document (U.S. Army, 2004).

Site-Specific Characterization According to Permit Requirements

Anniston

The Anniston Chemical Agent Disposal Facility (ANCDF) RCRA permit language defines "chemical agent free" as agent concentrations below the lowest achievable method detection limits as specified by the analytical method used. In addition, at ANCDF, under a recent permit modification, certain solid wastes not exposed to chemical agent liquids or to vapors >1 STL are deemed to be nonhazardous with respect to chemical agent and may be disposed of off-site in accordance with the applicable solid waste regulations.

Under the ANCDF waste analysis plan, where an EPA analytical methodology exists, it must be used to determine whether a sample contains agent or other toxic constituents. Methods developed by the Army will be used for those materials with no EPA methods. The ANCDF waste analysis plan was amended in June 2006 to establish a nonextractive analysis to determine chemical agent contamination for certain waste streams deemed potentially suitable for off-site treatment and disposal. According to the Alabama Department of Environmental Management (ADEM) approved methodology, chemical agent vapor monitoring with the automatic continuous air monitoring system (ACAMS), the depot area air monitoring system (DAAMS), or the miniature continuous air monitoring

BOX 3-1
U.S. Army Decontamination Metrics for Potentially Exposed Materials

Not agent contaminated 0 (zero) indicates an item, although located in an area with liquid agent and/or agent vapor, has not been contaminated (for example, it does not present an agent hazard through contact or presence of vapor).

Decontamination level 1X (X) indicates the item has been partially decontaminated of agent. Further decontamination processes are required before the item is moved or any maintenance or repair is performed without the use of chemical protective clothing and equipment. This degree generally shall be applied to the item as it stands used and subjected only to routine cleaning after use.

Decontamination level 3X (XXX) indicates that the item has been surface decontaminated by locally approved procedures, has been bagged or contained in an agent-tight barrier (plastic bags may be used if they have been tested and found to be effective for the purpose) of sufficient volume to permit an air sample to be withdrawn while minimizing dilution with incoming air, and/or appropriate tests/monitoring have verified that concentrations are not above 0.0001 mg/m^3 for agents GA/GB, 0.00001 mg/m^3 for agent VX, 0.003 mg/m^3 for H or lewisite, or 0.00003 mg/m^3 for agent GD (unmasked worker AEL values for other covered chemicals). Monitoring is not required for completely decontaminated and disassembled parts that are shaped simply (no crevices, threads, or the like) and are made of essentially impervious materials (such as simple lab glassware and steel gears).

Decontamination level 5X (XXXXX) indicates an item has been decontaminated completely of the indicated agent and may be released for general use or sold to the general public in accordance with all applicable federal, state, and local regulations. An item is decontaminated completely when it has been subjected to procedures that are known to completely degrade the agent molecule or when analyses, submitted through MACOM and DA channels for approval by the DDESB, have shown that the total quantity of agent is less than the minimal health effects dosage as determined by the Surgeon General. 5X condition must be certified by the commander or DA PAM 385-designated representative. One approved method is heating the item to 538°C (1000°F) for 15 minutes. This is considered sufficient to destroy chemical agent molecules.

NOTE: AEL, airborne exposure limit; DA, Department of the Army; DDESB, Department of Defense Explosives Safety Board; and MACOM, major Army command.

SOURCE: Adapted from U.S. Army, 2002, pp. 18-19.

system (also known as Mini-CAMS) may be conducted on nonporous waste streams that have been exposed to liquid chemical agent or chemical agent vapor concentrations >1 STL to determine their suitability for off-site shipment.[4]

Under the modified ANCDF waste analysis plan, specific waste streams will be screened based on the STL values for chemical agent (ADEM, 2006). These wastes may be shipped to an off-site TSDF if the concentrations are <1 VSL.[5] Wastes shown by monitoring to contain <1 STL of GB and/or VX may be disposed of at an off-site thermal treatment facility. Only nonporous solid wastes that are combustible in nature or objects that do not possess internal cavities will be evaluated for off-site disposal using chemical agent vapor monitoring (ADEM, 2006).

Pine Bluff

At the Pine Bluff Chemical Agent Disposal Facility (PBCDF), process knowledge, quality assurance data, and analytical data are used to make waste characterization decisions. Under the PBCDF RCRA permit, the term "chemical agent free" refers to contaminated or potentially contaminated solid materials that have been tested per the PBCDF waste analysis plan and found to be below the WCL or to have been thermally treated for 15 minutes at 1000°F. Under the waste analysis plan, waste may be shipped off-facility for treatment and/or disposal only if

- The waste was not agent contaminated, or
- The waste meets the criteria for chemical agent free, or
- The waste has been decontaminated and/or monitored to a vapor concentration equivalent to less than the STEL for agent.

Under the PBCDF waste analysis plan, each batch of waste from areas where chemical agent may be present will either be sampled and tested for agent or the vapor space above the waste will monitored for

[4]ACAMS and Mini-CAMS are automated, near-real-time air-monitoring systems used in chemical agent disposal facilities since 1990. DAAMS is a manual monitoring system, used primarily to confirm an agent alarm, and has been in use since 1988. More in-depth information can be found in Chapter 4 of NRC, 2005.

[5]Rob Malone, SAIC, "Secondary waste background and management criteria by site," Presentation to the committee, August 2, 2006.

TABLE 3-4 UMCDF Permit Compliance Criteria for Off-site Disposal

		Permit Compliance Concentration (ppb)		
Matrix Type	Waste Stream	GB	VX	HD
WML/WSS	Brines	13	8	127
WML/WSS	Spent hydraulic fluid	13	8	127
WML/WSS	CHB sump liquids of known origin	13	8	127
WIL	Lubricating oil	16	15	177
WIS	LIC slag	16	13	152
WIS	DFS ash	16	13	152
WIS	DFS cyclone residues	16	13	152
WIS	MPF ash	16	13	152
WIS	Non-RCRA empty munition casings	16	13	152
WIS	Wood pallet material	16	13	152
WIS	PAS residue	16	13	152
WIS	PAS mist eliminator candles	16	13	152
WIS	Brine tank sludge solids	16	13	152
WIS	RCRA empty munition casings	16	13	152

NOTE: CHB, container handling building; WIL, water-immiscible liquid; WIS, water-insoluble solid; WML, water-miscible liquid; and WSS, water-soluble solid.
SOURCE: ODEQ, 1997.

agent. For those batches characterized by sampling and analysis, the TCLP extraction method will be used to determine parameter concentrations. Agent vapor space monitoring is performed by placing the wastes in a container (e.g., drum or bag) and allowing at least 4 hours at 70°F for the agent vapor in the container to reach equilibrium.

After equilibrium is reached, the concentration of agent in the vapor space will be measured using near-real-time monitoring (e.g., ACAMS). The specific characterization analysis methodology to be used for each secondary waste stream destined for off-site shipment is detailed in the waste analysis plan (ADEQ, 2006).

Umatilla

At the Umatilla Chemical Agent Disposal Facility (UMCDF) any nerve, military, and chemical agents or any residues from demilitarization, treatment, and testing of nerve, military, and chemical agents (e.g., secondary waste) is, by Oregon regulations, a state listed hazardous waste (i.e., Oregon waste codes P999/P998 and F999/F998). Under the UMCDF waste analysis plan, wastes must be agent-free prior to shipment to an off-site facility. Samples will be considered agent-free if they are below the established permit compliance concentrations (PCCs), as shown in Table 3-4. The PCCs included in the UMCDF permit were selected based on process knowledge, previous results for similar waste streams at the Johnston Atoll Chemical Agent Disposal System (JACADS) or TOCDF, and existing RCRA land disposal restriction (LDR) notification requirements. These values are modestly lower than the 20 ppb criterion for GB and VX at the other disposal facilities.

Under the UMCDF waste analysis plan, waste stream compliance concentrations are determined using EPA SW-846 unless another characterization methodology is approved. For the detection of chemical agent, UMCDF standard operating procedure UM-0000-M-559, "Agent Extraction and Analyses" is used. This procedure tailors the analyses to different sample matrices; if a process stream is not listed, the matrix that the sample most resembles is to be used (ODEQ, 1997).

Tooele

Under the Tooele Chemical Agent Disposal Facility (TOCDF) waste analysis plan, only secondary wastes having a chemical agent concentration below the WCL of 20 ppb for GB and VX and 200 ppb for mustard agent may be transported to an off-site RCRA TSDF. These wastes are designated as process wastes (i.e., Utah F999). Wastes above the WCL are designated as acute wastes (Utah P999). For certain other wastes, such as demilitarization protective ensemble (DPE) suits, discussed later in this chapter, vapor monitoring for agents is used to determine if a waste (1) is designated as a Utah process waste (Utah F999) and allowed to be shipped off-site for treatment and ultimate disposal if it meets the WCL or (2) is an acute waste (Utah P999), which must be treated on-site (UDEQ, 2004).

Newport

At the Newport Chemical Agent Disposal Facility (NECDF), chemical agents are, by Indiana regulations, a state listed hazardous waste (i.e., Indiana waste code I001). Under the NECDF waste analysis plan, secondary wastes may be determined to contain agent and may therefore also be listed hazardous wastes. These wastes may or may not have other hazardous waste characteristics associated with them, as determined in the NECDF waste analysis plan. Hydrolysate, for example, is designated as an Indiana listed waste (I001) and is also considered to be corrosive (D002) and ignitable (D001). On the other hand, spent carbon is a listed waste (I001) but does not contain enough agent to generate sufficient vapors to present a danger to human health or the environment and is therefore not determined to be a reactive waste (D003).

Under the NECDF waste analysis plan, wastes that cannot be initially decontaminated to the Army's 3X decontamination level are to be placed into containers and stored until additional on-site decontamination or treatment can be provided or shipped off-site to a commercial TSDF for treatment and/or disposal.[6]

Under the RCRA permit for NECDF, process knowledge and analytical sampling are also used to identify and characterize wastes. NECDF performs agent-related analysis and headspace screening of agent-contaminated materials, using state regulatory approved analytical methods. As part of the NECDF waste characterization, any applicable RCRA waste codes, LDR waste codes, and underlying hazardous constituents for the D001, D002, and D003 wastes must also be determined. Where process knowledge is not sufficient for waste characterization, nonroutine samples will be collected as necessary for off-site analysis. For liquid wastes, EPA-approved sampling methods are used and sampling activities conform to EPA's SW-846 requirements. Solid wastes such as PPE, components and parts, glassware, disposable items, and filters are decontaminated with caustic or hypochlorite solutions and then monitored for compliance with the Army's 3X decontamination level. Under the NECDF waste analysis plan, off-site commercial TSDFs will provide any required treatment to achieve LDR treatment standards (IDEM, 2006).

Analysis of Waste Categorization Situation Across Sites

Various measurements are used at the different sites to characterize and classify secondary waste streams for possible shipment to off-site TSDFs. These categories and characterizations are often dictated by the types of waste material involved, the permit requirements, and the availability of an approved, reliable, direct analytical technique. Because some heterogeneous wastes and some porous waste materials do not yield reliable measurements by current analytical techniques deployed at the sites, conservative classifications and or indirect analytical techniques have been used in permit provisions for establishing off-site shipment parameters and requirements.

For example, residual chemical agents can be strongly bound to the surfaces or internal pores of materials, which in turn can make identification and quantification difficult or impossible. Rates of release can only be estimated using transport modeling, which provides an estimate of what is possible but cannot be effectively validated. Given this situation and the rapidly evolving field of analytical instrumentation, investments in developing additional analytical techniques for heterogeneous or porous materials could prove beneficial.[7]

The Army's use of X designations for classifying waste streams is unique to the chemical agent disposal facilities and is language not commonly used by regulators, the public, or the scientific community. These designations are sometimes confusing and counterintuitive. For example, in the case of PBCDF, the STL,

[6]NECDF management defined decontamination levels as X = agent-contaminated waste with VSL >0.7 STEL; 3X = agent-contaminated waste with VSL <0.7 STEL; 5X = waste decontaminated completely when subjected to procedures known to completely degrade the agent molecule (such as 1000°F for 15 minutes).

[7]Methods such as static secondary ion mass spectrometry and desorption electrospray ionization are cited in recent technical literature for detection of chemical agent. These and other recent advances in analytical techniques are reported in NRC, 2005.

VSL, and X designations are all used in various contexts to describe the same waste streams and the permit parameters. The Army's Chemical Materials Agency (CMA) directs the chemical stockpile disposal program and in recent years has attempted to move away from the X designations to a consistent characterization system that is based on treatment history.

Under the ANCDF permit, the WCL for off-site disposal is agent concentrations of less than 20 and 200 ppb for nerve agent and mustard agent, respectively (ADEM, 2006). Ideally, extraction followed by laboratory analysis would be used to determine whether or not a waste had agent concentrations above or below these levels. However, ANCDF managers have deemed this measurement approach impractical because nonhomogeneity in the contents of the (drummed) wastes makes it impossible to obtain a statistically meaningful sample. Instead, they have requested that headspace monitoring and STLs be used in lieu of extraction analysis methodologies.

ANCDF management filed a permit modification request to the ADEM, asking for certain wastes to be characterized based on vapor screening methodologies, with VSLs of 8 STL for GB, 6 STL for VX, and 2 STL for HD/HT. The permit modification granted to date by the ADEM allows off-site shipment of wastes that monitor at agent concentrations of <1 STL for GB and/or VX agent. The permit modification request limited the use of this methodology to nonporous solid wastes that are combustible and/or objects that do not possess internal cavities. The permit modification granted by ADEM contained the same limits for these specific materials. ADEM continues to consider the pending permit modification application to allow the same limitations for certain types of 8, 6, and 2 STL waste. To date, approximately 650 drums of waste meeting the approved VSL of <1 STL have been shipped to Texas for incineration.[8]

This vapor screening methodology involves measuring agent concentrations in the head space of the drums after thermal equilibration at 70°F, which would provide a measure of the potential for exposure for an individual who might come into contact with the drum's atmosphere. The supporting documentation for the modification request used the EPA acute exposure guideline levels for GB, VX, and HD/HT to determine that the 8 STL, 6 STL, and 2 STL limits assure protection of human health and the environment.[9]

Calculations linking headspace monitoring directly to residual agent concentration have been made by ANCDF staff. However, the head space measurement cannot be correlated with residual agent in the condensed phases of the drum contents, because phase partitioning is not accurately known. Furthermore, even for agent concentrations measured in the head space, it is certainly likely that temperatures inside the drums will at times exceed 70°F, which could produce agent concentrations higher than those indicated by the monitoring test. The vapor pressures for chemical agents increase steeply with increasing temperature.

The ANCDF proposal for off-site disposal of secondary waste with a designated maximum allowable agent vapor concentration of up to 8 STL for GB and 6 STL for VX also involves the following proposed requirements and restrictions:

- Special waste packaging requirements,
- Designated restrictions on disposal technique at the permitted TSDF,
- Disallowing certain classes of secondary waste for off-site shipment,
- Requirement for agent air monitoring at the TSDF,
- Limited handling and direct burn of the drums,
- Documentation of specific requirements for transportation, and
- Involvement of public stakeholders.

The desire to increase off-site shipment and disposal of wastes by chemical agent disposal facilities is also driven by the limited capacity to process secondary waste on-site during operations and a desire to minimize the amount of secondary waste remaining to be disposed of during closure. The CMA gave the committee a summary of on-site capacity for processing secondary waste at select chemical agent disposal facilities, based on site experience (see Table 3-5). The capacity to manage similar wastes at a single off-site commercial hazardous waste incineration facility visited by the committee is estimated to be well over

[8]Rob Brooks, ANCDF, "Rationale for selection of headspace monitoring levels for off-site shipment of secondary waste," Presentation to the committee, October 16, 2006.

[9]Timothy Garrett, Site Manager, ANCDF, "Protection of the on-site and off-site worker handling drums containing GB and VX waste using headspace monitoring," Memorandum to ADEM, December 19, 2005.

TABLE 3-5 Demonstrated Capacities to Process Secondary Waste During Operations (tons/day)

	ANCDF		TOCDF		JACADS		
Secondary Waste Processing Period	Average	Best	Average	Best	Average	Best	Clean Harbors Aragonite[a]
During operations	0.2	1					312
During changeovers in disposal campaigns	0.2	0.5	0.1	0.3			
During closure					2	3	

[a]A commercial hazardous waste incineration facility in the state of Utah. Full permitted operating capacity is 312 tons/day. Actual operating capacity is waste specific.
SOURCE: UDEQ, 2003; Rob Malone, CMA Task Manager for Closure and Secondary Waste Disposal, "Secondary waste background and management criteria by site," Presentation to the committee, August 2, 2006.

10 times the capacity of any one of the chemical agent disposal facilities.[10]

The CMA has issued program-wide secondary waste recommendations on restrictions and requirements for each facility to follow in pursuit of potential permit modifications that would allow off-site shipments of contaminated waste. These restrictions are the same as the ANCDF-proposed restrictions and include guidelines on packing, monitoring, shipping, transport, disposal techniques, and stakeholder involvement, as outlined above.[11] The operating contractor and CMA personnel should also continue to audit the TSDFs being used to receive secondary wastes, to ensure that they are compliant.

Finding 3-1. In the absence of better techniques for measuring agent concentrations on certain heterogeneous, porous, and permeable materials, indirect measurements leading to conservative classifications of waste materials are being used at chemical agent disposal facilities.

Recommendation 3-1. The Chemical Materials Agency should develop improved analytical techniques for heterogeneous, porous, and permeable materials. Better analytical techniques could enable more exact quantification of agent contamination to meet off-site shipping criteria and help reduce waste remaining on-site at the end of munitions destruction operations.

Finding 3-2. Currently, permit provisions at the various sites require the use of a variety of parameters (including the short-term exposure limit, the short-term limit, the waste control limit, the permit compliance concentration, the vapor screening level, and the Army's X-based notations) for characterizing secondary waste from the chemical agent disposal processes. This inconsistency inhibits clear communication with and understanding by the broader population.

Recommendation 3-2. The Chemical Materials Agency should continue to move away from the Army's X-based notation for agent contamination levels and encourage the use of waste contaminant level (ppb) or vapor space concentration (mg/m^3) classifications where appropriate. The CMA should seek to move toward a more uniform means of designating levels of agent contamination when applying for site permits and permit modifications.

Finding 3-3. The availability and capacity of equipment for the concurrent treatment of secondary waste during agent disposal operations or changeovers at chemical agent destruction facilities is severely limited in comparison with the capacity available at off-site commercial treatment facilities that could process the waste.

Recommendation 3-3. The committee encourages the CMA to continue the pursuit of off-site shipment and disposal of >1 STL secondary waste. The committee believes this can be done safely in a ramp-up fashion, based on the use of double bags and containerized packing, truck loading restrictions, designated handling and shipping routes, air monitoring at the receiving TSDF, and restrictions on the disposal technique. Appropriate

[10]Committee visit to Clean Harbors Aragonite, LLC, Aragonite, Utah, on September 27, 2006.

[11]"Off-site shipping and commercial treatment of greater than 1 vapor screening level (VSL) chemical agent contaminated secondary waste," Memorandum from Kevin Flamm, Program Manager for the Elimination of Chemical Weapons, February 6, 2006.

details, including permit modifications, must be worked out in conjunction with the local regulatory agencies and local stakeholders for the practice to be allowed.

SPENT ACTIVATED CARBON WASTE

Banks of activated carbon are used to capture and remove any trace residual semivolatile organics that might be contained in exhaust gases and air streams from all parts of the process before release to the environment. The carbon beds are continuously monitored for organic breakthrough between individual trays of carbon, indicating when beds need to be replenished with fresh carbon. These carbon beds, along with redundant air monitoring systems, ensure that no organics are emitted above the permitted levels. The activated carbon filtration systems for reducing emissions from chemical agent incineration facilities, including fundamentals of adsorption, were reviewed in an earlier NRC report (NRC, 1999).

Spent activated carbon waste streams are generated at facilities employing both the baseline incineration system and the chemical neutralization (hydrolysis) process. Depending on the organic contaminants adsorbed, spent carbon may be classified as hazardous or nonhazardous. Other minor sources of activated carbon will be added to the main carbon filter stream for disposal.

General Carbon Waste Issues Across Sites

Spent activated carbon is the most problematic waste for disposal. It is used at all the chemical agent disposal facilities, but its adsorption properties make it difficult to directly measure its contamination by agent using current techniques. Generator knowledge and direct measurements of process streams, before and after the carbon beds, are indirect methods used to determine whether the carbon is spent or not. Spent, agent-contaminated carbon may also be contaminated with semivolatile organics. At TOCDF and UMCDF the carbon may also become mercury-contaminated when bulk mustard is being destroyed.

The rate at which spent activated carbon is generated varies from site to site depending on factors such as filter configuration, agents processed, and change-out cycles dictated by the individual site RCRA permits. Spent activated carbon is generated at the estimated rates of from 25 tons per year at NECDF to more than 75 tons per year at UMCDF during certain phases of operation. An estimated cumulative 1,980 tons of spent activated carbon are currently projected to remain in inventory for disposal at the end of operations at all sites.

Spent Activated Carbon Practices and Permit Requirements: Commonalities and Differences

As discussed above, ANCDF recently obtained a permit modification to allow off-site shipments of certain solid, noncombustible wastes having headspace concentrations of <1 STL. The original permit modification application, however, is still pending; it requested a provision for off-site shipments of solid wastes with agent concentrations of <8 STL for GB, <6 STL for VX, and <2 STL for HD/HT.[12] However, as stated above, only nonporous solid wastes that are combustible and/or objects that do not possess internal cavities will be evaluated for off-site disposal using chemical agent vapor monitoring. Spent carbon that is agent-contaminated is currently either disposed of on-site by combustion in the metal parts furnace (MPF) or stored on-site for future treatment and disposal. ANCDF management has identified a need to develop better analytical methods for porous materials, to help facilitate additional off-site carbon disposal.[13]

The current ANCDF operating permit states that the spent carbon will be evaluated for chemical agent contamination if it has been exposed to agent concentrations of ≥1 STL. If generator knowledge is not sufficient to establish the exposure history, extractive analysis can be used to measure the level of chemical agent if the waste is being considered for off-site disposal. Spent carbon that experiences breakthrough of >1 STL will not be sampled and is to be treated on-site. Spent carbon considered for off-site disposal is also required to be tested for EPA's TCLP organics and TCLP metals.

The means and permit requirements for managing spent activated carbon disposal at PBCDF are currently similar to those at ANCDF. The PBCDF waste analysis plan states that agent-contaminated carbon will be incinerated on-site in an appropriate manner. Spent

[12]"CMA secondary waste management," Presentation to the CMA committee, December 6, 2006.

[13]Timothy Garrett, ANCDF Site Manager, "ANCDF secondary waste initiative," Presentation to a fact-finding team of the committee on October 16, 2006.

carbon that has not been exposed to agent is managed by off-site disposal.

The TOCDF permit currently requires on-site carbon micronization and incineration as the only allowable disposal option (UDEQ, 2004). Micronization is a process in which carbon is ground to a fine powder in order to improve the carbon burnout achieved during combustion. The process of micronization and incineration was used in the JACADS closure operation to dispose of spent activated carbon (Jordan and Kaminski, 2001). Many difficulties were experienced with the carbon micronization technologies at JACADS and are discussed in various JACADS lessons-learned reports issued by the systems contractor, Washington Group. Based on that experience, micronization followed by incineration would appear to be a highly problematic disposal choice for future use. However, an on-site alternative to the micronization technology has not yet been defined and tested. Spent activated carbon is accumulating at the TOCDF site.

The mercury contamination of significant amounts of mustard agent stockpiled at TOCDF is another factor influencing potential carbon disposition. TOCDF is implementing a pollution abatement system filtration system (PFS) that will trap mercury on carbon. The resulting secondary waste stream consisting of carbon with adsorbed mercury will present a unique disposal problem.[14]

Mustard agent accounts for the largest fraction of chemical agent yet to be processed at UMCDF. Management of the spent carbon from the HD campaign at UMCDF will be similar to the practices developed at TOCDF for its HD campaign. UMCDF also plans to follow the TOCDF lead on any plans for the disposal of carbon waste that is potentially mercury-contaminated. The UMCDF waste analysis plan requires carbon to be treated on-site and simply states that the treatment method for spent carbon has not yet been determined (ODEQ, 1997).

The spent carbon generated at NECDF originates from three parallel trains of carbon adsorbers that are used to clean the exhaust gases from the destruction facility. Gaseous effluent from the reactor first encounters a prefilter, then a high-efficiency particulate air filter, then the first of the six serial activated carbon beds.

The NECDF carbon can be divided into two categories: 0X[15] carbon has not been exposed to VX (determination based on process knowledge and prefilter analytical monitoring). The expectation is that a carbon vendor will take back this material, or that an off-site contractor will regenerate it. For the 1X carbon that has been exposed to VX, the anticipation is that it will be disposed of off-site by an incineration process.

At the date of this report, NECDF has 7 tons of >1 VSL carbon in storage on-site and is projected to generate 135 tons over the course of its operation.[16] NECDF management intends to ship spent activated carbon for final treatment, using head-space measurements to determine that the material is acceptable for shipping.[17]

Analysis of Spent Activated Carbon Waste Practices Across Sites

Spent activated carbon is generated and is accumulating at each of the five chemical agent disposal facilities. It represents one of the largest secondary waste streams currently projected to remain in storage at the end of munitions destruction operations.

The disposal of contaminated activated carbon in the JACADS facility used a micronization process followed by incineration. Communications from technical managers involved with this process stated that the micronization and incineration disposal process presented many technical challenges and required a significantly longer investment of time and effort to complete than anticipated.[18] No alternative to on-site micronization has been identified, but one is likely to be needed at both TOCDF and UMCDF.

The ability to ship agent-contaminated carbon to off-site disposal facilities has also been shown to significantly reduce the time and effort required to accomplish site closure. The recent closure of the Aberdeen Chemical Agent Disposal Facility (ABCDF)

[14]Wastes contaminated with more than 0.2 mg/L of mercury are hazardous wastes (D009). Mercury-contaminated hazardous wastes must meet the LDR of 0.025 mg/L (for nonwastewater) prior to disposal.

[15]"0X" is the same as "not agent contaminated 0," defined in Box 3-1. "0X" is the term used by NECDF staff.

[16]Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, December 11, 2006.

[17]Information gathered from committee site visit, November 20-21, 2006.

[18]Information provided to the committee by Steven Bushman, CMA Chief, Closure and Contract Team, February 2, 2007.

at Edgewood, Maryland, demonstrated safe shipment and treatment of waste contaminated with HD agent at up to 6-8 STL from its closure operation. The wastes were transported and disposed of at the same Texas location proposed for use by ANCDF. Over 2,500 drums of Aberdeen waste, including spent activated carbon waste, have been handled in this fashion. ANCDF has modeled its off-site waste shipment and disposal restrictions on those used at ABCDF.

The use of incineration to dispose of secondary waste off-site is a very reasonable disposition plan if the off-site shipping recommendations suggested by the ABCDF experience are used and adhered to. These practices, which are the same as those proposed by ANCDF, included:

- Special waste packaging requirements,
- Designated restrictions on disposal technique at the permitted TSDF,
- Disallowing certain classes of secondary waste for off-site shipment,
- Requirement of agent air monitoring at the TSDF,
- Limited handling and direct burn of the drums,
- Documentation of specific requirements for transportation, and
- Involvement of public stakeholders.

Finding 3-4. Contaminated activated carbon from the treatment of several different waste streams is a major waste disposal problem at all chemical agent disposal facility sites. The micronization pretreatment of activated carbon in preparing it to be destroyed by on-site incineration has been shown to be a highly problematic process option.

Recommendation 3-4. The Chemical Materials Agency should select an alternative to on-site micronization followed by incineration for decontamination and/or destruction, and ultimate disposal of contaminated activated carbon. Off-site decontamination, and/or destruction and disposal of contaminated activated carbon should be pursued whenever possible.

Finding 3-5. Some of the mustard agent to be processed at the Tooele Chemical Agent Disposal Facility and the Umatilla Chemical Agent Disposal Facility is mercury-contaminated and will result in some of the activated carbon from the pollution abatement system also being contaminated with mercury. Special treatment may be required or additional challenges may be faced in disposing of this carbon.

Recommendation 3-5. The Chemical Materials Agency should evaluate and select appropriate methods for the treatment and disposal of mercury-contaminated carbon. Mercury-contaminated carbon should not be intermingled with other contaminated carbons during storage.

BRINE SOLUTIONS AND BRINE SALTS WASTE

Scrubber brine wastes result from treating the process gases coming from the incinerators in the PAS to remove acid gases and particulates. Spent brine contains water, dissolved salts, suspended solids, and trace amounts of heavy metals and is characterized as a hazardous waste. The brine is either transferred to storage tanks for shipment to a permitted TSDF, or is further treated on-site to produce a salt. That salt is then disposed of off-site in an approved TSDF.

Description of Waste Brine Solutions and Salt Issues Across Sites

Brine waste represents the largest waste stream at baseline incineration sites. The total volume is estimated to be as much as 24,000 tons per year at ANCDF, PBCDF, and TOCDF.[19] At UMCDF, a thermal evaporation brine reduction process is used to concentrate the brine solution to brine salts before disposal. Analytical procedures exist for the characterization of brine solutions and brine salt waste. The procedures are detailed in the waste analysis plan for each site. Most brine waste streams, either liquid or salt, are characterized and shipped off-site for disposal at a permitted TSDF. Therefore, while brine waste is a large stream, readily available off-site disposal options exist for both the spent brine solutions and the brine salts. No brine waste exists at NECDF.

Brine Waste Practices and Permit Requirements: Commonalities and Differences

ANCDF, PBCDF, and TOCDF have similar procedures and permit requirements for characterization,

[19]Personal communication from Raj Malhotra, CMA Deputy, Technical Support Directorate, to Billy Williams, NRC study director, December 11, 2006.

management, and disposal of brine. In general, the permits allow the PAS scrubber liquid brines to be treated in the brine reduction area (BRA) evaporator and drum dryers or shipped off-site to a RCRA TSDF. Each tank of brine is analyzed for chemical agent, which must not be present in the brine at greater than the WCL before it is shipped off-site or before processing through the BRA. Brine samples are to be analyzed for the EPA's TCLP metals and TCLP organics as necessary to characterize the brine for shipment. Agent-derived brines will be sampled batchwise and analyzed for chemical agent to ensure the brine salt meets the appropriate WCLs prior to shipment.

All UMCDF PAS brines must be processed in the UMCDF BRA (ODEQ, 1997). Brine salts from UMCDF are currently disposed of in a hazardous waste landfill. An exception is made if there is a shortage of BRA processing capacity and/or brine storage capacity. In this case, agent-derived brines can be shipped to a TSDF for treatment if UMCDF shows that:

- Brine processing will inhibit the destruction of chemical agent or chemical agent munitions/bulk items;
- Reasonable measures are taken to minimize the quantities of brine generation;
- Reasonable measures are taken to maximize the BRA processing and/or storage capacity; and
- Agent concentration is less than the PCC of 13 ppb.

Analysis of Waste Brine Requirements and Practices Across Sites

The RCRA permit requirements and practices for disposal of brine are fairly uniform across the four baseline sites. There are no analytical issues preventing the accurate characterization of brines, and sites have had no problem meeting the waste control limits. Disposal options for brine solution and brine salts at off-site TSDFs are also readily available and utilized. A stricter requirement for on-site brine salt evaporation is enforced at UMCDF but has not impeded the overall waste management program at that site.

Finding 3-6. Brine solutions are shipped for off-site disposal from chemical agent disposal facilities upon meeting the permit criteria for the particular agent at the respective sites.

Recommendation 3-6. The Chemical Materials Agency should, in conjunction with the concurrence of regulators, continue to actively dispose of as much brine solution or brine salts off-site as possible, as either a hazardous or nonhazardous waste, as appropriate.

DUNNAGE WASTE

Wood dunnage is primarily the wood packing used to store the munitions. The quantity of wood dunnage varies considerably across sites, depending on the number and types of munitions originally stored on wooden pallets. In a few cases, the dunnage will amount to more than 200 tons/year at an individual site. Options for dunnage disposal will depend on its exposure history and site permit requirements.

Description of Dunnage Waste Issues Across Sites

Classification of dunnage as hazardous or nonhazardous is primarily based on generator knowledge and its history of potential exposure to agent. In general, wood dunnage is not a hazardous waste unless there is reason to believe (by way of generator knowledge or environmental monitoring) it has come into contact with agent or agent vapors. The classification of non-agent-exposed dunnage varies by permit, and in the case of TOCDF and UMCDF, all dunnage is classified as hazardous until proven otherwise by monitoring. Because the contamination is likely to be nonuniform, there are no simple, direct, and reliable analytical techniques for determining contaminants that may be adsorbed into the dunnage.

Dunnage Waste Practices and Permit Requirements: Commonalities and Differences

Dunnage that is agent-contaminated above the WCL requires on-site treatment at all sites. However, the permit requirements and management practices that apply to non-agent-exposed dunnage vary across the sites.

At ANCDF, packaging materials such as wood crates and metal containers that were used for storage of chemical agent munitions are not handled as a hazardous waste unless there is reason to believe liquid has leaked from the chemical agent munitions and the packaging container has come into contact with agent. If deemed necessary, headspace sampling and analysis is performed for proper classification. Uncontaminated packaging is handled as a nonregulated solid waste (ADEM, 2006).

At PBCDF, all dunnage generated in the toxic maintenance area with a decontamination level X is required to be treated as hazardous waste and processed in the MPF. However, dunnage originating from areas other than the toxic maintenance area, which is contaminated or potentially contaminated with chemical agent, can be characterized for off-site shipment. For instance, dunnage waste generated in an environment where (1) no liquid or aerosol contact with chemical agent was possible and (2) real-time or near-real-time monitoring was conducted during the full duration of the exposure period showing chemical agent concentration was always less than the STEL is not agent-contaminated and may be disposed of as solid waste (ADEQ, 2006).

At UMCDF, for wood pallets originating from igloos without a record of leakers, the enhanced on-site containers[20] for transferring the pallets are monitored using DAAMS or ACAMS for the agent associated with the munition/bulk container. If no agent is detected at or above 1.0 worker protection limit (as stipulated in the UMCDF waste analysis plan), the pallet material is considered agent-free and may be shipped off-site for disposal as a hazardous waste at a permitted facility. If agent is detected in the enhanced on-site container at or above 1.0 worker protection limit and cannot be refuted using DAAMS, the pallets are either (1) treated on-site without further sampling being required or (2) sampled and analyzed in order to determine if they are an agent-free. If the sample is determined to qualify as agent-free, the pallets are likewise considered agent-free and may be shipped off-site for disposal as a hazardous waste at a permitted facility.[21] If the sample is not agent-free or an agent-free determination cannot be made, the pallet or pallets must be treated on-site.

Pallets from igloos that contain leakers and that are suspected of being contaminated must be further assessed by sampling and analysis to determine how they are to be handled and disposed of. If the sampling establishes that the pallet group is to be considered agent free, the pallets may be shipped off-site for disposal as a hazardous waste at a permitted facility. If the sampling shows that the pallet group is not agent free, or an agent-free determination cannot be made, the pallets from that pallet group must be treated on-site in the MPF (ODEQ, 1997).

At TOCDF, dunnage is considered an acute hazardous waste (i.e., P999) that must be treated on-site if it (1) was held within an on-site container or munitions overpack found to contain leaking munition(s)[22] or (2) the extract prepared from a representative sample is found to contain agent at concentrations equal to or greater than the WCL. If the on-site container or the munitions overpack is monitored at less than 0.5 VSL, the dunnage must be sampled. If the analysis shows the agent concentration is below the WCL and the dunnage exhibits no other hazardous waste characteristics or listings, the dunnage is not considered a listed hazardous waste and may be disposed of as nonhazardous waste (UDEQ, 2004).

Analysis of Dunnage Waste Practices Across Sites

Practices concerning the handling, treatment, and disposition of dunnage are similar across the chemical agent disposal facility sites. Dunnage is initially segregated based on generator knowledge and exposure history. In some cases this is followed by analytical characterization to establish the level of contamination and to determine the ultimate disposal method: by incineration or in a hazardous waste landfill. While analytical characterization by sampling and extractive analysis is accurate for the sample taken, the sample taken may not be sufficiently representative to accurately profile the entire batch of dunnage. In cases such as this, conservative judgments are made, and disposal by either incineration or permitted burial in a hazardous waste landfill should continue to be preferred. The committee's Finding 3-1 and Recommendation 3-1,

[20]The enhanced on-site container is an improved second-generation version of the original design and features an improved latching system that makes sealing the container more efficient.

[21]The specific sampling spots are to be picked with bias at the location of any staining indicating the wood or porous material has previously been in contact with liquids as opposed to vapors. A wood plane or other tool capable of taking flat surface samples of generally consistent thickness will be used to collect wood shavings at an average thickness of 2 mm or less from the surface of two pallet corners, and those shavings will be composited with the shavings from the other pallets in the pallet group. If a sample contains multiple pallets, approximately equal contributions from each pallet will be used for the composite sample. Stained areas, if evident, will be given priority for sampling over unstained areas. Using UMCDF analytical procedure UM-0000-M-559, a minimum of 6 g total of composited sample must be collected for homogenization and analysis for chemical agents.

[22]As evidenced by monitoring of the air within the sealed on-site containers or overpack that shows agent at 0.5 VSL or above.

discussed earlier in this chapter, also apply to dunnage waste.

SCRAP METAL WASTE

Scrap metal generated at stockpile disposal facilities comes from the treatment of metal munitions casings and bulk ton containers (TCs) in the MPF or deactivation furnace system (DFS) after the agent has been drained. Drained bulk containers and munition casings with energetic materials removed and metal munition components are treated in the MPF to destroy any agent residues. After treatment, the metal parts are allowed to cool, vacuumed to remove loose paint flakes and ash residue, and stored temporarily prior to shipment off-site.

Metal Waste Issues Across Sites

Scrap metal is generated at up to 300 tons per year per site. The volume varies depending on the type of original munitions in the individual site stockpiles. In general, scrap metal parts are classified and managed either as a hazardous waste for disposal at an approved TSDF or as scrap metal for recycling.

The hazardous waste regulations in all five states with operating chemical disposal facilities have provisions that exempt scrap metal from RCRA regulation (adopted from the federal regulatory scheme) and allow scrap metal, contaminated or not, to be recycled. Hazardous scrap metal that is not recycled must be disposed of as hazardous waste—for example, in a permitted hazardous waste landfill (40 CFR 261.4(a)(13) and 261.6(a)(3)(ii)). However, the characterization and disposition of scrap metal generated at chemical agent disposal facilities is specifically addressed in the RCRA permit of each facility. The waste permit classification of similar metal waste varies from site to site. Scrap metal sent for recycle from all chemical agent disposal facilities must first be decontaminated, unlike recycle exemptions sometimes allowed in industry. This is a restriction that is imposed by the Army, as well as the site RCRA permits, to ensure that chemical agent is managed appropriately.

Metal Waste Practices and Permit Requirements: Commonalities and Differences

At ANCDF, the Army verified through testing that metal scrap from the operation of the deactivation furnace system (DFS) or the MPF is thermally decontaminated.[23] Therefore the ANCDF RCRA permit provides that scrap metal (bulk containers, projectiles, mortar rounds, etc.) that has been thermally decontaminated and further cleaned to remove any remaining loose residue may be recycled as a feedstock for steelmaking (i.e., smelting) (ADEM, 2006).

Similarly, PBCDF agent-contaminated scrap metal that has been thermally decontaminated and further cleaned to remove loose residue may be managed as a hazardous waste and disposed of at a permitted RCRA TSDF or, alternatively, managed as scrap metal and recycled exclusively by smelting (ADEQ, 2006).

UMCDF is unique in that all waste generated that has potentially been exposed to agent is considered hazardous notwithstanding the permit provisions. Under the UMCDF permit, munition casings that previously contained chemical agent GB and that (1) have undergone standard thermal treatment in the MPF at 1000°F for 15 min and (2) had all loose exterior and interior residue removed may be considered empty containers under RCRA regulation 40 CFR 261.7(b)(3)(ii). Munition casings that qualify as empty containers can be recycled directly to a recycling smelter. Munition casings that do not meet these requirements are not considered empty containers and must be managed as an Oregon listed hazardous waste and sent to a RCRA-permitted, Subtitle C hazardous waste smelting or disposal facility. Additionally, no munition casings may be sent off-site until they are confirmed agent-free by grab sample of the casing internal residue. UMCDF has shipped over 2.6 million pounds decontaminated scrap metal for recycling (ODEQ, 1997).[24]

At TOCDF, treated scrap metal must be managed as a hazardous waste until verification testing has been accepted. Treated scrap metal is defined in the permit as metal from bulk containers, projectiles, and mortar rounds that has undergone thermal decontamination in the MPF under normal operating parameters and has no residue, internally or externally. Before shipment of treated scrap metal, residue in the interior and on

[23]Heated to 1000°F for at least 15 minutes.

[24]Personal communication between Mike Strong, UMCDF Deputy Project Manager, and Billy Williams, NRC study director, February 2007.

the exterior of the scrap metal must be removed (by vacuuming, for example) and visually verified as clean. After treatment and verification, TOCDF personnel may then manage scrap metal by recycling exclusively for smelting or as a hazardous waste with disposal in a RCRA-permitted landfill. However, any treated scrap metal that contains residue that cannot be removed is considered a Utah hazardous waste (F999) and must be managed as a hazardous waste for disposal at an off-site TSDF (UDEQ, 2004).

NECDF metal waste consists primarily of empty TCs. As of December 2006, a total of 272 TCs out of 1,690 had been processed through the TC thermal decontamination unit. Empty TCs are heated to 1000°F in this unit, which produces decontamination equivalent to the Army designation 5X (agent free or decontaminated potentially agent-contaminated waste). TCs decontaminated to this level at NECDF are routinely recycled to metal processors as scrap metal for smelting and reprocessing.

Analysis of Metal Waste Disposal Practices Across Sites

Scrap metal waste disposal practices and permit requirements across sites are very similar. All involve some method of thermal decontamination for achieving agent-free designation, either 1000°F for at least 15 minutes in the MPF or DFS, or the same time and temperature in the TC thermal decontamination unit. All sites are allowed to recycle the decontaminated metal by sending it to smelters. In one case, however, the designation of the decontaminated metal as hazardous caused concern on the part of the recyclers and interfered with acceptance of the scrap metal. This concern was later resolved through exercising the scrap metal exemption within the RCRA regulations (40 CFR 261.4).

Finding 3-7. Scrap metal from chemical agent disposal facilities is subject to regulatory requirements not imposed on commercial scrap metal generators. However, thermally treated and decontaminated scrap metal from all five sites is acceptable for off-site disposal and recycling.

Recommendation 3-7. Each site should continue to work with the local regulatory authority to maintain and enhance acceptance of criteria allowing for off-site disposal or recycling of thermally treated and decontaminated scrap metal.

PLASTIC DEMILITARIZATION PROTECTIVE ENSEMBLES AND PERSONAL PROTECTIVE EQUIPMENT WASTE

Demilitarization protective ensemble (DPE) suits are encapsulating, supplied-air PPE worn by personnel required to enter areas where chemical agent liquid or vapor is known to exist. Each suit is decontaminated and monitored for chemical agent vapor before being removed from the worker.

Description of DPE and Plastic Waste Issues Across Sites

Waste DPEs and PPE are a waste stream common to all chemical agent destruction facilities. The waste products have generally been exposed to agent and have been packaged and stored on-site for further treatment and disposal by incineration either on-site or off-site. The main issue with waste DPEs is obtaining representative samples for analysis, given the nonuniform deposition of any residual agent, and meeting the current waste characterization and permit requirements for off-site disposal.

DPE Waste Practices and Permit Requirements: Commonalities and Differences

Waste DPE material is managed in very similar fashion at ANCDF and PBCDF. Normally, DPE suits are worn once, decontaminated with decontamination solution, and double-bagged. At ANCDF, the DPE suits are monitored using the vapor screening monitoring methodology established in the site's modified permit (see discussion earlier in this chapter). The waste DPE suits that monitor at less than 1 STL for GB or VX may then be sent to an off-site thermal treatment facility (ADEM, 2006).

At PBCDF, DPE suits with decontamination level X are managed on-site as hazardous wastes and processed in the MPF. Alternatively, decontaminated DPE suits can be bagged in drum containers (typically a double plastic bag, with two to three suits per container), and the vapor space is monitored for agent. The bags must be large enough to permit sample air to be withdrawn while minimizing dilution with incoming air. The air within the bag is sampled for agent using the ACAMS to determine the vapor concentration of agent. Owing to the thoroughness of the initial decontamination of the DPE suits, it is expected that the concentration of agent in the vapor space will be <1 STEL. Waste DPE suits with vapor space monitoring results <1 STEL for agent are not characteristic waste due to agent contamination and may be either sent to a permitted off-site TSDF or incinerated on-site (ADEQ, 2006; U.S. Army, 2006).

At UMCDF, all discarded DPE suits are containerized and placed into a permitted storage area until treated at the site's MPF. Under the UMCDF permit, the physical state of the DPE suits prevents the collection of a representative sample. These materials are weighed and then treated in the MPF (ODEQ, 1997).

At TOCDF, DPE suits are packaged, stored, and characterized based on generator knowledge, agent monitoring, and analysis of samples. Suits having agent-monitoring results ≥0.2 VSL are characterized as acute Utah listed hazardous waste (P999) and may not be shipped off-site. These are currently designated for on-site incineration in the MPF. Suits with an agent concentration of <0.2 VSL (designated as Utah listed process waste, or F999) or that have an agent concentration in the waste below the WCL (20 ppb for GB and VX and 200 ppb for mustard) may be shipped off-site to a RCRA-permitted TSDF (UDEQ, 2004).

Analysis of DPE and Plastic Waste Practices Across Sites

The packaging, storage, and characterization of DPE waste is similar across sites. Some sites use only headspace analysis for primary characterization, while others use both headspace and direct sampling while recognizing the limits and nonuniformity of direct sampling results. All baseline sites use incineration as the primary method for disposal of materials considered to be agent-contaminated, with the main difference being whether it is performed on-site or off.[25] Capacity limitations for on-site disposal of DPE suits and other secondary waste during munitions processing is a factor at most locations, as discussed earlier in this chapter and referenced in Table 3-5. NECDF does not have on-site capability for disposal, so the decontaminated suits are shipped off-site for incineration.

Finding 3-8. The waste management practices for demilitarization protective ensemble suits and other plastics are limited by the on-site capacity for treatment and, at some sites, by the regulatory restrictions for off-site disposal.

Recommendation 3-8. The Chemical Materials Agency should actively pursue off-site shipment and disposal of waste plastic and personal protective equipment such as demilitarization protective ensemble suits from all sites based on adherence to and enforcement of packing, shipping, monitoring, and treatment restrictions.

SPENT DECONTAMINATION SOLUTION WASTE

Spent decontamination solution (SDS) consists of caustic or bleach-based aqueous solutions that have been used in the decontamination of personal protective clothing or the operations areas. SDS may also result from rinsing drained TCs or munition cavities. These solutions are captured and stored for treatment and disposal, either on-site or off-site. SDS typically contains less than 1 percent levels of sodium chloride and organic decomposition products from agent hydrolysis.

Description of SDS Waste Issues Across Sites

SDS is a common waste across baseline incineration and neutralization facilities. The volumes are small, however, compared with those of other waste streams. The volume of decontamination solution from NECDF is estimated at 150 tons per year. Direct analytical methods are used to characterize this liquid waste and are outlined in each site's waste analysis plan.

SDS Waste Practices and Permit Requirements: Commonalities and Differences

SDS at all sites in this study is characterized and managed according to the hazardous waste limits for chemical agents (mustard, GB, VX), as well as other hazardous waste characteristics. The SDS is containerized and stored in a permitted storage area prior to treatment and disposal.

At ANCDF, spent decontamination solution is characterized and managed according to the hazardous

[25]The incineration of DPE suits (which are made of a mixture of polyvinyl chloride, chlorinated polyethylene, resins, plasticizers, and metal stabilizers) is subject to the same dioxin emission limits at industrial incineration facilities as they are at chemical agent disposal facilities. Thus the waste feed load and incineration burn conditions for any of these chlorinated materials into incineration units may be regulated to meet air emission control requirements. These emission control limits and resulting incineration performance requirements are spelled out in the RCRA and Clean Air Act Title 5 permits for each site.

waste codes applicable to chemical agents (mustard, GB, VX). It is containerized and stored prior to on-site treatment by incineration (ADEM, 2006).

At PBCDF and TOCDF, if the chemical agent concentration is below 20 ppb for GB, 20 ppb for VX, or 200 ppb for HD, it may be shipped for off-site disposal (UDEQ, 2004; ADEQ, 2006). At PBCDF, if the chemical agent concentration is equal to or above the WCL, additional decontamination solution will be added to the tank, the contents of the tank will be mixed, and another sample will be analyzed for chemical agent. Also, off-site management must ensure that the SDS is directly fed into an incinerator from either the tanker truck or tanks dedicated to storing only this waste stream (ADEQ, 2006).

At UMCDF, SDS will be analyzed for chemical agent, total metals, total organics, and chlorine in accordance with EPA analysis guidance. If chemical agent is detected above the WCL, additional decontamination solution will be added to the tank, the contents of the tank will be mixed, and another sample will be analyzed for chemical agent. The UMCDF permit also has special requirements for treating SDS in the on-site liquid incinerator (ODEQ, 1997).

Analysis of SDS Waste Practices Across Sites

Practices and regulatory requirements for managing SDS are consistent across each of the five sites included in this study, with either on-site feed to an incinerator or off-site disposal at a permitted TSDF. Direct analytical techniques exist for the exact characterization and disposition of this waste. Disposal of SDS does not currently represent a significant issue for the sites and does not require new technology, practices, or permit modifications.

HYDROLYSATE

The liquid waste stream from the first step of the VX neutralization process at NECDF is called hydrolysate. Hydrolysate is the solution resulting from the treatment of the VX agent with an aqueous NaOH solution. It is a high-pH mixture that consists of two phases, aqueous and organic. The organic phase may represent up to 5 percent by volume of the total mixture. This hydrolysate process waste stream must be destroyed for compliance with the Chemical Weapons Convention treaty (NRC, 1998). Approximately 33 percent of the original VX stockpile at NECDF has been neutralized as of January 2007, resulting in the accumulation of 500,000 gallons of hydrolysate. The hydrolysate is stored on-site at NECDF in intermodal shipping containers after analytical results confirm that a destruction and removal efficiency (DRE) of 99.9999 percent has been achieved and that VX has not been detected at the analytical detection limit.

Several plans for on-site and off-site treatment and disposal of hydrolysate have been considered, the most recent being off-site chemical and biological treatment and disposal by a commercial TSDF. A treatment and disposal option for VX hydrolysate involving pretreatment oxidation and precipitation, followed by biological decomposition and disposal, has been proposed by DuPont, with subsequent follow-up evaluations by the EPA and the CDC (DuPont, 2004; CDC, 2005, 2006). These evaluations found that the treatment proposed by DuPont was technically feasible and provided a safe and effective off-site treatment and disposal option for NECDF VX hydrolysate. However, due to public opposition, plans for hydrolysate treatment and disposal are now being reexamined by the CMA. VX neutralization continues at NECDF while the reexamination is under way. Hydrolysate from VX neutralization continues to accumulate in storage containers.[26] Complete neutralization of the VX stockpile will generate approximately 1.5 million gallons of hydrolysate for treatment and disposal.

Finding 3-9. As of January 2007, over 500,000 gallons of VX hydrolysate generated by the neutralization destruction of bulk nerve agent VX at the Newport Chemical Agent Disposal Facility was being stored in more than 140 intermodal storage containers. It is anticipated that 1.5 million gallons of VX hydrolysate will eventually be generated. Studies by outside government agencies and technical organizations have found that safe, environmentally sound, off-site disposal of VX hydrolysate (such as that proposed by DuPont) is technically feasible.

Recommendation 3-9. The Chemical Materials Agency should evaluate and select an appropriate method to dispose of the VX hydrolysate currently being stored at the Newport, Indiana, site, with preference for off-site disposal.

[26]The disposition of the Newport hydrolysate recently changed. As of May 1, 2007, the Army was shipping Newport hydrolysate to a commercial TSDF incinerator. Since this change occurred after the report was completed but before it was published, the committee is unable to comment.

STAKEHOLDERS AND STAKEHOLDER INVOLVEMENT IN SECONDARY WASTE PRACTICES AT CHEMICAL AGENT DISPOSAL SITES

Stakeholder involvement is an important aspect of the regulatory and management process for chemical agent secondary waste at each chemical agent disposal site. Federal guidelines and state governments offer formal opportunities for public comment and direct involvement in the regulatory permit process. Each state where chemical agent disposal facilities are located has also established a local Citizens Advisory Commission (CAC) for its chemical demilitarization activities. A CAC is appointed by the state governor and reports state and public concerns and opinions about the chemical agent disposal program to the Army. The local CAC is also a key stakeholder with an important voice in the permitting process that takes place with state regulatory agencies. It serves as a direct and formal communications link between the facility and local citizens on critical issues such as secondary waste disposal plans. In Oregon, a local sovereign tribal nation, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), is a key stakeholder community and is included in site-specific secondary waste disposal discussions and decisions.

The committee held discussions with representatives of the local CACs (and in Oregon with the CTUIR) to gain local public input and to gauge perceptions on site-specific secondary-waste-related issues. Communications channels were found to be well established and frequently used. The public outreach offices and site leaders at each location appear to be very effective in establishing an atmosphere of transparency and trust with the local public. Because the long-term fate and status of the UMCDF site remains of great interest to them, the CTUIR expressed additional concerns about the transfer of waste across their land as well as the speed of closure of UMCDF operations, which may be impacted by secondary waste disposal.

The committee found, based on discussions with the local CACs, state regulators, and site managers, that the outreach programs include ongoing discussion of operations and potential changes. All the site managers and contractors follow an open-door policy for communicating with local stakeholders. These efforts at continuous communication and open dialog are important for maintaining public acceptability of the agent disposal program and help to minimize issues when changes, including permit modifications, are necessary.

Finding 3-10. Each chemical agent disposal facility in this study has established open and effective communication channels and has regular dialogue with its Citizens Advisory Commission and other local stakeholders. The input of these stakeholders is also sought by regulatory officials and is an important factor in negotiating permit modifications concerning secondary waste disposal practices.

Recommendation 3-10. The Chemical Materials Agency should continue its support for and emphasis on local stakeholder input and involvement as mission-critical elements when acceptable secondary waste disposal practices are being defined and regulatory permit requirements are negotiated.

HAZARDOUS WASTE MANAGEMENT PRACTICES AT INDUSTRIAL FACILITIES

Commercial hazardous waste TSDFs, like permitted chemical agent disposal facilities, must manage all hazardous waste according to federal and state regulations and the specific provisions of their permits. As noted previously, and similar to the practice at chemical agent disposal facilities, the characterization of wastes, including acceptable analytical methodologies and management and disposal options for specific wastes or types of wastes, is guided by the facility's RCRA permit and associated waste analysis plan. Generally, commercial TSDFs receive waste from off-site generators. The generator provides documentation based on either chemical analysis or generator knowledge. Each generator's waste is initially sampled to verify the hazardous waste classification, as well as to determine the underlying contaminants listed in the generator's LDR certificate.[27] This waste profile is then applied to the management and ultimate disposal of the waste stream.

[27]LDRs require that before a hazardous waste can be land-disposed, treatment standards specific to that waste material must be met. A facility may meet such standards by either (1) treating the hazardous chemical constituents in the waste to meet required treatment levels or (2) treating the hazardous waste using a treatment technology specified by the EPA. A certificate must accompany each hazardous waste shipment showing the applicable treatment level or treatment technology and any underlying constituents of the waste.

Chemical agent disposal facilities differ from commercial TSDFs in that the wastes being treated at the former and the treatment residues being generated there are chemical warfare agent wastes. No commercial facility manages or treats chemical warfare agent in bulk quantities. Whether some or all of the chemical agent secondary waste exhibit any of the RCRA characteristics has been a subject of debate. In only one state (Indiana) agent residue waste is designated as a characteristic waste (D003) by regulation. In other states, the permit may assign hazardous waste codes. In the regulations of only three states (Indiana, Oregon, and Utah) are the wastes, and the residues from their treatment, specifically designated as state listed hazardous wastes. In addition, no state has adopted land disposal restrictions for chemical-agent-derived secondary wastes from chemical agent destruction processes.

Two leading companies with RCRA-regulated facilities provided comments on their own waste characterization and handling practices, as summarized below.

Dow Chemical Company Waste Management Experience

RCRA-regulated facilities operated by the Dow Chemical Company characterize all hazardous and nonhazardous wastes generated on-site or received from off-site locations according to a waste analysis plan as required by RCRA and prepared in accordance with federal and state regulations.[28] The waste analysis plan is a part of the RCRA permit for the facility and describes the procedures used to collect information needed for the storage, treatment, and disposal of waste either on-site or at an off-site facility. Specified in the waste analysis plan are the following elements:

- Analytical procedures,
- Sampling methods,
- Frequency of evaluation, and
- Analytical requirements for complying with land disposal restrictions.

The following information is documented for each waste:

- Physical state of the waste,
- Substance composition and properties,
- Waste handling and transportation requirements,
- Reactive chemical properties,
- Safety and exposure hazards, and
- Required worker personal protective equipment.

Dow Chemical must also comply with the feedstream analysis plan required under the Hazardous Waste Combustor Maximum Achievable Control Technology Standard for incinerators, which is very similar to the site waste analysis plan and describes the information necessary to burn wastes in an incinerator. Dow uses the following approved methodologies to characterize hazardous waste:

- The sampling equipment and methods used are those listed in 40 CFR 261, Appendix I, and the associated references.
- The analytical methods that can be used are from Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods (SW-846, EPA-600/4-79/020); Standard Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79/020); Standard Methods for the Examination of Water and Wastewater; or American Society for Testing and Materials Standard Methods.

These methods will change over time depending on EPA revisions, updates, and/or technology improvements.

The above procedures are specified in the site's waste analysis plan and RCRA permit and thus are required by law. For Dow Chemical Company sites that use off-site facilities for treatment and disposal, these same protocols are generally used because of the requirements established by the off-site facilities' permits or regulatory requirements for receipt of hazardous wastes.

DuPont Sabine River Works

The E.I. du Pont de Nemours and Company (DuPont) Sabine River Works incinerator characterizes hazardous waste primarily using the facility waste analysis plan, which is required by RCRA; the feed stream analysis plan, which is required by the Hazardous Waste Combustor Maximum Achievable Control Technology Standard; or LDRs.[29] The incinerator also must comply with the Occupational Safety and Health Administra-

[28] Based on information received from the Dow Chemical Company in response to the committee's request.

[29] Based on information received from E.I. duPont de Nemours and Company in response to the committee's request.

tion requirements for safety reviews. DuPont has also completed stack testing for state-mandated risk assessment as part of the RCRA permit renewal.

Based on the derived-from rule, items such as PPE are normally incinerated since these contaminated materials carry the same EPA waste codes as the waste with which they came into contact. However, on-site incineration is often done as a matter of convenience rather than because of specific risk assessments or regulatory requirements.

The analytical protocols used to characterize hazardous wastes are primarily the EPA-approved methodologies found in their publication Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods, SW-846. Because these methodologies are a part of the waste analysis plan and the feed-stream analysis plan, they are required by the facility's RCRA permit. In the case of the feedstream analysis plan and the LDRs, adherence is required to meet specific regulatory requirements. Occasionally, DuPont will analyze streams for hazardous constituents or properties other than those required under the permit or regulations in order to address a specific issue (e.g., to determine if the stream can be recycled). Analyses like these should be considered not as an industrial best practice but only as an internal planning aid.

Each waste stream, including derived-from waste, is required to be considered on a case-by-case basis, both for management practices as well as analytical requirements. Regulatory requirements such as the LDRs are used to determine the appropriate management and treatment practices to apply.

COMPARISON OF WASTE MANAGEMENT REQUIREMENTS, PRACTICES, AND IMPLEMENTATION BY THE U.S. ARMY AND INDUSTRY

Based on information gathered and analyzed by the committee and described above, there is little difference between the application of regulatory conditions and requirements at industrial TSDFs and chemical agent disposal facilities. A few specific exceptions were found and have been cited, such as the requirements for scrap metal decontamination before recycle at smelting operations and the requirement at UMCDF that all waste from the site be considered hazardous, wherein the regulatory requirements or the Army's self-imposed restrictions for chemical agent disposal facilities were more stringent than those at commercial facilities. In general, differences arise from the fact that commercial TSDFs manage and treat wastes that are clearly characterized or listed under federal and state regulatory management protocols—that is, they clearly meet hazardous waste characteristics based on methodologies set forth in EPA SW-846 and have distinct regulatory treatment limitations and disposal criteria (e.g., the derived-from rule and LDRs). However, the characterization, management, and disposal of chemical agents and the related secondary wastes at chemical agent disposal facilities are not specifically addressed in federal or state regulations and must therefore be addressed in the individual chemical agent disposal facility permit. This results in the differences seen between the management and disposal requirements at each chemical agent disposal facility, since each permit is based on an individual state's regulatory interpretation of the limits necessary for these distinctive wastes.

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4

Closure Wastes

Closure plans are required for all treatment, storage, and disposal facilities (TSDFs) authorized under the Resource Conservation and Recovery Act (RCRA) as a condition of obtaining a permit.[1] As chemical agent disposal facilities are regulated the same as commercial TSDFs, facility closure plans have been filed with the state regulatory agency for each of the chemical agent disposal facilities. These plans were submitted as part of a facility's permit application and are likely to change as conditions of closure are finalized.

During a closure operation, all contaminated equipment, structures, and soils must be properly disposed of or decontaminated. The act of removing any hazardous wastes or hazardous constituents during closure results in the owner or operator becoming a generator of hazardous waste. The waste must be managed in accordance with all applicable RCRA requirements (e.g., characterization and disposal as appropriate).

The closure of the baseline incineration system chemical agent disposal facilities will generate significant wastes. In most instances, these wastes will be similar to the wastes that were generated during the closure of the Johnston Atoll Chemical Agent Disposal System (JACADS) on Johnston Island. Most of the wastes generated during closure of the Newport Chemical Agent Disposal Facility (NECDF) will be similar to those generated during the closure of the baseline incineration facilities but with the added challenge that there will not be any large furnaces available for thermal decontamination. In this regard, the closure waste experiences at NECDF will be most similar to the experiences at the Aberdeen Chemical Agent Disposal Facility (ABCDF). This chapter discusses the wastes that can be expected to be generated during closure of each of the five presently operating chemical agent disposal facilities and the current proposed plans for disposition of those wastes.[2] A more detailed closure analysis will be required as detailed closure plans for each site become available. However, the main waste streams have been identified based on the JACADS and ABCDF closure experiences.

[1]A TSDF closure plan must include a detailed description of the methods for removing, transporting, treating, storing, or disposing of all (legacy) hazardous wastes prior to closure and a detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure. The plan descriptions must include, but are not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to minimize the need for further maintenance and to control, minimize, or eliminate to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere (40 CFR 264.111; 264.112; and 264.114).

[2]The NRC has issued a report on chemical agent disposal facility closure considerations using JACADS as an example (NRC, 2002).

CLOSURE WASTES FROM BASELINE INCINERATION FACILITIES

The closure wastes at JACADS included significant amounts of legacy wastes that were generated during operations and stored awaiting disposal at the end of the munitions disposal campaigns. At the five currently operating disposal sites, much of this waste is being managed and disposed of during the operations phase and therefore will not be part of the closure. Other than the wastes from operations, the material generated during closure of the four baseline sites will be similar in type and quantity to those generated at JACADS with two notable exceptions, which are discussed below.

Definitive estimates of the quantities and methods for disposal of closure wastes had not been finalized by the Army when this report was being prepared. However, rough projections of waste that will be generated during closure were available. These are summarized in Tables 4-1 and 4-2. The ultimate end use of each site

TABLE 4-1 Projected Waste Quantities Generated During Closure According to Vapor Screening Levels

	Total Across All Sites (tons)[a]	
Secondary Waste Stream	Above VSLs	Below VSLs
Spent carbon from filters	741	154
Containerized combustible solids	45	2
Containerized miscellaneous solids	30	40
Containerized DPE/PPE/TAP[b] gear	500	69
Metals	469	3,326
Bulk solids: concrete and soils[c]	1,670	803
Subtotal solids	3,455	4,394
Spent decontamination solution	3,944	0
Miscellaneous liquids	14	3
Subtotal liquids	3,958	3
Total	7,413	4,397

[a]Site managements' best estimates as of January 2007.

[b]DPE, demilitarization protective ensemble; PPE, personal protective equipment; TAP gear, protective clothing made mostly of butyl rubber.

[c]Final end state for bulk solid wastes at the Anniston Chemical Agent Disposal Facility (ANCDF) and NECDF is yet to be determined, so these two sites are not included in estimate.

SOURCE: Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, December 11, 2006.

TABLE 4-2 Projected Total Waste Quantities Generated During Closure (tons)[a]

Secondary Waste Stream	ANCDF	PBCDF	UMCDF	TOCDF	NECDF	Total Across All Sites
Spent carbon from filters	160	161	275	220	79	895
Containerized combustible solids	45	2				47
Containerized miscellaneous solids		1	2	2	65	70
Containerized DPE/PPE/TAP[b] gear	145	27	126	167	104	569
Metals	469	1,285	878	878	285	3,795
Bulk solids: concrete and soils[c]		803	835	835		2,473
Subtotal solids	819	2,279	2,116	2,102	533	7,849
Spent decontamination solution	1,202	0	1,371	1,371		3,944
Miscellaneous liquids	0	1	6	6	4	17
Subtotal liquids	1,202	1	1,377	1,377	4	3,961
Total	2,021	2,280	3,493	3,479	537	11,810

[a]Site managements' best estimates as of January 2007.

[b]DPE, demilitarization protective ensemble; PPE, personal protective equipment; TAP gear, protective clothing made mostly of butyl rubber.

[c]Final end state for ANCDF and NECDF is yet to be determined, so it is not possible to estimate the quantities of bulk solids for these two sites.

SOURCE: Personal communication between Raj Malhotra, CMA Deputy, Technical Support Directorate, and Billy Williams, NRC study director, December 11, 2006.

will have some effect on the estimates, but probably not a significant one.

The most significant closure wastes at the incineration sites will be concrete and other rubble; metal, including piping, pumps, and other process equipment; decontamination solution; and activated carbon. These projections assume that the majority of wastes being generated during operations are going to be managed and disposed of in the course of the agent disposal operations. While every effort is presently being made to accomplish this goal, it remains to be seen if scheduling and other disposal arrangements will allow that, as discussed below.

Depending on the particular site of the baseline incineration system, some wastes are being managed through the metal parts furnace for decontamination and disposal. Other wastes are being shipped off-site, as was discussed in Chapter 3. These two approaches are very dependent on circumstances at the particular site. In many cases, off-site disposal issues are yet to be resolved, but the goal is to minimize the amount of wastes that must be handled during closure. From the perspective of minimizing cost, it is important that as much as possible of the wastes generated during operations be handled during the munitions disposal operations rather than during closure, either through decontamination on-site followed by final disposal or by disposal to an appropriate off-site commercial TSDF.

The three most voluminous closure wastes at the incineration sites are metals, spent activated carbon, and rubble or debris. Of these, contaminated metal is probably the easiest to manage as it will most probably be cut up and put through the metal parts furnace for decontamination and disposal. Provisions for recycling treated scrap metal have already been included in the RCRA permits for each site. A review is needed prior to closure to ensure that scrap metal from closure operations can be handled in the same fashion and that proper analytical and on-site decontamination procedures are in place to clear the metal for shipment.

Rubble or debris will fall into two categories. Although the amount of concrete rubble that will have to be scabbled[3] from the currently operating disposal facilities to remove any contamination will be less than at JACADS because of better housekeeping and the thinner concrete layer to be removed, it will still be a significant waste stream and will require analytical characterization for off-site disposal. The earlier the analytical techniques are developed and any alternative methodology or waste control limits for off-site disposal are negotiated with state regulators, the more efficient will be the handling of these large amounts of waste. Analytical procedures at JACADS for secondary waste generated during operations were not always acceptable to the regulatory agency for application there to closure waste.[4] Whatever concrete is determined, by sampling and analysis, not to be contaminated will not require scabbling before it is deconstructed into rubble. However, the criteria for classifying rubble as noncontaminated must be negotiated with each state.

Activated carbon used in the baseline incineration facilities was disposed of at JACADS by using a micronization process developed for the Army that produced a fine powder that was then fed to the deactivation furnace system for treatment, resulting in an uncontaminated powder.[5] The micronization process proved difficult to operate, and throughputs were much lower than expected. In addition, while being transported in pipes from the micronizer to the deactivation furnace system, the resulting powder could under some circumstances become an explosive mixture. Fortunately, no explosive event happened at JACADS, but the possibility is real and must be considered. A prudent course now would be for the Chemical Materials Agency to immediately pursue alternative disposal options for treating spent activated carbon resulting from current operations as well as for the large amounts of spent activated carbon that will generated during closure operations.

In the case of the Tooele Chemical Agent Disposal Facility (TOCDF), and probably the Umatilla Chemical Agent Disposal Facility (UMCDF), a portion of the carbon will be contaminated with mercury in some

[3]Scabbling is the scarification process used to remove concrete surfaces. Scabblers utilize several piston heads that contain tungsten carbide cutters to cut or chip away concrete surfaces.

[4]Johnston Atoll Chemical Agent Disposal System (JACADS) Periodic Closure Production Report, December 1, 2001, through May 3, 2002, CL-070, provided to the Chemical Materials Agency by the contractor, the Washington Group.

[5]The carbon micronization system at JACADS recovered and destroyed agent-contaminated charcoal from heating, ventilation, and cooling system filter trays; agent collection system tank vent filters; mask canister filters; and miscellaneous small filters. The system micronized the carbon and destroyed it in the deactivation furnace system burner. The carbon micronization system consists of delivering the drums of charcoal (filter trays and bulk), unpacking the drums, emptying the drums and filter trays, and pulverizing the charcoal.

form. This waste stream will require special handling. Planning for the management of this waste should be done long before closure operations begin.

TOCDF faces a particular challenge concerning the management of spent activated carbon wastes. The permit under which it operates stipulates that micronization is to be used to manage the activated carbon waste, the result of a requirement to use proven technologies that were available at the time the permit was issued. As discussed previously, however, micronization has not proven to be a viable treatment process. An alternative needs to be demonstrated to and accepted by the regulatory community at the earliest possible time in order to avoid an extended closure period and the attendant added costs.

NEWPORT CLOSURE WASTES

The closure of NECDF will result in much less waste than the closure of baseline incineration systems (Table 4-2). However, it will still entail significant amounts of waste metal scrap from the process equipment as well as spent activated carbon, waste plastics, demilitarization protective ensemble suits, and debris. The specific option chosen for the treatment of VX hydrolysate may also significantly impact the amount and type of closure waste. The experience of managing closure waste from the now closed ABCDF should provide sound guidance for NECDF. ABCDF was successful in negotiating permit modifications and arranging for shipping large quantities of closure wastes, including waste activated carbon, for off-site disposal.

There are no commercial TSDFs in Indiana to support NECDF's closure activities. To date, NECDF has been permitted to ship limited quantities of its secondary wastes to out-of-state permitted disposal facilities. However, additional quantities need to be shipped while bulk VX disposal operations are still ongoing so that the wastes from agent destruction operations do not accumulate and become problematic when NECDF begins closure. Early negotiations with the Indiana regulators and potential receiving states would appear to be in order so that disposal of wastes from this facility will not become a last-minute challenge.

FINDINGS AND RECOMMENDATIONS

Finding 4-1. Closure planning and the time to achieve closure for chemical agent disposal facilities are both very dependent on the extent of waste treatment and disposal that occurs during agent disposal operations—that is, on the degree of concurrent waste minimization that takes place. However, there is only limited treatment capacity for secondary waste during agent disposal operations and changeovers at chemical agent disposal facilities.

Recommendation 4-1. The Chemical Materials Agency should use off-site disposal concurrent with ongoing agent disposal operations wherever possible, practical, and environmentally sound for all secondary and closure wastes generated during operations.

Finding 4-2. An analytical methodology for establishing agent contamination levels in porous wastes generated during closure, such as concrete scrabble, is not available.

Recommendation 4-2. The Chemical Materials Agency should develop appropriate analytical methods for establishing agent levels in porous materials and have them certified at the earliest possible time as a means of minimizing closure costs.

REFERENCE

NRC (National Research Council). 2002. Closure and Johnston Atoll Chemical Agent Disposal System. Washington, D.C.: National Academy Press.

5

Findings and Recommendations

Finding 2-1. An examination of the situation concerning trial burn requirements for incinerators at chemical agent disposal facilities has led to several observations:

- Surrogate trial burns demonstrate that incinerators at chemical agent disposal facilities can operate safely. The requirement to perform surrogate trial burns at these facilities is consistent with the initial start-up procedures followed at commercial hazardous waste incineration facilities.
- In the earlier phases of the Army's Chemical Stockpile Disposal Program, an agent trial burn conducted for each incinerator with each agent to be processed was an appropriate way for disposal facility staff and state regulatory staff to gain operational experience and confidence in the performance of the incinerators.
- As the Chemical Stockpile Disposal Program has matured, there has been only limited use of the data-in-lieu-of regulatory mechanism provided for in the Resource Conservation and Recovery Act. This provision, if applied more extensively to chemical agent disposal facilities, could allow data from other similar incinerators at chemical agent disposal facilities to be used in lieu of conducting additional agent trial burns.

Recommendation 2-1. The Chemical Materials Agency should vigorously pursue the application of the Resource Conservation and Recovery Act provision for using trial burn data from other similar chemical agent disposal facility incinerators in lieu of conducting trial burns for additional agents. This is a reasonable way to proceed now that (1) at least one agent trial burn has occurred for each type of agent in each type of incinerator at all the chemical agent disposal facilities and (2) a surrogate trial burn and an initial agent trial burn have occurred for each incinerator at all sites.

Finding 2-2. The time required to obtain state regulatory approval to proceed to a full feed rate following submission of agent trial burn data for incinerators at chemical agent disposal facilities can be lengthy. This is a consequence of the volume and complexity of the documents filed, as well as limited state regulatory agency resources to review and analyze them.

Recommendation 2-2. The Chemical Materials Agency should seek to provide funding to state authorities for third-party or other support to facilitate the analysis and disposition of trial burn data. This would shorten the time needed to obtain approval for incinerators at chemical agent disposal facilities and allow them to proceed more rapidly to a full processing rate.

Finding 2-3. The same requirements concerning health risk assessments apply to chemical agent disposal facilities and industry. Although the currently applicable laws do not specifically require health risk assessments, state regulatory agencies frequently require them under the authority granted to them by either the new Resource Conservation and Recovery Act/Maximum Achievable Control Technology provisions or general omnibus provisions. Requirements concerning health risk assessments are typically expressed in each site's RCRA operating permit provisions.

Finding 2-4. The requirements for conducting a health and environmental risk assessment for the Newport Chemical Agent Disposal Facility are similar to the state of Indiana requirements for a risk assessment of gaseous emissions from a commercial PCB incinerator. These requirements, which are similar to EPA guidelines for health risk assessments, are a reasonable approach to assessing the health risk posed by the NECDF.

Finding 2-5. The committee's examination of how transportation risk assessments for agent-contaminated waste materials are conducted at chemical agent disposal facilities indicated that widely differing models and parameters have been used. A specific problem identified by the committee is that the methodology used for general ton-mile data in transportation risk assessments to achieve a Class 6 ton-mile value is not consistent.

Recommendation 2-5. The Chemical Materials Agency should establish consistent and detailed criteria for conducting whatever transportation risk assessments are required to ensure accuracy and uniformity in the expression of results.

Finding 2-6. The state of Indiana requirements for an evaluation of transportation risks and for preparing a transport safety plan for hazardous waste derived from the neutralization and destruction of bulk VX exceed the regulatory requirements for the transportation of hazardous waste by industry.

Recommendation 2-6. The Chemical Materials Agency should continue to perform transportation risk assessments for shipping any secondary wastes from chemical agent disposal facilities with agent contaminant levels >1 VSL, despite the fact that doing so is not a DOT requirement.

Finding 3-1. In the absence of better techniques for measuring agent concentrations on certain heterogeneous, porous, and permeable materials, indirect measurements leading to conservative classifications of waste materials are being used at chemical agent disposal facilities.

Recommendation 3-1. The Chemical Materials Agency should develop improved analytical techniques for heterogeneous, porous, and permeable materials. Better analytical techniques could enable more exact quantification of agent contamination to meet off-site shipping criteria and help reduce waste remaining on-site at the end of munitions destruction operations.

Finding 3-2. Currently, permit provisions at the various sites require the use of a variety of parameters (including the short-term exposure limit, the short-term limit, the waste control limit, the permit compliance concentration, the vapor screening level, and the Army's X-based notations) for characterizing secondary waste from the chemical agent disposal processes. This inconsistency inhibits clear communication with and understanding by the broader population.

Recommendation 3-2. The Chemical Materials Agency should continue to move away from the Army's X-based notation for agent contamination levels and encourage the use of waste contaminant level (ppb) or vapor space concentration (mg/m^3) classifications where appropriate. The CMA should seek to move toward a more uniform means of designating levels of agent contamination when applying for site permits and permit modifications.

Finding 3-3. The availability and capacity of equipment for the concurrent treatment of secondary waste during agent disposal operations or changeovers at chemical agent destruction facilities is severely limited in comparison with the capacity available at off-site commercial treatment facilities that could process the waste.

Recommendation 3-3. The committee encourages the CMA to continue the pursuit of off-site shipment and disposal of >1 STL secondary waste. The committee believes this can be done safely in a ramp-up fashion, based on the use of double bags and containerized packing, truck loading restrictions, designated handling and shipping routes, air monitoring at the receiving TSDF, and restrictions on the disposal technique. Appropriate details, including permit modifications, must be worked out in conjunction with the local regulatory agencies and local stakeholders for the practice to be allowed.

Finding 3-4. Contaminated activated carbon from the treatment of several different waste streams is a major waste disposal problem at all chemical agent disposal facility sites. The micronization pretreatment of activated carbon in preparing it to be destroyed by on-site incineration has been shown to be a highly problematic process option.

Recommendation 3-4. The Chemical Materials Agency should select an alternative to on-site micronization followed by incineration for decontamination and/or destruction, and ultimate disposal of contaminated activated carbon. Off-site decontamination, and/or destruction and disposal of contaminated activated carbon should be pursued whenever possible.

Finding 3-5. Some of the mustard agent to be processed at the Tooele Chemical Agent Disposal Facility and the Umatilla Chemical Agent Disposal Facility is mercury-contaminated and will result in some of the activated carbon from the pollution abatement system also being contaminated with mercury. Special treatment may be required or additional challenges may be faced in disposing of this carbon.

Recommendation 3-5. The Chemical Materials Agency should evaluate and select appropriate methods for the treatment and disposal of mercury-contaminated carbon. Mercury-contaminated carbon should not be intermingled with other contaminated carbons during storage.

Finding 3-6. Brine solutions are shipped for off-site disposal from chemical agent disposal facilities upon meeting the permit criteria for the particular agent at the respective sites.

Recommendation 3-6. The Chemical Materials Agency should, in conjunction with the concurrence of regulators, continue to actively dispose of as much brine solution or brine salts off-site as possible, as either a hazardous or nonhazardous waste, as appropriate.

Finding 3-7. Scrap metal from chemical agent disposal facilities is subject to regulatory requirements not imposed on commercial scrap metal generators. However, thermally treated and decontaminated scrap metal from all five sites is acceptable for off-site disposal and recycling.

Recommendation 3-7. Each site should continue to work with the local regulatory authority to maintain and enhance acceptance of criteria allowing for off-site disposal or recycling of thermally treated and decontaminated scrap metal.

Finding 3-8. The waste management practices for demilitarization protective ensemble suits and other plastics are limited by the on-site capacity for treatment and, at some sites, by the regulatory restrictions for off-site disposal.

Recommendation 3-8. The Chemical Materials Agency should actively pursue off-site shipment and disposal of waste plastic and personal protective equipment such as demilitarization protective ensemble suits from all sites based on adherence to and enforcement of packing, shipping, monitoring, and treatment restrictions.

Finding 3-9. As of January 2007, over 500,000 gallons of VX hydrolysate generated by the neutralization destruction of bulk nerve agent VX at the Newport Chemical Agent Disposal Facility was being stored in more than 140 intermodal storage containers. It is anticipated that 1.5 million gallons of VX hydrolysate will eventually be generated. Studies by outside government agencies and technical organizations have found that safe, environmentally sound, off-site disposal of VX hydrolysate (such as that proposed by DuPont) is technically feasible.

Recommendation 3-9. The Chemical Materials Agency should evaluate and select an appropriate method to dispose of the VX hydrolysate currently being stored at the Newport, Indiana, site, with preference for off-site disposal.

Finding 3-10. Each chemical agent disposal facility in this study has established open and effective communication channels and has regular dialogue with its Citizens Advisory Commission and other local stakeholders. The input of these stakeholders is also sought by regulatory officials and is an important factor in negotiating permit modifications concerning secondary waste disposal practices.

Recommendation 3-10. The Chemical Materials Agency should continue its support for and emphasis on local stakeholder input and involvement as mission-critical elements when acceptable secondary waste disposal practices are being defined and regulatory permit requirements are negotiated.

Finding 4-1. Closure planning and the time to achieve closure for chemical agent disposal facilities are both very dependent on the extent of waste treatment and disposal that occurs during agent disposal operations—that is, on the degree of concurrent waste minimization that takes place. However, there is only limited treatment capacity for secondary waste during agent disposal operations and changeovers at chemical agent disposal facilities.

Recommendation 4-1. The Chemical Materials Agency should use off-site disposal concurrent with ongoing agent disposal operations wherever possible, practical, and environmentally sound for all secondary and closure wastes generated during operations.

Finding 4-2. An analytical methodology for establishing agent contamination levels in porous wastes generated during closure, such as concrete scrabble, is not available.

Recommendation 4-2. The Chemical Materials Agency should develop appropriate analytical methods for establishing agent levels in porous materials and have them certified at the earliest possible time as a means of minimizing closure costs.

Appendixes

Appendix A

Biographical Sketches of Committee Members

Peter B. Lederman, *Chair,* retired as executive director, Hazardous Substance Management Research Center, as executive director, Office of Intellectual Property, New Jersey Institute of Technology, and as vice-president, Roy Weston, Inc., where he also served as one of the leaders of the hazardous materials management practice. He continues to teach environmental management, policy, and site remediation and is active as a consultant in the area of hazardous materials management. He has a Ph.D. in chemical engineering from the University of Michigan. Dr. Lederman has over 50 years of broad experience in all facets of environmental management, control, and policy development; considerable experience in hazardous substance treatment and management; process design and development in the petrochemical industry; and over 18 years of experience as an educator. He has industrial experience as a process designer and managed the development of new processes through full-scale plant demonstrations. He is well known for his work as a professor in chemical process design. He led his company's safety program in the early 1980s. Dr. Lederman is a registered professional engineer, a registered professional planner, a certified hazardous material manager, and a diplomate in environmental engineering. Dr. Lederman has also worked at the federal EPA as a laboratory director and at state levels, with particular emphasis on environmental policy. He is a national associate of the National Academies.

Robin L. Autenrieth, a professor of civil and environmental engineering at Texas A&M University, received a B.S. in biological sciences from the University of Maryland, an M.S. in civil and environmental engineering from Clarkson College of Technology, and a Ph.D. in civil and environmental engineering from Clarkson University. Dr. Autenrieth conducts research that connects engineering principles to the biological responses of environments exposed to damaging chemicals. Microbial biodegradation is one alternative to traditional remediation methods that rely on physically removing the contaminants or treating them on-site with neutralizing chemicals. Dr. Autenrieth's research on biodegradation kinetics on nerve and blister agents, as well as explosives and petroleum products, is being used to develop models to predict risks associated with exposure.

Richard J. Ayen, retired, was director of technology for Waste Management, Inc. He also managed all aspects of Waste Management's Clemson Technical Center, including treatability studies and technology demonstrations for the treatment of hazardous and radioactive waste. His previous experience includes 20 years at Stauffer Chemical Company, where he was manager of the Process Development Department at Stauffer's Eastern Research Center. Dr. Ayen has published extensively in his fields of interest. He was a member of the NRC Committee on Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons (I and II) and was Chair of the NRC Committee on Review and Evaluation of International Technologies for the Destruction of Non-Stockpile Materiel. He received a Ph.D. in chemical engineering from the University of Illinois.

John D. Glass is a consultant on a wide range of environmental actions, including environmental assessments, hazardous waste management plans, site investigations, and feasibility studies. His clients include several federal agencies, heavy industry, and municipalities. Prior to this Mr. Glass served as an engineer in the U.S. Army, including assignments as a construction unit commander, district engineer, and later as chief of the U.S. Army's Environmental Office. During his Army career, he gained extensive experience in environmental regulations and hazardous waste management and remediation and was involved in planning for and managing a wide variety of environmental issues and resolving field implementation problems at the Army level. Mr. Glass holds master's degrees in civil engineering from Iowa State University, in management from Salve Regina University, and in strategic studies from the U.S. Naval War College. His publications include *The Brownfields Redevelopment Initiative—An Update,* with Brad Peebles.

Christine S. Grant is currently a professor of chemical engineering at North Carolina State University. She is a member and officer of several professional organizations, including the American Institute of Chemical Engineers, the National Society of Black Engineers, and the American Chemical Society. Dr. Grant's research programs include an intelligent image sensing system for environmentally benign cleaning processes and environmentally benign CO_2-based surfactant decontamination processes. Dr. Grant received her Ph.D. in chemical engineering from the Georgia Institute of Technology.

Gary S. Groenewold is a staff scientist who has conducted research in surface chemistry, gas-phase chemistry, and secondary ion mass spectrometry at the Idaho National Laboratory (INL) since 1991. His research has focused on determining the speciation of adsorbed radioactive and toxic metals (U, Np, Pu, Am, Hg, Al, and Cu) and organic compounds (e.g., VX, G agents, HD, organophosphates, amines, and sulfides). Prior to this, Dr. Groenewold served 3 years in line management at the INL and as the technical leader of an environmental organic analysis group. Before coming to the INL, he worked in anticancer drug discovery for Bristol-Myers, using mass spectrometry as an identification tool. He received his Ph.D. in chemistry at the University of Nebraska, where he studied ion-molecule condensation and elimination reactions in the gas phase. He has authored 85 scientific publications on these subjects.

Rebecca A. Haffenden is an attorney and technical staff member of the Los Alamos National Laboratory. Prior to joining Los Alamos, she served as a program attorney with the Argonne National Laboratory. Her recent professional work has included serving as project manager for the Air Force Material Command (AFMC) Headquarters Environmental Compliance Assistance Program (ECAMP); work for the U.S. Department of Homeland Security to evaluate legislation and regulations associated with security vulnerabilities; and providing legal expertise to programs involving federal facility site remediation and hazardous waste compliance and corrective actions (RCRA). She also coauthored a working paper on the application of federal and state hazardous waste regulatory programs to waste chemical agents, in addition to being a coauthor of the Environmental Impact Statement for the Assembled Chemical Weapons Alternates program. Ms. Haffenden received a B.A. in psychology from the University of Illinois and a J.D. degree from Suffolk Law School, in Boston.

Peter C. Hsu has 20 years of professional experience in research and development in weapons demilitarization technology; chemical engineering of secondary waste treatment processes; mixed waste treatment technologies; high explosives safety and performance properties of aged materials; and chemical engineering processes of explosives manufacturing. Since 1994, he has worked as the chemical engineer/project leader/demilitarization program leader for Lawrence Livermore National Laboratory in Livermore, California. His work includes waste treatment technology R&D; abandoned chemical weapons (ACW); destruction processes for chemical agents and secondary wastes; high explosives synthesis and scale-up R&D; process R&D for treating mixed wastes and high explosives; design and prototyping of MSO plants for treating toxic waste streams; and developing processes for cleaning and recycling spent salts. Dr. Hsu received his Ph.D. in chemical engineering from Michigan State University in 1988. He currently holds six patents and has published over 40 articles.

Loren D. Koller is an independent consultant and former professor and dean of the College of Veterinary Medicine at Oregon State University. His areas of expertise include pathology, toxicology, immunotoxicology, carcinogenesis, and risk assessment. He is a former member of the NRC Committee on Toxicology and has participated on several of its subcommittees, primarily involved in risk assessment. He has served on the Institute of Medicine's Committee on the Assessment of Wartime Exposure to Herbicides in Vietnam and been invited to serve on committees for the CDC, EPA, the Agency for Toxic Substances and Disease Registry, and the U.S. Army. He received his D.V.M. from Washington State University and his Ph.D. in pathology from the University of Wisconsin.

William R. Rhyne is a retired risk and safety analysis consultant to the nuclear, chemical, and transportation industries. He has over 30 years' experience associated with nuclear and chemical processing facilities and with the transportation of hazardous materials. From 1984 to 1987, he was the project manager and principal investigator for a probabilistic analysis of transporting obsolete chemical munitions. From 1997 to 2002, he was a member of the NRC Committee for the Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons (I and II). Dr. Rhyne has authored or coauthored numerous publications and reports on nuclear and chemical safety and risk analysis areas and is the author of *Hazardous Materials Transportation Risk Analysis: Quantitative Approaches for Truck and Train*. He is a current member of the NRC Transportation Research Board Hazardous Materials Committee and a former member of the Society for Risk Analysis, the American Nuclear Society, and the American Institute of Chemical Engineers. Dr. Rhyne received his B.S. in nuclear engineering from the University of Tennessee and M.S. and D.Sc. degrees in nuclear engineering from the University of Virginia.

Subhas K. Sikdar is the associate director for science for the National Risk Management Research Laboratory at the U.S. Environmental Protection Agency. As the director of the Sustainable Technology Division until January 2004, he was the primary spokesman for the EPA's R&D on clean technologies and pollution prevention. He directed research, both intramural and extramural, on tools and methods for pollution prevention, cleaner process technologies, and demonstration and verification of cleaner technologies. Before joining the EPA in 1990, Dr. Sikdar held managerial positions at the National Institute of Standards and Technology in Boulder, Colorado, and General Electric's Corporate Research & Development Center in Schenectady, New York. He began his professional career as a senior research engineer with Occidental Research Corporation in Irvine, California, in 1975. Dr. Sikdar earned his B.S. in chemistry, a B.Tech in chemical engineering, and an M.Tech in polymer science from Calcutta University in India. He received his M.S. and Ph.D. in chemical engineering from the University of Arizona. Dr. Sikdar is a fellow of the American Association for the Advancement of Science (AAAS), a fellow of the American Institute of Chemical Engineers, an honorary fellow of the Indian Institute of Chemical Engineers, winner of three EPA bronze medals, an R&D 100 award (1990), AIChE's Larry Cecil Award for Environmental Chemical Engineering (2002), and the University of Arizona's Distinguished Engineering Alumnus Award (2003). Dr. Sikdar is the leader of the technical expert group for the Center of Excellence on Environmental Engineering and Hazardous Wastes, composed of several universities in Thailand.

Jack Solomon retired recently as director of technology assessment for Praxair, Inc., and is currently chairman of Vision 2020 for the Chemical Industry. At Praxair, Dr. Solomon was most recently responsible for leading the identification and assessment of outside technologies and new business opportunities. As part of Vision 2020, Dr. Solomon also led the development of a cross-industry R&D roadmap for nanomaterials, including working groups on environmental, health, and safety issues. Dr. Solomon participated in NRC's *New Directions in Manufacturing* and served on the technical advisory board for Semiconductor Research Corporation as well as the review team for the National Nanotechnology Initiative He has also served on the board of the directors for the Council for Chemical Research and the National Hydrogen Association. He has been an invited speaker on various chemical science issues at the American Chemical Society, the Industrial Research Institute, and other national technical meetings. Dr. Solomon received a B.S. in chemistry from the Massachusetts Institute of Technology and a Ph.D. in physical chemistry from Columbia University.

Walter J. Weber, Jr. (NAE) is the Gordon M. Fair and Earnest Boyce Distinguished University Professor of Environmental Engineering at the University of Michigan, where he has taught and conducted research since 1963. He is also founding director of ConsEnSus, the College of Engineering's academic program of

Concentrations in Environmental Sustainability (2001-present); founding director, Great Lakes and Mid-Atlantic Center for Hazardous Substance Research (1988-2002); founding director, Institute for Environmental Sciences, Engineering, and Technology (1997-2001); and founding director, National Center for Integrated Bioremediation Research and Development (1993-1999). A registered and professional engineer since 1963 and a diplomate of the American Academy of Environmental Engineers since 1975, Dr. Weber has consulted extensively with industrial, commercial, and governmental agencies throughout the world in the application of advanced technologies for solution of water supply, pollution control, and hazardous waste minimization and remediation. He served for a decade in the 1990s and early 2000s as a member and chairperson of the Strategic Environmental Research and Development Program of the Department of Defense. Dr. Weber has been recognized by the International Science Index as one of the most highly cited and quoted scientists in the world. He has served on the National Academy of Engineering's Review Panel as well as the NRC's Board on Environmental Studies and Toxicology. Dr. Weber received an Sc.B. in chemical engineering from Brown University, an MSE in civil engineering from Rutgers University, and a Ph.D. in water resources engineering from Harvard University. He was elected to the National Academy of Engineering in 1985.

Appendix B

Committee Meetings and Site Visits

MEETINGS

First Committee Meeting: August 1-2, 2006 Washington, D.C.

Objectives: Receive briefings intended to orient the committee on the history, background, and overview of the Army's Chemical Materials Agency (CMA) program, including presentations on the detailed processes and specific site challenges associated with secondary waste disposal and regulatory requirements; decide on the initial approach to the task; make committee assignments; and decide on future activities.

Program Overview, Statement of Task, and Sponsor's Expectations: Raj Malhotra, Deputy, Technical Support Directorate U.S. Army, CMA

Overview of CMA Program, History, Materials Handled, and Key Challenges: COL Jesse Barber, Program Manager for Chemical Stockpile Elimination (PMCSE)

Description of the Demilitarization Processes—Baseline and Neutralization: Conrad Whyne, Deputy Program Manager for Chemical Stockpile Elimination

Regulatory Requirements for Chemical Agent Disposal Facilities: Drew Lyle, Chief, Environmental Office, Risk Management Directorate, CMA

EPA/DHS Agent-Contaminated Waste Disposal Study: Paul Lemieux, Office of Research and Development, EPA

Overview of Secondary Waste Reports by Site: Lloyd Pusey, Performance Management Team Leader, Lifecycle Management Office, PMCSE, and Rob Malone, Task Manager for Closure and Secondary Waste Disposal

Second Committee Meeting: September 26-27, 2006 Salt Lake City and Tooele, Utah

Objectives: Gather data and discuss secondary waste issues specific to Tooele Chemical Agent Disposal Facility (TOCDF). Tour portions of TOCDF and a local Utah hazardous waste incineration facility to familiarize committee with processes and practices. Discuss secondary waste regulatory issues with Utah environmental regulatory officials and representatives of Utah's Citizens Advisory Commission (CAC). Review initial findings, discuss report development, make writing assignments, and decide on future activities.

Briefing and Discussions: TOCDF secondary waste site briefing by Ted Ryba, TODCF Site Project Manager, and Elizabeth Lowes, EG&G. Discussions were held with members of the TOCDF staff and contractors on variety of topics related to the committee's task. Discussions were also held with Shawn Raju, General Manager, Clean Harbors Aragonite Inc.; Dennis Downs, Executive Secretary, Utah Department of Environmental Quality (DEQ) and his staff; and Deborah Kim, Chair, Utah's CAC on chemical weapons demilitarization on topics related to the committee's task.

Third Committee Meeting: December 4-5, 2006 Washington, D.C.

Objectives: Review concept rough draft report and establish assignments and timeline for developing full message draft. Develop tentative recommendations.

Fourth Committee Meeting: January 17-18, 2007 Irvine, California

Objectives: Complete and review first full message draft. Identify and fill holes in report text. Review and confirm findings and recommendations for pre-concurrence draft.

Fifth Committee Meeting: February 20-21, 2007 Washington, D.C.

Objectives: Detailed review and corrections to preliminary concurrence draft. Discuss and finalize report text. Discuss concurrence process and the NRC review process.

FACILITY SITE VISITS AND DATA-GATHERING ACTIVITIES

Anniston, Alabama, October 16, 2006

Objectives: Gather data from ANCDF and contractor personnel on site-specific secondary waste disposal issues related to committee task. Discuss specific regulatory issues and concerns with Alabama Department of Environmental Management (ADEM) and gain input and perspective on secondary waste issues from local citizens.

Individuals met with: Gerald Hardy Chief, Land Division, ADEM; Stephen Cobb, Chief, Government Hazardous Waste Branch, Land Division, ADEM; Greg Potts, BAE Systems; Sherri Summers, President, Calhoun County Chamber of Commerce; Drew Lyle, CMA; Tim Garrett, Site Manager, ANCDF; Robie Jackson, Rob Brooks, and Tracy Smith, ANCDF staff.

NRC participants: Peter Lederman, Richard Ayen, and Rebecca Haffenden, committee members; Billy Williams, study director.

Umatilla, Oregon, October 31-November 1, 2006

Objectives: Gather data from UMCDF and contractor personnel on site-specific secondary waste disposal issues related to committee task. Discuss specific regulatory issues and concerns with Oregon Department of Environmental Quality (DEQ) officials and gain input and perspective on secondary waste issues from local stakeholders. Gain additional industrial perspective through meeting with management of a regional hazardous waste landfill, Chemical Waste Management of the Northwest.

Individuals met with: Mike Strong, Deputy Site Project Manager, UMCDF; Robert Flourney, Chair, Oregon's CAC; Joni Hammond, Administrator, Eastern Region Oregon DEQ; Richard Duval, Oregon DEQ; Stuart G. Harris, Director, Department of Science and Engineering, Confederated Tribes of the Umatilla Indian Reservation (CTUIR); Rod Skeen, Engineer, CTUIR; Raj Malhotra, CMA; Don Barclay and Doug Hamrick, UMCDF staff.

NRC participants: Peter Lederman, William Rhyne, John Glass, Subhas Sikdar, committee members; Billy Williams, study director.

Newport, Indiana, November 20-21, 2006

Objectives: Gather data from NECDF and contractor personnel on Newport site-specific secondary waste disposal issues related to committee task. Discuss specific secondary waste regulatory issues with Indiana Department of Environmental Management (IDEM) officials and gain input and perspective on secondary waste issues from the local CAC.

Individuals met with: Jeff Brubaker, Site Project Manager, NECDF; Tom Linson, Division Chief, IDEM; Fred Martin, Indiana CAC; Richard Card, Indiana Department of Homeland Security; Raj Malhotra, CMA; Bob Irvine, Chief Scientist, Parsons Corporation; Scott Rowden, Environmental Manager, Parsons Corporation; Scott Haraburda, NECDF staff.

NRC participants: Peter Lederman, Gary Groenewold, Jack Solomon, William Rhyne, committee members; Bruce Braun, BAST Director; Billy Williams, study director.