Assembled Chemical Weapons Assessment Program

Annual Report to Congress

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A Message from Michael A. Parker
Program Manager

In the past fiscal year, the Assembled Chemical Weapons Assessment (ACWA) Program has been engaged in a number of activities that will ultimately prepare the Under Secretary of Defense for Acquisition, Technology and Logistics for the selection of a technology process, either baseline incineration or an alternative technology, at each of the candidate chemical demilitarization facilities that is safe, cost-effective, and compliant with Public Law. Two major activities have been undertaken in this past year—Technology Demonstration II and Engineering Design Studies I. The final demonstration tests of viable alternative technologies have been completed. Technical evaluations of the demonstration test data are underway and a detailed Supplemental Report is scheduled for submittal to Congress in March 2001. The Supplemental Report will contain information and conclusions gathered from the evaluation of the final alternative technologies.

The following status report is an update of all efforts that have been accomplished since the last ACWA Program report submitted to Congress in September 1999. As with previous reports, this status update will demonstrate the tremendous effort put forth by all involved with this program. Government personnel, representatives from private industry, and affected stockpile community members have continually put forth a strong effort to identify and successfully demonstrate alternative technologies for the destruction of assembled chemical weapons.

The program office is focusing its efforts toward meeting the requirements established within Public Law 105-261. Actions are currently underway to determine if an alternate technology pilot facility can meet the certification requirements established in Public Law 105-261. In moving forward, continued efforts must be made to maintain open communication with interested stakeholders and consistent collaboration with the Program Manager for Chemical Demilitarization is essential. As stated in my previous message, "Combining implementation expertise with a truly open and collaborative process will yield the best results toward finally ridding the nation of these lethal weapons of mass destruction."

A Message from the Dialogue on Assembled Chemical Weapons Assessment

The Program on Assembled Chemical Weapons Assessment was established in 1996 under Public Law 104-208 to facilitate and accelerate the ongoing destruction of chemical weapons stockpiles in the United States by investigating non-incineration, alternative technologies. As an integral part of ACWA, the ACWA Dialogue was formed in May 1997 to ensure the integration of concerns and ideas of local, state, and federal officials, citizens, and others into the decision-making process of the program. The Dialogue, now over three and one-half years old, includes individuals from the nine states with stockpiles of chemical weapons (Alabama, Arkansas, Colorado, Hawaii [Johnston Atoll], Indiana, Kentucky, Maryland, Oregon, and Utah); state regulators; tribal representatives; U.S. Environmental Protection Agency (EPA) staff; Department of Defense (DOD) staff from affected sites and headquarters; and representatives from national citizen groups that regularly work on weapons demilitarization issues.

Dialogue members and the ACWA program manager and staff have worked closely over these several years in a unique and productive process to first develop criteria for evaluating alternative, non-incineration technologies; to review and evaluate industry technology proposals in response to RFPs; to oversee demonstrations and engineering studies of alternative technologies; and to ensure the fair and consistent application of criteria to the demonstration and study data. This cooperative and inclusive process has required thousands of hours of volunteer time and much effort at consensus building through frank exchange of opinions and recommendations. It has continued to produce key decisions and innovative technology demonstrations, supported jointly by the Dialogue and the ACWA staff, which will have long-term benefits for the chemical weapons destruction program of the United States.

The Dialogue has emphasized a number of relevant points in prior messages to Congress (e.g., in the September 1999 *Supplemental Report to Congress).* We will not seek to repeat all of these here, and we will be drafting an additional message to Congress in the March 2001 ACWA report when data is fully analyzed and available from the current demonstrations. However, several key points deserve mention below.

The ACWA program continues to meet the mandates of the law. Public Laws 104-208, 105-261, and 106-79 required that the ACWA program identify and demonstrate “not less than two alternatives” to “baseline” incineration for the destruction of assembled chemical weapons. The ACWA program to date has identified six technologies, three of which were demonstrated in fiscal year 1999, and the additional three in fiscal year 2000. From the initial three demonstrations, two technologies (neutralization/biotreatment and neutralization/supercritical water oxidation [SCWO]) have moved forward this past year into Engineering Design Studies (EDS). From the second group of three (neutralization/SCWO/gas phase chemical reduction, solvated electron technology, and electro-chemical oxidation), one or more will likely proceed to EDS this coming year.

The ACWA program is a successful model for consensus building in contentious public policymaking. The construction and operation of large destruction facilities in eight states and on Johnston Atoll has come under much public and regulatory scrutiny. The ACWA process seeks to build consensus early in the decision process in order to expedite the construction, operation, and closure of these demilitarization facilities. It thereby seeks to overcome and preclude protests, suits, delays in permits, and other potential obstacles, which may slow the program down considerably over time.

The ACWA-demonstrated technologies are likely to compete for deployment at Pueblo, Colorado and Blue Grass, Kentucky. Of the nine U.S. stockpiles of chemical weapons, only two sites – Pueblo and Blue Grass – have yet to decide which technology to deploy for the stockpile destruction process. Both sites have fully assembled chemical weapons (as opposed to agent stored in bulk tanks) and will consider one or more of the technologies demonstrated over the past two years in the ACWA program.

The ACWA-demonstrated technologies are likely to have application at some or all of the other chemical weapons sites. Of the seven other sites, five have incinerators operating or under construction and two are constructing alternative technologies. The ACWA-demonstrated technologies are very likely to have application at all of these sites, either as complements to the baseline incinerator technology to aid with destruction of agent and/or secondary waste (metal parts, wood, rubber suits, and other contaminated materials), or in support of existing alternative technology development programs. The Dialogue fully endorses Public Law 99-145 requiring the Secretary of Defense to provide maximum protection to the environment during the destruction of chemical weapons. The Dialogue recommends that as the technologies are piloted and scaled up to implementation, the individual unit operations continue to be monitored and assessed for potential application at all sites.

The ACWA-demonstrated technologies are likely to have important applications in toxic waste management. While the ACWA program has been designed to apply to chemical weapons, the technologies demonstrated under the ACWA program will also have lasting impact on other toxic waste management issues. An assembled chemical weapon always includes chemical agent but may also include explosives, propellant, plastic, metals, wood, fiberglass, and various other contaminants such as polychlorinated biphenyls (PCBs). The technologies demonstrated in the ACWA program will no doubt have much broader applications, especially in high toxic waste situations.

There is a growing need for a broader national Dialogue for chemical weapons demilitarization. Many of the issues that arise in ACWA Dialogue meetings go beyond the strict limits of developing and demonstrating non-incineration, alternative technologies. For example, it is clear that the ACWA technologies are applicable to agent stored in bulk as well as to assembled chemical weapons. Yet ACWA is directed solely at the latter group. When one compares life-cycle processes, issues of schedule and cost arise and experiences at baseline incinerator sites become very relevant. While the ACWA Dialogue discusses these issues from time to time when they are relevant to the ACWA program, it is increasingly clear that a national dialogue on the complete chemical demilitarization program will be very helpful in future years.

The Dialogue process as demonstrated through ACWA is very successful. The ACWA Dialogue has operated successfully at several levels: open meetings of the full Dialogue every four to six months which attract over 100 participants to discuss both process and technologies for chemical weapons destruction; a Citizens' Advisory Technical Team (CATT) of four dedicated Dialogue volunteers who participate actively in the procurement process; an independent technology advisor (SBR Technologies), chosen by the CATT, who works closely with all participants to provide an independent analysis and eye; and weekly conference calls of various working groups, most often with the CATT participating. These discussions and meetings, often lasting for several days, have been very successful at building consensus over which technologies are most appropriate and acceptable at which sites.

If the ACWA Program continues to address issues of national policy, some members of the Dialogue recommend that a process similar to the ACWA Dialogue, including a CATT and an independent technical advisor, should continue. This could be through the current Dialogue as designed or as a subset of a national dialogue on chemical weapons as noted in the preceding paragraph. The Dialogue recognizes that many issues that the Dialogue has addressed in the past have been both national and site-specific in nature. The Dialogue encourages communities, regulators, and the military at these sites to work together in a cooperative and transparent manner to reach decisions that their communities can support and implement.

Lastly, we would like to take this opportunity to congratulate the ACWA team – from the Program Manager to the technical teams and support staffs – and our congressional supporters who have worked diligently and productively over several years to craft a very successful model of inclusive and transparent public policy making. We hope that this model can be replicated in other areas far beyond chemical weapons destruction and are convinced that it will remain a key to success in this program itself for years to come.

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Executive Summary

This report responds to the requirements contained in Title VIII, section 8065 of the Omnibus Consolidated Appropriations Act, 1997 (Public Law 104-208), and describes the activities accomplished for the Assembled Chemical Weapons Assessment (ACWA) Program during fiscal year 2000. Significant activities included:

- **Conduct demonstrations (Demonstration II) of technologies that did not receive demonstration contracts in July 1998, in response to the Military Construction Appropriations Act, 2000 (Public Law 106-52, Section 131).**

  The technologies were provided by AEA Technology, Foster Wheeler/ELI Eco Logic, and Teledyne-Commodore. During Demonstration II Testing, ACWA evaluated AEA Technology's SILVER II™ oxidation of agent and energetics, Foster Wheeler/Eco Logic's supercritical water oxidation and gas phase chemical reduction (SCWO and GPCR), and Teledyne-Commodore's Solvated Electron Technology (SET™) followed by oxidation. Testing occurred from early July to October 3, 2000. The final results of the technical evaluation will be provided in the *Supplemental Report to Congress* in March 2001.

- **Initiate Engineering Design Studies (EDS) for the two alternative technologies that were validated in 1999 during Demonstration I to be effective in the destruction of chemical weapons.**

  Those technologies were provided by Parsons/Honeywell and General Atomics. The technology proposed by Parsons/Honeywell is neutralization followed by biotreatment, which was validated for processing of mustard-containing munitions only. The technology proposed by General Atomics is neutralization followed by supercritical water oxidation and was validated for processing all chemical weapons. EDS will result in a preliminary full-scale design for the construction of a demilitarization facility with the associated cost, schedule, and preliminary hazard analysis. This information will be the basis for certification under the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (Public Law 105-261).

- **Participate in acquisition activities regarding construction of a chemical demilitarization facility at Pueblo Chemical Depot, Pueblo, Colorado.**

  ACWA is participating in two ongoing acquisition activities. These are a joint Program Manager Chemical Demilitarization/Program Manager ACWA Acquisition Working Group addressing contracting and acquisition strategies, and a Colorado Environmental Working Integrated Process Team that is coordinating the issues related to environmental permits.

- **Determine the applicability of other alternative technologies proposed under a Broad Agency Announcement (BAA).**

  A BAA was issued in 1997 to prevent the exclusion of any potential and promising partial alternative technologies that could not meet the "total program solution" requirement of the Go/No-Go Criteria, defined by the ACWA Dialogue in 1997. ACWA received over 25 proposals from technology providers. During the April – July 2000 time frame, a BAA Work Group, comprised of Dialogue members and ACWA technical staff, evaluated each proposal and determined that none of them would merit investment by the ACWA Program.

- **Conduct National Environmental Policy Act (NEPA) activities.**

  In April 2000, the Department of the Army announced its intent to prepare an Environmental Impact Statement (EIS) for the construction and operation of one or more pilot test facilities for chemical weapons destruction technologies demonstrated by ACWA at one or more chemical stockpile sites. In the weeks following, ACWA held NEPA scoping meetings with the public in Pueblo, Colorado; Pine Bluff, Arkansas; Anniston, Alabama; and Blue Grass, Kentucky —all potential sites for a test facility. Another NEPA scoping meeting was held in Washington, D.C. Many written comments and suggestions were submitted to ACWA and will be folded into the draft EIS. ACWA expects to complete the final EIS by July 2001. A Record of Decision (ROD) will follow shortly thereafter.

- **Conduct evaluation of Demonstration II technologies and conduct Engineering Design Studies on the alternative technologies that are validated under Demonstration II.**

  The ACWA Program's next steps are to assess the Demonstration II technologies, using the same program implementation criteria developed by the ACWA Dialogue and used to evaluate Demonstration I technologies. ACWA will prepare a *Supplemental Report to Congress* that will include the results of the Demonstration II testing program, including each technology provider's data evaluated against the program implementation criteria. ACWA will provide conclusions to Congress on those technologies that are successfully demonstrated and have a high likelihood of being implemented at the full-scale level. Validated technologies will either meet or exceed the goals defined in the implementation criteria for performance, schedule, cost and public acceptance. In addition, ACWA will conduct Engineering Design Studies on the alternative technologies that are validated under the Demonstration II program (EDS II). EDS II may include AEA Technology (SILVER II™), Foster Wheeler/Eco Logic (neutralization followed by SCWO and GPCR), and Teledyne-Commodore (SET™).

I. INTRODUCTION/BACKGROUND

This annual report is submitted to the United States (U.S.) Congress in compliance with the requirements contained in Title VIII, section 8065 of the Omnibus Consolidated Appropriations Act, 1997 (Public Law 104-208). This report presents the status of activities associated with the Department of Defense (DOD) Assembled Chemical Weapons Assessment (ACWA) Program accomplished during fiscal year (FY) 2000.

In accordance with Public Law 104-208, the Under Secretary of Defense for Acquisition, Technology and Logistics appointed Mr. Michael A. Parker the Program Manager for ACWA (the Program Manager) with the mission to "demonstrate not less than two alternatives to the baseline incineration process for the demilitarization of assembled chemical munitions." Assembled chemical munitions for this purpose represent the chemical weapons stockpile configured with fuzes, explosives, propellant, chemical agents, shipping and firing tubes, and packaging materials.

The foundation of the ACWA Program is based on stakeholder involvement from each of the chemical stockpile storage sites and identification of their concerns about the program. In response to the desire to integrate stakeholder input, The Keystone Center, a non-profit, neutral facilitation organization specializing in environmental and health policy issues, was asked by a diversity of individuals from DOD and community organizations to convene a Dialogue on ACWA and to facilitate Dialogue meetings.

Participants of the Dialogue on ACWA include representatives from affected communities; appropriate state and/or tribal representatives; relevant U.S. Environmental Protection Agency (EPA) staff; appropriate DOD staff from affected sites and headquarters; representatives from national citizen groups that work regularly on this issue; and other concerned entities (see Appendix A for a complete list of Dialogue participants and alternates). Many Dialogue participants noted the need for involvement throughout the source selection process. This was clearly impractical for the entire Dialogue. Therefore, four Dialogue members, chosen by the Dialogue, agreed to sign confidentiality agreements and to dedicate their time to participate in technical evaluations along with the government's Technical Evaluation Team. Because of the need for independent technical assistance to advise these citizens, as well as the entire Dialogue throughout the program, the Program Manager agreed to engage a technical consulting firm. Together, the four Dialogue members and the consulting firm comprise the Citizens' Advisory Technical Team (CATT). The CATT works on behalf of Dialogue participants and is charged with overseeing, consulting, and reporting duties regarding complex and technical information during the program.

The ACWA Program involves a three-phased approach—evaluation criteria development, technology assessment, and demonstration of the technologies. The evaluation criteria development phase took place during the months of May, June, and July 1997. During this phase, the Program Manager, in concert with the Dialogue on ACWA, developed the program evaluation criteria.

The technology assessment phase took place during the September 1997–June 1998 time frame. In July 1998, based on the evaluation of the Demonstration Work Plans and a determination of best value to the government, three technology providers were awarded task order contracts to conduct demonstration testing. They were Burns and Roe (Plasma Arc), General Atomics (Neutralization/Supercritical Water Oxidation), and Parsons/Honeywell (Neutralization/Biotreatment).

The actual demonstrations (Demonstration I) of alternative technologies took place between January and May 1999. The evaluation of the demonstrations took place between June and August 1999. The evaluations were performed collectively by the technology providers, Dialogue participants, contractor personnel, and ACWA personnel. The purpose of the demonstrations was to validate the chosen technologies' ability to safely destroy chemical munitions and their associated materials. The Program Manager's Program Evaluation Team (PET) and representatives from the Dialogue performed the assessment of the technology demonstrations. Using the previously approved program implementation criteria, the PET and representatives from the Dialogue assessed each of the technologies demonstrated. The information used for these assessments included the technology providers' demonstration reports, the Program Manager's milestone reports, the validated demonstration data, and all previous documentation submitted by the technology providers. As reported in the September 1999 *Supplemental Report to Congress*, the technology assessment concluded that the General Atomics and Parsons/Honeywell technologies were viable to go to pilot testing. The Program Manager for Assembled Chemical Weapons Assessment (PMACWA) is currently conducting Engineering Design Studies for the General Atomics and Parsons/Honeywell technologies to develop the information necessary to satisfy the requirements in the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (Public Law 105-261).

Pursuant to the direction in the Military Construction Appropriations Act, 2000, Public Law 106-52, section 131, the ACWA program expanded the demonstration program to conduct demonstrations (Demonstration II) of the three technologies that did not receive demonstration contracts in July 1998. They are AEA Technology, Foster Wheeler/Eco Logic and Teledyne-Commodore. The status of the Demonstration II testing is discussed in the next section of this report.

II. DEMONSTRATION II

Three alternative technologies were demonstrated in 2000. These three technologies consisted of the following technology providers and processes:

- AEA – SILVER II™ oxidation of agent and energetics
- Foster Wheeler/ELI Eco Logic International, Inc. – agent and energetics neutralization followed by supercritical water oxidation (SCWO) of hydrolysate and gas phase chemical reduction (GPCR) of off-gases, metal parts, and dunnage
- Teledyne-Commodore – Solvated Electron Technology (SET™) followed by oxidation.

The contracts for the Demonstration II Test Program were awarded in February 2000. Demonstration testing occurred from early July to October 3, 2000 and the Final Technical

Reports were submitted in November 2000. They include a preliminary design, cost and schedule for demilitarization plants at Pueblo Chemical Depot and Blue Grass Chemical Depot. The technical evaluation of the technologies by PMACWA is in progress and will be completed in February 2001. The results of the technical evaluation will be provided in the *Supplemental Report to Congress* in March 2001.

A. Technology Overview

The total technology solutions proposed by the Demonstration II technology providers are summarized in Table 1 and are described in more detail in Appendix B. The unit operations or processes that were selected for demonstration are identified in Table 2.

B. Demonstration Objectives and Planning

The ACWA technology demonstrations were designed to be a series of tests on each technology provider's critical unit operations to validate their performance, characterize the intermediate and final effluents, and to establish confidence that they can be incorporated into an overall system or "total system solution." The unit operation selections were based on information (test scale size, use of readily available equipment, prior test data, technology maturity, etc.) in the technology providers' original proposals, their Data Gap Resolution Reports, and meetings with them to discuss their test matrices. Due to schedule and budgetary constraints, it was determined at the outset that testing of a fully integrated system would not be feasible. The tests were conducted independently by government personnel in existing government facilities.

The following overall test program objectives were established:

- Independent validation of selected unit operations;
- Characterization of major feed materials, intermediate process streams, and final products/effluents; and
- Independent validation of analytical methods for constituents of interest (including agents and energetics) used during demonstration testing.

To ensure a successful demonstration test program, specific test objectives that were in full alignment with the overall program test objectives were developed. A detailed test program was designed to meet specific test objectives, which were clear, concise, definitive, measurable, and practicable within the ACWA Program schedule, resource, and budget limitations. The specific test objectives were developed with consistency across all technology providers.

Table 1. Technology Descriptions for the Technology Providers Awarded Demonstration II Task Orders

Offerer	Munitions Access	Agent	Energetics	Metal Parts	Dunnage

		Treatment	Treatment	Treatment	Treatment
AEA Technology CH2MHill	Modified reverse assembly (water jet cutting, propellant push-out & milling, burster washout)	Electrochemical oxidation using silver ions in nitric acid (SILVER II™)	Treated with SILVER II™ process Electrochemical oxidation using silver ions in nitric acid (SILVER II™)	Metal parts treater with steam treatment	Rotary dunnage treater with steam treatment
Foster Wheeler Development Corporation ELI Eco Logic International	Modified reverse assembly (horizontal punch & drain mechanism, propellant push-out and masticating/grinding with caustic)	Hydrolysis with caustic followed by SCWO	Hydrolysis with caustic followed by SCWO	Washed in caustic followed by Gas Phase Chemical Reduction (GPCR) to 5X	Washed in caustic followed by Gas Phase Chemical Reduction (GPCR) to 5X
Teledyne - Commodore	Fluid Jet Cutting Remove, initiate fuzes and capture residues in Solvated Electron Technology (SET™) Access and drain agent Wash energetics out in ammonia	Solvated electron process using sodium metal and ammonia followed by chemical oxidation	Solvated electron process using sodium metal and ammonia followed by chemical oxidation	Wash in SET™ followed by oxidation treats residues and heels to 3X Shipped to RIA for government disposal	Crush or shred charcoal, personal protective equipment, wood, fiberglass Treat in SET™, shipped to landfill Destroys contamination on dunnage

Table 2. Summary of Unit Operations Selected for Demonstration

Technology Provider	Unit Operations
AEA Technology/CH2Mhill	SILVER II™ Agent System SILVER II™ Energetic System
Foster Wheeler/Eco Logic	Supercritical Water Oxidation Gas Phase Chemical Reduction
Teledyne-Commodore	Metal Parts and Dunnage Shredding System Ammonia Fluid Jet Cutting and Washout System SET™ / Chemical Oxidation – Agent System SET™ / Chemical Oxidation – Energetics System SET™ / Dunnage – Metal Parts System

The Program Manager's Demonstration Working Group (DWG) consists of representatives of the Technical Team, Environmental Team, and support contractors. The DWG worked in an iterative process with test installation representatives, technology providers, support contractors, and members of the CATT in performing detailed planning activities. Planning was an essential part of this test program. The technology demonstration phase was very complex and its success depended upon the timely completion of critical, preparatory activities, such as:

- Test facility modifications;
- Test facility, technology provider coordination;
- Feed materials (agent, metal parts, dunnage, etc.) availability and transport;
- Agent/energetic hydrolysate production;
- Analytical methods identification/validation;

- Test facility standard operating procedure (SOP) requirements;
- Test facility safety (pre-operational survey) requirements;
- Quality Assurance/Quality Control (QA/QC) program development and implementation; and
- Sampling and analysis support coordination.

Detailed information regarding Demonstration II planning can be found in Appendix C.

C. Demonstration Testing Status

1. General Demonstration Operations

a. Agent and Energetic Hydrolysate Generation

The Foster Wheeler/Eco Logic total solution involves hydrolysis of both agent and energetics. Agent hydrolysis was a government technology offered as part of a total solution; therefore, the government provided these feeds. The energetic hydrolysate was also provided by the government, due to the expertise within the government, the limited availability of demonstration site facilities, and costs associated with having to conduct two separate hydrolysis operations if it were to be conducted as part of the technology provider's demonstration. Agent and energetic hydrolysates were also required for Engineering Design Studies.

b. Agent Hydrolysate Generation

The objective of this effort was to produce HD hydrolysates for use as feed material for the demonstration testing of a technology provider's secondary treatment process for both Demonstration II (Foster Wheeler SCWO) and Engineering Design Studies (General Atomics SCWO and Parsons/Honeywell Biotreatment).

Approximately 2,000 pounds of HD were hydrolyzed by the Edgewood Chemical and Biological Center (ECBC) at Aberdeen Proving Ground (APG), Maryland for these purposes. In excess of 3,500 gallons of HD hydrolysate were produced in a campaign of 121 batch runs.

Approximately 50 gallons of GB and VX hydrolysate that remained from Demonstration I testing were used for the Demonstration II testing and Engineering Design Studies – specifically in the SCWO units developed by Foster Wheeler and General Atomics.

c. Energetics Hydrolysate Generation

Approximately 520 pounds of tetrytol, 700 pounds of cyclotol (the Comp B replacement), and 3,000 pounds of M28 propellant were hydrolyzed to support Demonstration II testing and Engineering Design Studies. This resulted in approximately 420 gallons of cyclotol hydrolysate, over 445 gallons of tetrytol hydrolysate, and 1,850 gallons of M28 hydrolysate respectively. Hydrolysis of tetrytol and cyclotol were handled by the Pantex Plant, Amarillo, Texas, and M28 hydrolysate was handled by the Radford Army Ammunition Depot, Radford, Virginia.

d. Sampling and Analysis

The primary purpose of the demonstration testing validation sampling and analysis support is to implement the sampling and analysis approach developed by each technology provider as detailed in the Final Study Plans. The overall Demonstration Test Program, including the preparation of the agent and energetic hydrolysate feed materials, consisted of the sampling and analysis of seven unit operations conducted in five geographical locations over a period of six months. It is estimated that the Demonstration II Test Program resulted in:

- The collection of approximately 1,100 samples for chemical characterization;
- Approximately 8,000 sample analyses; and
- About 125,000 analytical data results.

The management of these activities includes the coordination of and support to 14 teams of sample collection personnel, the submittal of samples to 15 analytical laboratories in approximately 800 shipments and the data processing of the analytical results submitted to the Program Manager by the laboratories for subsequent transmission to the technology providers.

2. Demonstration Status

a. AEA Technology/CH2MHill

Two configurations of the SILVER II^{TM} process were used in this demonstration. A 2-kilowatt (kW) system was tested to demonstrate the ability of the process to effectively destroy chemical agents and chemical agent simulants. The plant designed for agent testing was required to be small enough to fit within a toxic chamber for safety and surety reasons. A 12-kW system was tested to demonstrate the ability of the process to effectively destroy energetic compounds and chemical agent simulants. The plant designed for energetics testing was designed larger to model the process closer to full-scale. Chemical agent simulants were tested in both plants in order to provide a comparison between the two plants to address scale-up issues of agent testing.

The SILVER II^{TM} technology is based on the highly oxidizing nature of silver ions, which are generated by passing an electric current through a solution of silver nitrate and nitric acid in a
standard industrial electrochemical cell. A more detailed discussion of this technology can be found in Appendix B.

2-kW SILVER II^{TM} System (Agent and Agent Simulant)

The demonstration tests for the 2-kW system were to consist of five, seven-day tests designed primarily to assess the ability of SILVER II^{TM} to destroy organic constituents and operate on a long-term, continuous basis. Five different feed streams were to be introduced to this unit including:

- 2-chloroethyl ethyl sulfide (CEES), an HD simulant – 1 workup and 1 validation run;
- dimethyl methylphosphonate (DMMP), a GB and VX simulant – 1 validation run;
- neat HD – 1 validation run;
- neat VX – 1 workup and 1 validation run; and
- neat GB – 1 validation run.

However, due to schedule constraints, the CEES run was eliminated and the DMMP and VX runs were shortened. The following objectives were established for the 2-kW SILVER II^{TM} agent and agent simulant demonstration:

- Validate the ability of the SILVER II^{TM} 2-kW unit operation to achieve a destruction and removal efficiency (DRE) of 99.9999 percent for HD, GB, and VX.
- Determine the impact of operations on materials of construction to be used in a full-scale system.
- Demonstrate the operation and performance of the key process components for future scale-up.
- Develop operational data to allow the SILVER II^{TM} 2-kW agent system to be compared to the 12-kW SILVER II^{TM} system for use in scaling up the SILVER II^{TM} agent system.
- Characterize silver-bearing residuals and determine potential silver recovery and determine disposal options (via characterization) for residuals from silver recovery operation (HD only).
- Characterize gas, liquid and solid process streams from the SILVER II^{TM} process for selected chemical constituents and physical parameters, and the presence/absence of hazardous, toxic, agent, agent simulant, and Schedule 2 compounds.

The 2-kW SILVER II^{TM} system was installed in Building E3566 at the Edgewood Area of APG, Maryland. Delays were incurred with equipment delivery; upgrades of electrical and steam utilities; and installation of analytical and monitoring equipment (including equipment failures, delays in process equipment installation, and changes to analytical methods).

Systemization activities for the 2-kW system began in June and continued until the commencement of demonstration testing on August 17, 2000. Systemization included equipment shakedown and testing, operator training, and safety review or pre-operational surveys. Systemization also took much longer than expected. Delays were due to equipment and installation delays; mechanical equipment problems (including degraded gaskets and burned out pump motors, and software control problems); and analytical equipment problems.

The demonstration tests for the 2-kW system were initiated on August 17, 2000 and were completed on October 1, 2000. Testing included the processing of DMMP, HD agent, VX agent, and GB agent. With the exception of some minor mechanical problems, testing of chemical agents and agent simulants proceeded smoothly. HD, VX, and GB were processed at a higher efficiency than predicted. However, DMMP was more difficult to process completely than had been anticipated. Although oxidation of the DMMP appeared to be complete, unidentified organic material remained in solution. This material is believed to be an intermediate by-product that requires additional time to oxidize. Despite the fact that DMMP was intended to be a simulant for VX and GB, this issue was not seen to the same extent in the VX and GB runs. Therefore, this issue may not be applicable to full-scale operation.

12-kW SILVER II™ System (Energetics and Agent Simulant)

The demonstration tests for the 12-kW system were intended to consist of five, seven-day tests designed to assess the ability of SILVER II™ to destroy organic constituents and operate on a long-term, continuous basis. Feeds to this system were to include:

- CEES (an HD simulant) – 1 workup and 1 validation run;
- DMMP (a GB and VX simulant) –1 validation run;
- M28 propellant – 1 workup and 1 validation run;
- Tetrytol – 1 validation run; and
- Comp B – 1 validation run.

However, due to schedule constraints, the CEES and Comp B runs were eliminated. The following objectives were established for the 12-kW SILVER II™ energetic and agent simulant demonstration:

- Validate the ability of the SILVER II™ unit operation to achieve a DRE of 99.999 percent for M28, Comp B, and tetrytol.
- Validate the ability of the SILVER II™ unit operation to achieve a DRE of 99.9999 percent for DMMP (VX/GB simulant).
- Determine impact of operations on materials of construction to be used in a full-scale system.
- Demonstrate the operation and performance of the key process components for future scale-up.
- Develop operational data to allow the SILVER II™ 2-kW agent system to be compared to the 12-kW SILVER II™ system for use in scaling up the SILVER II™ agent destruction system.
- Demonstrate the ability/inability to recycle, reuse, or dispose of nitric acid.
- Characterize gas, liquid and solid process streams of the SILVER II™ process for selected chemical constituents and physical parameters and for the presence/absence of hazardous and toxic compounds.

The 12-kW SILVER II^{TM} system was installed in the Fire Safety Test Enclosure or "Firebox" at the Aberdeen Test Center, Aberdeen Area of APG, Maryland. Installation of the 12-kW SILVER II^{TM} system took place between March and July 2000. Installation took longer than anticipated primarily as a result of delays in equipment delivery; mechanical equipment failures; on-site design modifications; problems with the control system software; and problems with the installation of sampling, analytical, and monitoring equipment.

Systemization activities for the 12-kW system began in April and continued until the commencement of demonstration testing on August 13, 2000. A series of process and analytical equipment problems and failures impacted the systemization schedule. Of most concern was a repeated blocking of the energetic feed system due to the "sticky" characteristic of dinitrotoluene, which was being processed during systemization to prove-out the system prior to initiating validation testing. This problem required the reconfiguration of the feed system to include larger-diameter feed lines and valve replacements.

Demonstration testing for the 12-kW system began on August 13, 2000 and was completed on October 3, 2000. The processing of DMMP, M28 propellant, and tetrytol was completed. More time was required to completely process the DMMP than originally expected due to the suspected formation of an intermediate by-product. As discussed above, the same problem was encountered during the DMMP run with the 2-kW plant. Processing of M28 propellant appears to have worked well. No major problems were encountered and the process reached an efficiency of 99 percent compared to the expected efficiency of 60 percent. However, there were significant delays during the processing of tetrytol, and consequently, there was no time to process Comp B before the end of the test program. While processing tetrytol, which contains trinitrotoluene (TNT), numerous blockages occurred throughout the system. These blockages are believed to be a result of trinitrobenzoic acid forming as an intermediate product and precipitating out of solution. In order to prevent formation of the precipitate, the feed rate of tetrytol was reduced; thereby decreasing the efficiency and eliminating the blockages. Thus, the validation run for tetrytol required more than twice the time originally scheduled.

A summary of the planned and actual demonstration tests can be found in Appendix C. The results of the Demonstration Testing and the Technical Evaluation of AEA Technology/CH2MHill will be presented in the March 2001 *Supplemental Report to Congress*.

b. Foster Wheeler/Eco Logic

For the demonstration testing, Foster Wheeler and Eco Logic tested the two primary components of their total solution: supercritical water oxidation (SCWO) and gas phase chemical reduction (GPCR). The SCWO process oxidizes the remaining organic compounds from the neutralization process in a high temperature and pressure environment. The GPCR decontaminates dunnage and metal parts in a hydrogen atmosphere. Additional details of these technologies can be found in Appendix B.

Supercritical Water Oxidation

The demonstration test program for SCWO consisted of four 100-hour tests designed primarily to assess the ability of Foster Wheeler's design of SCWO (transpiring wall reactor) to destroy organic constituents (including Schedule 2 compounds) and control corrosion and salt plugging on a long-term, continuous basis. The first feed, VX hydrolysate simulant, consisted of the exact recipe utilized by General Atomics in a similar 100-hour test conducted during the Demonstration I Test Program in 1999. The results were intended to directly compare the performance of the Foster Wheeler SCWO system design to that of the General Atomics SCWO system design. The remaining three feeds consisted of mixtures of agent and energetic hydrolysates in proportions set to mimic the ratios of agent and energetics expected from hydrolysis of specific munitions. The feeds that were introduced included the following:

- VX hydrolysate simulant – 1 workup and 1 validation run;
- HD/tetrytol/aluminum hydrolysate and simulant – 1 workup and 1 validation run;
- GB/Comp B/aluminum hydrolysate and simulant – 1 workup and 1 validation run; and,
- VX/Comp B/M28 propellant/aluminum hydrolysate and simulant – 1 workup and 1 validation run.

The following objectives were established for the SCWO demonstration:

- Demonstrate long-term, continuous operability of the SCWO unit with respect to salt plugging, corrosion, integrity of the platelet liner and erosion of the pressure control valve of the SCWO reactor.
- Determine if aluminum from the energetic hydrolysis process can be processed by the SCWO reactor without plugging.
- Demonstrate ability to destroy Chemical Weapons Convention (CWC) Schedule 2 compounds in the feed to below their detection levels.
- Characterize the gas, liquid and solid process streams from the SCWO process for selected chemical constituents and physical parameters and the presence or absence of hazardous, toxic, agent and CWC Schedule 2 compounds.

The Foster Wheeler SCWO system was installed in Building 4165 at Dugway Proving Ground (DPG) in Dugway, Utah. Installation of the equipment took place during May 2000. Foster Wheeler began its systemization period on May 30, 2000. Systemization included equipment shakedown and testing, operator training, and safety review or pre-operational surveys. Systemization took longer than anticipated because of several problems with the air compressor (which is not part of the full-scale design) and extended training needed for the

DPG operators. Systemization of the SCWO equipment was completed by July 25, 2000 with the start of the first validation test.

During demonstration testing, Foster Wheeler tested all planned feeds; however, some validation runs were shortened for various reasons. Each validation run, except for the VX/CompB/M28/aluminum hydrolysate, was preceded by a workup run. One hundred hours of the validation run for VX simulant were completed with two interruptions, both due to problems with the air compressor, which would not be used in the full-scale system. During the workup run for HD/tetrytol hydrolysate, a crack in the upper liner of the SCWO reactor was discovered. The liner section including and surrounding the crack was found to be severely corroded because of the absence of transpiration water protection in that region due to a known fabrication error. The crack was caused by cyclic thermal stresses in the corrosion-weakened liner material. (No corrosion was observed in the region of the upper liner that was protected by transpiration water.) In the absence of an appropriate spare liner for the cracked upper section, a spare liner, not designed for the upper section, was modified and installed. The modification included the drilling of a bleed hole in the replacement liner, not a desirable solution, to permit use of the "wrong" upper liner for continued testing.

During the 100-hour HD/tetrytol hydrolysate validation run, the run was stopped after 55 hours due to a blister or bulge that formed in a new upper liner, likely from thermal stress caused by the bleed hole. This indicated a limited lifetime remaining for the liner. It was then determined to terminate the HD/tetrytol hydrolysate validation run and reduce the GB/CompB/aluminum hydrolysate validation run to 50 hours instead of 100 hours. It was planned that after these two runs, the 100- hour validation run for VX/CompB/M28/aluminum hydrolysate would be run until the 100 hours or failure was attained.

During the GB/CompB/aluminum hydrolysate run, the system experienced fouling in a low-pressure heat exchanger, downstream of the pressure control valve. Periodic plugs of oxides of aluminum formed in the heat exchanger tubing that required flushing and maintenance. Fifty hours of the GB/CompB/aluminum hydrolysate validation run were completed without any interruption. Several additional problems were experienced throughout the VX/CompB/M28/aluminum hydrolysate validation test. These included trouble achieving ignition, distorted spray pattern from injector ports, and problems with the caustic feed pump. The validation run was terminated after approximately 26 hours of operation because of these problems. Despite various problems with upstream and downstream system components experienced over the course of testing, the transpiring wall reactor consistently exhibited no salt plugging, relatively minimal salt buildup, and good resistance to corrosion throughout the test program for all feeds.

Gas Phase Chemical Reduction

The demonstration test program for the GPCR system consisted of testing dunnage and chemical agents. The feeds that were to be introduced included the following:

- Carbon trays – 1 workup and 3 validation runs;

- Wood spiked with 4,000 ppm pentachlorophenol (PCP) – 1 workup and 3 validation runs;
- Demilitarization Protective Ensemble (DPE) with 10% butyl rubber by weight to simulate gloves and boots – 1 workup and 3 validation runs;
- Fiberglass firing tubes – 1 workup and 3 validation runs;
- Neat GB – 1 workup and 3 validation runs; and
- M2A1 4.2 inch mortar spiked with simulated 30% HD heel – 1 workup and 3 validation runs.

The following six objectives were established for the GPCR system demonstration:

- Validate the ability of the GPCR process to achieve 5X decontamination[1] condition for metal parts and dunnage.
- Demonstrate the effectiveness of the GPCR process to treat product gases generated during the treatment of metal parts and dunnage.
- Validate the ability of the GPCR process to achieve a DRE of 99.9999 for HD and neat GB.
- Characterize the gas, liquid and solid process streams from the GPCR process for selected chemical constituents and physical parameters and the presence or absence of hazardous, toxic, agent and CWC Schedule 2 compounds.
- Demonstrate the ability of the GPCR process to produce a gas effluent that meets either EPA Syngas or Boiler and Industrial Furnace (BIF) requirements.
- Determine the need for stabilization of residual dunnage solids based on Toxic Characteristic Leaching Procedure results.

The GPCR system was installed in Building E3726 at the Edgewood Area of APG, Maryland. Installation of the GPCR took place during May and June 2000. Although no major problems occurred during installation, several activities required more time than expected. Systemization included equipment shakedown and testing, operator training, and safety reviews or pre-operational surveys. Because of the compressed schedule for these activities, they did not necessarily occur sequentially and there was often considerable overlap. Furthermore, during systemization activities, some problems were encountered and overcome. Systemization activities occurred from June 2000 until the commencement of demonstration testing on July 10, 2000.

The demonstration testing of the dunnage was completed as scheduled. However, the technology provider and test facility encountered some problems while processing neat GB agent. These problems included: blockages in the agent feed line and liquid waste preheater system, test facility carbon filter change-out, high temperatures in test chamber which often prevented operators from entering the chamber, partial melting/corrosion of the product gas burner liner, and difficulties with the agent analytical method in the gas stream. Although these problems were overcome, the agent test schedule was compromised. Therefore, only

[1] 5X decontamination refers to chemical agent decontamination achieved through treatment at 1000°F for 15 minutes.

two of the three runs with an M2A1 4.2-inch mortar and a simulated 30 percent HD heel were completed. The demonstration tests concluded on October 1, 2000.

A summary of the planned and actual demonstration tests can be found in Appendix C. The results of the Demonstration Testing and the Technical Evaluation of Foster Wheeler/Eco Logic will be presented in the March 2001 *Supplemental Report to Congress*.

c. Teledyne-Commodore

The demonstration test program for Teledyne-Commodore's Solvated Electron Technology (SET^{TM}) was to test all seven primary components of their total solution. The demonstrations were to be conducted at DPG in Dugway, Utah, and at Deseret Chemical Depot (DCD) at the Chemical Agent Munitions Disposal System (CAMDS) in Tooele, Utah. The agent systems were to be tested at CAMDS and the energetics and dunnage systems were to be tested at DPG. The components to be tested are listed below.

- Ammonia Fluid Jet Cutting and Washout System (AFJC&W)
- SET^{TM}/Energetics System
- SET^{TM}/Energetics Chemical Oxidation System
- SET^{TM}/Agent System
- SET^{TM}/Agent Chemical Oxidation System
- Metal Parts and Dunnage Shredding System
- SET^{TM}/Dunnage System for Metal Parts and Dunnage

As discussed in the following paragraphs, the following components were not (completely or partially) tested as planned.

- Ammonia Fluid Jet Cutting and Washout System (AFJC&W)
- SET^{TM}/Energetics System
- SET^{TM}/Energetics Chemical Oxidation System
- SET^{TM}/Agent System

- SET^{TM}/Agent Chemical Oxidation System

The primary treatment process is a solvated electron reaction (dissolved sodium in anhydrous liquid ammonia) to destroy agent and energetics. A more detailed discussion of this technology can be found in Appendix B.

Provided below is a summary of the demonstration program. It is divided into the three areas of testing: (1) AFJC&W and SET^{TM}/Energetics with oxidation (conducted at DPG); (2) SET^{TM}/Dunnage spiked with agent simulant (conducted at DPG); and (3) SET^{TM}/Agent with oxidation (conducted at CAMDS).

AFJC&W and SET^{TM}/Energetics with Oxidation

The SET^{TM} energetics destruction system was installed inside of the Suppressive Shield Facility at DPG. The following feeds were planned to be processed:

- M60 (inert) rockets (cutting only) - 2 workup and 15 validation runs;
- M61 (energetic only) rockets (cutting and processing) - 4 workup and 3 validation runs;
- Comp B processing in SET^{TM} (from M61s) - 4 workup and 3 validation runs;
- M28 processing in SET^{TM} (from M61s) - 4 workup and 3 validation runs; and
- Bulk tetrytol processing in SET^{TM}/Oxidation - 2 workup and 3 validation runs.

The test objectives for the AFJC&W included:

- Demonstrate the ability of the Fluid Jet Cutting/Washout to prepare a suitable feed to the SET^{TM}/Oxidation Reactors.
- Demonstrate the ability of Fluid Jet Cutting/Washout to separate the burster and propellant from the rockets.
- Demonstrate the accuracy and precision with which the fluid jet cutting system can position and cut the rockets using manual placement of the rockets.
- Determine the impact of fluid jet cutting and fluid washout operations on chamber components (e.g., integrity of the chamber seals).

The test objectives for the SET^{TM}/Energetics and Oxidation included:

- Validate the ability of the SET^{TM}/Oxidation Reactors to achieve a DRE of 99.999% for the following:
  - Comp B (RDX and TNT)
  - Tetrytol (tetryl and TNT)
  - M28 propellant (NC and NG)
- Demonstrate the operation and performance of the key process components to support future scale-up.
- Demonstrate the ability to produce a gas effluent that meets either the EPA Syngas or BIF requirements.

- Demonstrate the effectiveness of the solidification and stabilization process for treatment of the solids from the SET™/Oxidation Reactor (M28 propellant runs only).
- Characterize gas, liquid, and solid process streams from the SET™/Oxidation Reactors for selected chemical constituents and physical parameters, and the presence/absence of hazardous and toxic compounds.

No major problems occurred during the installation and systemization phase. However, several activities required more time than expected causing program delays. It took approximately two months longer than planned to install the equipment at DPG. Systemization was therefore delayed and also took longer than planned. Due to the delays, the only validation test runs conducted were the cutting of the M60 (inert) rockets from September 8-13, 2000. On September 18-19, 2000, two M61 workup runs were conducted. On September 19, 2000, an energetic ignition of the M61 rocket was observed. Although there were no health or safety-related issues, the impact this event had on schedule prevented any further testing.

SET™/Dunnage

The SET™/Dunnage System was installed inside of the Suppressive Shield Facility at DPG. There were two steps involved with processing and decontaminating dunnage materials and metal parts: 1) Shredding and size-reducing; and 2) SET™ treatment in the SET™/Dunnage Reactor.

Five dunnage feed types were used for the ACWA Program; they are listed below. All materials were spiked with agent simulants in the DPG Laboratory prior to testing. No agent was used for this demonstration.

- DPE suits (shredded);
- Wood pallets (shredded);
- Fiberglass from rocket firing tubes of inert rockets such as M60s, without polychlorinated biphenyl (PCB) contamination (shredded);
- Carbon (supplied granulated – not shredded); and
- Metal parts from inert 4.2-inch mortars (shredded).

The test objectives for the SET™/Dunnage unit operations included:

- Validate the ability of the shredder to adequately prepare the dunnage and metal parts for downstream processing in the SET™/Dunnage Reactor.
- Demonstrate the ability to handle and feed the shredded dunnage and metal parts into the SET™/Dunnage Reactor.
- Validate the ability of the SET™/Dunnage Reactor to meet a 3X condition[2] or equivalent for agent simulants for metal parts and dunnage.

[2] 3X decontamination indicates an item has been surface decontaminated, bagged, or contained and that appropriate tests have verified that vapor concentrations do not exist above 0.0001 mg/m^3 for GB,

- Demonstrate the operation and performance of the key process components to support future scale-up.
- Relate the characterization of SET™/Dunnage Reactor offgas to produce a total facility gas effluent that meets either the EPA Syngas or BIF requirements.
- Characterize gas, liquid, and solid process streams from the SET™ process for selected chemical constituents and physical parameters, and the presence or absence of hazardous and toxic compounds including residual agent simulants.

The feed preparation step was conducted from May 3 to 4, 2000 at a commercial facility. There were no installation or systemization requirements because all equipment was existing at the facility. There were no major problems with any of the shredding activities and all feed types were successfully size-reduced for subsequent processing in the SET™/Dunnage system.

Due to the delays in the installation and systemization of the SET™/Energetics system, it was determined that Teledyne-Commodore would be allowed to test the SET™/Dunnage system first. There were no major problems observed during the installation, systemization, or testing activities. The validation tests began on August 15, 2000 and ended on August 28, 2000. The system processed all five dunnage feeds as planned and all necessary validation data were collected.

SET™/Agent

The SET™/Agent system was installed inside the Chemical Test Facility at CAMDS. The original Teledyne-Commodore schedule allowed for approximately three months of testing. The following three dunnage feeds were planned to be processed:

- GB – 2 workup and 3 validation runs;
- VX – 2 workup and 3 validation runs; and
- HD – 2 workup and 3 validation runs.

The program objectives for the SET™/Agent system are provided below:

- Validate the ability of the SET™/Oxidation Reactors to achieve a DRE of 99.9999% for VX, GB, and HD.
- Demonstrate the operation and performance of the key process components to support future scale-up.
- Demonstrate the effectiveness and accuracy of the ambient monitoring equipment for agent in the presence of ammonia.
- Validate the ability of the oxidation reactor to eliminate Schedule 2 compounds present in the feed to the Oxidation Reactor.
- Demonstrate the ability to produce a gas effluent that meets either the EPA Syngas or BIF requirements.

and 0.00001 mg/m^3 for VX.

- Characterize gas, liquid, and solid process streams from the SET™/Oxidation Reactors for selected chemical constituents and physical parameters, and the presence/absence of hazardous and toxic compounds including residual agent and Schedule 2 compounds.

There were significant delays in the installation and systemization phases. The three primary causes of these delays were: (1) Incomplete systems were shipped to the test facility which added considerably more time required for installation (such as electrical connection and instrumentation placement); (2) Incomplete and inaccurate electrical and mechanical design drawings (the field installation teams frequently needed clarification on how to install the system); and (3) Teledyne-Commodore underestimated the time required to conduct all the necessary installation and systemization activities.

In addition to these previously discussed causes for delay, on July 6, 2000, several workers were exposed to a small sulfuric acid spill that occurred during systemization activities. This incident required an investigation by both Teledyne-Commodore and test facility personnel. Some minor corrective actions were identified and incorporated to reduce the risk of similar events from happening in the future. The process of determining and implementing the necessary corrective measures delayed the program further. On August 24, 2000, it was determined that agent testing could not be conducted prior to the PMACWA deadline of September 25, 2000, and as a result, PMACWA terminated all Teledyne-Commodore operations at CAMDS. Consequently, there were no agent tests conducted for Teledyne-Commodore. The schedule delays resulted in a test end date that went far beyond the timelines that were established in order to deliver the *Supplemental Report to Congress* in March 2001. In addition, substantial cost growths occurred. These cost growths are being reviewed to determine what portions must be reimbursed to Teledyne-Commodore. Procurement sent a letter to Teledyne-Commodore on August 24, 2000 to cease work under their contract with ACWA. This decision was discussed with the CATT. Teledyne-Commodore was authorized to complete testing at DPG with the SET™ Energetics/Dunnage and Fluid Jet Cutting/Washout at their own expense as long as testing was complete by September 27, 2000, and a final report was delivered. PMACWA was willing to fund the test facility and analytical support.

During the Fluid Jet Cutting/Washout testing of an M61 rocket on September 19, 2000, a fire occurred inside a pressure vessel located inside a chamber that was specifically designed to safely handle events of this nature. The DPG emergency response team was notified immediately and responded. All operations were conducted remotely in accordance with standard safety procedures. No personnel were injured and no damage to the test facility was reported. The cause of the fire was the ignition of energetic components in the rocket. Teledyne-Commodore, DPG, and PMACWA are investigating the cause of the energetic ignition and subsequent fire.

Subsequent to this incident, it was decided that no further testing of the Teledyne-Commodore Fluid Jet Cutting/Washout or SET™/Energetics unit operations would be conducted.

A summary of the planned and actual demonstration tests can be found in Appendix C. The results of the Demonstration Testing and the Technical Evaluation of Teledyne-Commodore will be presented in the March 2001 *Supplemental Report to Congress*.

3. Demonstration Issues

There were several demonstration issues and considerations identified during the demonstration planning process that were generic to all the technologies. The major issues and considerations included facility limitations, analytical methods and procedures, hydrolysate production, toxic materials, baseline operations, environmental and regulatory compliance, and analytical issues.

Throughout demonstration testing, problems and issues surfaced that required modification to the Demonstration II Study Plan for each technology provider. There were also changes to the test equipment and test procedures throughout the demonstrations. Changes were submitted in accordance with the Program's Manager's Configuration Management Plan where each change was developed by the technology provider, and reviewed by the ACWA staff and support contractors, prior to the change being approved and incorporated.

III. ENGINEERING DESIGN STUDIES

Public Law 105-261 directed the continuation of the ACWA Program and stated that if an alternative technology is to be chosen to be piloted, the Under Secretary of Defense for Acquisition, Technology and Logistics must certify in writing to Congress that any ACWA technology to be implemented is as safe and cost effective for disposing of assembled chemical munitions as is incineration; and, is capable of completing the destruction on or before the later of the date by which the destruction of the munitions would be completed if incineration were used or the deadline date for completing the destruction of the munitions under the Chemical Weapons Convention. To this end, Engineering Design Studies were initiated for the two alternative technologies that were validated during the Demonstration I program as having the potential to be effective in the destruction of chemical weapons. These two technologies use neutralization as the main destruction mechanism for the agent and energetics contained in the chemical weapons. The technology proposed by Parsons/Honeywell is neutralization followed by biotreatment, which was validated for processing of mustard-containing munitions only. The technology proposed by General Atomics is neutralization followed by supercritical water oxidation and was validated for processing of all chemical weapons.

Engineering Design Studies will result in a preliminary full-scale design for the construction of a demilitarization facility with the associated cost, schedule, and preliminary hazards analysis. This information will be the basis for certification under Public Law 105-261. The design package will be made available as part of the request for proposals that will be developed for implementation of a technology at Pueblo Chemical Depot and Blue Grass Chemical Depot.

A. General Atomics

The approach proposed by General Atomics for a total solution for the destruction of all assembled chemical weapons uses modified reverse assembly for rockets and modified reverse assembly plus cryofracture for projectiles. Cryofracture is a process developed by General Atomics for the Army in which munitions are embrittled by cooling in liquid nitrogen and then fractured to access the agent after the energetics have been removed. General Atomics proposes to neutralize (hydrolyze with caustic) the agents and energetics separately and then destroy the hydrolysate and shredded dunnage using separate supercritical water oxidation (SCWO) units. SCWO mineralizes the hydrolysates at temperatures and pressures above the critical point of water, and produces effluents that can be held and tested before release. General Atomics proposes to recover process water for reuse and to dispose of dry salts and solid residues in a permitted waste landfill.
The following General Atomics unit operations are being tested as part of the EDS program in order to provide the engineering basis for the designs being developed for the General Atomics Total Solution. Three primary process systems are being tested separately and concurrently by the Parsons/Honeywell team at DPG, Utah. These systems include an Energetics Rotary Hydrolyzer (ERH) to neutralize the weapons energetics, a SCWO unit to treat the neutralized agent and energetics, and a Dunnage Shredding and Hydrolysis System (DSHS) to pretreat miscellaneous dunnage for subsequent treatment in SCWO.

1. Energetics Rotary Hydrolyzer

The ERH, a rotating drum with internal flights, is designed to deactivate the energetics components of the chemical munitions (e.g., fuzes, bursters, and propellant) by immersing them in a strong solution of sodium hydroxide. The specific objectives of the testing include the following:

- Observe the effects on M28 propellant hydrolysis for smaller cut lengths of rocket motors.
- Observe containment of fugitive emissions.
- Observe the effect of higher caustic concentration and bath temperature on the rate of M28 propellant hydrolysis. This will be performed on a smaller scale as part of PMACWA energetics hydrolysate EDS program.
- Characterize gas, liquid, and solid process streams from the ERH process to supplement data generated during Demonstration I.

The ERH testing is being conducted with sections of rocket motors representing pieces that would be sheered in the current reverse assembly process.

2. Dunnage Shredding/Hydrolysis System

The DSHS is used to reduce dunnage to a size where the shredded product can be slurried in a hydropulper for subsequent processing in a SCWO unit. The DSHS system consists of three operations: wood shredding (low speed shredder, hammermill, and micronizer); plastic shredding (low speed shredder, cryocooler, and granulator); and hydropulping (hydropulper, grinding pump, and progressive cavity pump). The DSHS system was installed at the DPG in Dugway, Utah. The specific objectives of the testing include the following:

- Demonstrate all changes (relative to PMACWA Demonstration I Test Program) to the dunnage shredding equipment proposed for the full-scale design and verify improved efficiency and uninterrupted operation (e.g., avoiding nesting and unit overloads) while meeting a particle size of < 1 mm for wood and plastic/rubber, and < 0.5 mm for carbon
- Generate information required for design of dust/agent vapor emission control system.
- Verify carbon size reduction in carbon grinder sufficient for downstream SCWO processing.
- Verify feasibility of DPE metal parts removal fixtures for full-scale facility.

The DSHS testing is being conducted with DPE material and wood to address size reduction and material transport issues resulting from testing conducted during Demonstration I.

3. Supercritical Water Oxidation System

The SCWO system is designed to oxidize an aqueous organic feed to CO_2, H_2O and salts. The SCWO system was installed at DPG. The system consists of four skids: hydrolysate (liquid feed), hydropulper (dunnage slurry feed), reactor, and compressor/cooling tower. The specific objectives of the testing include the following:

- Demonstrate long-term continuous operability without plugging.
- Demonstrate acceptable corrosion rate.
- Demonstrate that any feed additives for salt transport control do not interact with feed and/or equipment to generate salt plugs or accelerate corrosion.
- Determine a maintenance schedule and the frequency of shutdowns based on the results of this long-term testing.
- Generate data for use in validating the SCWO model development work sponsored by the Army Research Office.

The SCWO testing is being conducted with HD hydrolysate and simulant, GB hydrolysate and simulant and M28, Composition B, and tetrytol energetics hydrolysate.

4. Schedule

Draft test plans for the General Atomics EDS testing were submitted in January 2000, and were finalized in April. Test preparations were made by coordinating efforts with the test sites, the state’s environmental offices in which the tests were conducted, the Treaty Compliance Office, and sampling and analysis contractors in order to maximize the success of the program. Testing began with dunnage shredder operations in May, SCWO operations in July, and ERH operations in November. Testing of the ERH was completed at the beginning of December. SCWO testing is still being conducted and is due to be completed in May 2001.

B. Parsons/Honeywell

The approach proposed by Parsons/Honeywell for a total solution for the destruction of mustard chemical weapons uses modified reverse assembly for chemical access. Modifications to reverse assembly include a gravity drain with water bath and rinse for agent removal and high-pressure wash to remove the energetics. Parsons/Honeywell proposes to neutralize (hydrolyze with water and caustic) the agent and energetics and then destroy the hydrolysates using a biological treatment process operated at ambient temperature and pressure. Organic vapors and odors will be passed through a catalytic purifier (similar to an automotive catalytic converter) developed by Honeywell. Parsons/Honeywell proposes to recover process water for reuse and to dispose of dry salts and solid residues in a permitted waste landfill. Recovered metal parts will be steam-treated and released as scrap.

The following Parsons/Honeywell unit operations are being tested as part of the EDS program in order to provide the engineering basis for the designs being developed for the Water Hydrolysis of Explosives and Agent Technology. Four primary process systems are being tested separately and concurrently by the Parsons/Honeywell team at locations including the ECBC at APG, Maryland; the Illinois Institute of Technology Research Institute (IITRI) in Chicago; and CAMDS in Tooele, Utah. These systems include an Immobilized Cell Bioreactor (ICB™) to treat neutralized mustard and energetics, Continuous Steam Treater (CST) to treat metal parts and miscellaneous dunnage, a catalytic oxidation unit (CatOx) to treat organics in the gaseous phase prior to carbon filtration, and a water washout system to treat mustard munitions that may contain heels.

1. Immobilized Cell Bioreactor™

The ICB™ system is used to treat the products of the agent and energetic neutralization process. This unit is being operated in Building E3570 at ECBC. The specific objectives of the testing include the following:

- Observe long-term (4 months [4 biomass retention times]), continuous operation of the HD ICB™ exclusive of unanticipated extended downtime, using the proposed full-scale operating conditions (e.g., aeration, effluent recycling and proposed hydrolysate feed rate).
- Observe the ability of the secondary unit operations (e.g., clarifier, filter press, and evaporator/crystallizer/filter press) to operate as proposed.
- Confirm critical design parameters (e.g., aeration rate, CatOx loading) developed during PMACWA Demonstration I Test Program.
- Observe effective control of the biomass throughout the HD ICB™ process including growth within the ICB™ unit, separation within the clarifier, and filtration.Observe the effectiveness of the proposed full-scale control strategy for the ICB™, clarifier, CatOx, and evaporator/crystallizer/filter press.
- Characterize the CatOx outlet, crystallizer off-gas, biomass and brine salts from the ICB™ process for selected chemical constituents and physical parameters, and the presence/absence of hazardous, toxic, agent, and Schedule 2 compounds.

- Observe the ability of the HD ICB™ unit to treat the neutralized CST condensate as part of the feed stream to the ICB™.

The ICB™ testing is being conducted with feeds consisting of combined process liquids of agent hydrolysate, energetic hydrolysate and condensate from the CST.

2. Continuous Steam Treater

The CST is used to decontaminate metal parts and dunnage to a 5X condition using an inductively heated vessel in the presence of steam. The CST system is being operated in the General Purpose Facility at the CAMDS site at DCD in Tooele, Utah. The specific objectives of the testing include the following:

- Observe long term operability, reliability and ease of material handling of the CST with the following feeds:
  - Wood (pallets)
  - DPE
  - Carbon (filter trays).
- Observe the effectiveness of the proposed full-scale control strategy for the CST.
- Observe the ability of the CST to reach a 5X condition throughout the feed material. Verify critical design parameters (e.g., temperature, steam flow rate, CatOx loading, feed throughput rate) developed during PMACWA Demonstration I Test Program.Observe the ability of the CatOx unit to effectively treat the uncondensed gases over a long-term operation.
- Determine whether the catalyst loses efficiency (due to poisoning, fouling, and/or plugging).
- Determine the expected CatOx catalyst life under continuous CST operation.
- Characterize neutralized CST condensate for selected chemical constituents and physical parameters and the presence/absence of hazardous and toxic compounds.

The CST testing is being conducted with feeds consisting of process wastes to include carbon, wood pallets and DPE.

3. Catalytic Oxidation

The CatOx is used to treat organic compounds in the gaseous phase to lessen the loading of these compounds on the facility's filtration system. This unit operation is being tested at IITRI. The specific objectives of the testing include the following:

- Observe long term (500 hrs), operation of the CatOx unit with HD.
- Determine whether the catalyst loses efficiency (due to poisoning, fouling and/or plugging).
- Determine the expected catalyst life under continuous HD operations.
- Determine (via characterization) ability of CatOx effluent to be treated by a downstream carbon bed.The CatOx testing is being conducted using HD agent as a

straight challenge to the system as a worst case scenario to determine catalyst effectiveness and duration.

4. Projectile Washer

The projectile washer is used to access the agent in mustard munitions that may contain heels that cannot be effectively drained. The Projectile Washer is being operated in the Chemical Test Facility at CAMDS in Tooele, Utah. The specific objectives of the testing include the following:

- Determine the washout process effectiveness and cycle time.
- Determine end products and their ability for treatment and post-treatment.

The Projectile Washer testing is being conducted with actual mustard mortars in order to address the heel problems that exist in stockpiled rounds.

5. Schedule

Draft test plans for the Parsons/Honeywell EDS testing were submitted in January 2000, and were finalized in April. Test preparations were made by coordinating efforts with the test sites, the state's environmental offices in which the tests were conducted, the Treaty Compliance Office, and sampling and analysis contractors in order to maximize the success of the program. Testing began with ICB operations in June, CatOx operations in August, and CST operations in September. The testing of these three systems has been completed. The Projectile Washer testing is scheduled to take place from mid-April until the end of May 2001.

C. Engineering Design Package

The testing outlined above will support the preparation of an Engineering Design Package that will be the basis for the cost, schedule and safety criteria development. The Engineering Design Package will include drawings and documentation sufficient to generate capital and operational and maintenance costs to within +/- 20 percent. The design package will also include a cost estimate that will be validated and used to develop a program life cycle cost estimate. A program schedule is also included in the package along with a Preliminary Hazards Analysis that will be used as a tool in the safety certification process. Since Pueblo Chemical Agent Disposal Facility (PUCDF) will have a stockpile of mustard-only weapons and Blue Grass Chemical Agent Disposal Facility (BGCDF) will have both mustard and nerve agent weapons, Parsons/Honeywell will be generating a Engineering Design Package for the PUCDF only, while General Atomics will develop a package for both PUCDF and BGCDF. These packages will be used for the certification process, the request for proposals for the two demilitarization sites, and for EIS process and Resource Conservation and Recovery Act (RCRA) permit applications.

Draft Engineering Design Packages were submitted to the Government on October 27, 2000. Design reviews were conducted at the end of November and changes are being made to these packages as a result. The final Engineering Design Packages are due to the Government on January 5, 2001.

IV. ACQUISITION ACTIVITIES

A. Colorado

PMACWA is participating in two on-going acquisition activities regarding the construction of a chemical demilitarization facility at Pueblo Chemical Depot: 1) Joint Program Manager for Chemical Demilitarization (PMCD)/ACWA Acquisition Working Group addressing contracting and acquisition strategy issues; and 2) Colorado Environmental Working Integrated Process Team (WIPT) that is working issues related to the environmental permits.

1. Joint PMCD/ACWA Acquisition Working Group

PMACWA is co-chairing a working group with PMCD to develop a Request for Proposals (RFP) and an Acquisition Strategy and Acquisition Plan for a chemical demilitarization facility at Pueblo Chemical Depot. The documents are being developed to reflect the joint acquisition activities between PMCD and PMACWA to have the flexibility to address contract requirements for both project managers for any of the technologies under consideration. Currently, there are four technologies being addressed in the Pueblo site-specific EIS. It is expected that an RFP will be released no later than January 19, 2001 and a contract awarded first quarter FY 2002 following the technology decision. The technology decision will be documented in the National Environmental Policy Act (NEPA) Record of Decision (ROD). Details of the NEPA activities are discussed in Section IV C of this report.

If a neutralization technology is chosen, a dual contractor approach will be used. The contractor from the initial contract (Contractor A) will be responsible for non-technology specific design and construction with follow-on options once the technology decision is made. Once the technology decision is made, an additional contract will be awarded to Contractor B for the technology–specific process design, equipment acquisition, fabrication and installation.

Although a technology decision is not expected until late FY 2001, the source selection process for either a Systems Contractor (for an incineration technology) or Contractor A has been initiated to enable a contract to be awarded as soon as possible after the technology decision.

Activities that have taken place to-date and are planned include:

- Industry Day. PMACWA and PMCD conducted a joint Industry Day on September 7, 2000 to provide potential bidders on the RFP for the Pueblo demilitarization facility background information, an overview of the program requirements and contracting strategies as well as a forum to give feedback.
- Meetings with the Pueblo Business Community. PMACWA and PMCD conducted joint meetings on October 12, 2000 with members of the Pueblo business community; e.g., City Council, Pueblo County Commissioners, and the Chambers of Commerce. The purpose of the meetings was to provide information to the business community

on upcoming events; e.g., draft RFP, pre-solicitation conference, final RFP, etc., as well as typical goods and services that the chemical demilitarization project will require in the coming years.

- Publication of the Draft RFP. The Draft RFP was published on November 20, 2000.
- Pre-Solicitation Conference. The Pre-Solicitation conference is planned to be held on December 5, 2000 in Pueblo. Details regarding the program requirements will be presented and discussed with potential bidders.

2. Colorado Environmental Working Integrated Process Team

PMACWA is tri-chairing a WIPT with PMCD and the Colorado Department of Public Health and Environment (CDPHE). Other members of the WIPT include representatives from Pueblo Chemical Depot (PCD), EPA Region 8, and the Army Corps of Engineers. The mission of the WIPT is to identify and resolve environmental permitting issues for all technologies being considered. The WIPT is an information-sharing team rather than a decision-making team. The WIPT meets approximately every six weeks with the meetings rotated between Pueblo, Colorado; CDPHE headquarters in Denver; and Edgewood, Maryland.

A key area of discussion has been the initiation of infrastructure projects at PCD that would be required regardless of the ultimate technology decision. To that end, CDPHE and EPA Region 8 have granted tentative approval to begin certain non-technology specific infrastructure projects in FY 2001-2002. This work will be conducted under contracts that are separate from the RFP referenced above for the overall chemical demilitarization facility. It is work that can begin prior to a technology decision.

The WIPT is also pursuing the possibility of additional construction projects that could be started once the technology decision is made but prior to the approval of the RCRA permit. The WIPT is discussing these on a project-by-project basis with CDPHE and the EPA.

To make the process as transparent as possible to the public, sharing of information outside of the WIPT with members of the public is a key goal. To that end, the WIPT has developed a Community Involvement Plan that lays out numerous ways information will be provided to the public. These include mailings, updates in PCD newsletters and providing information on the CDPHE web site. To go one step beyond simply providing information to the public, all WIPT meetings will be announced in the *Pueblo Chieftain*, the local newspaper, and be open to the public. Opening the WIPT meetings to the public will facilitate the exchange of information between the organizations involved in preparation of the permit application and the public.

B. Kentucky

This year the Kentucky Legislature revised its statutes to allow for the permitting of chemical stockpile pilot destruction technologies. This change allows for Blue Grass to be included as one of the potential sites to pilot an alternative technology. The current EIS being prepared by ACWA includes Blue Grass, Kentucky, and will assess the impacts of piloting an alternative technology at this site. PMACWA will participate in acquisition activities similar to those currently underway in Pueblo upon the publication of the PMCD Blue Grass Notice of Intent (NOI). The results of the ACWA EIS, demonstrations, and engineering design studies will be considered with other information during a Defense Acquisition Executive (DAE) Review, which will determine the best approach for the destruction of the chemical stockpile at Blue Grass.

C. National Environmental Policy Act

1. Environmental Effects of ACWA Actions

NEPA sets forth policy, responsibilities and procedures for integrating environmental considerations into Army actions. A Notice of Intent to prepare an EIS for the ACWA program was published April 14, 2000. This EIS will examine the potential impacts of the design, construction and operation of one or more pilot test facilities for assembled chemical weapons destruction technologies at one or more chemical weapons stockpile sites, potentially simultaneously with any existing demilitarization programs and schedules at these sites. The size of the pilot tests and the location of the test facilities will be determined in this process.

While all of the chemical stockpile sites were initially believed to be potential test sites, Edgewood Chemical Activity in Maryland, Newport Chemical Depot in Indiana, Deseret Chemical Depot in Utah, Umatilla Chemical Depot in Oregon, and Johnston Atoll in the Pacific Ocean have been eliminated from any consideration. Chemical stockpile sites at Edgewood and Newport will not be considered because no assembled chemical weapons are at those locations. Johnston Atoll will not be considered because all chemical weapons at the site will be destroyed before the EIS can be completed. Deseret Chemical Depot in Utah and Umatilla Chemical Depot in Oregon are not being considered because the schedule for those plants indicates that the assembled chemical weapons will be destroyed prior to the time that a pilot facility would be operational.

Sites at Anniston Chemical Activity in Alabama, Pine Bluff Chemical Activity in Arkansas, Pueblo Chemical Depot in Colorado, and Blue Grass Chemical Activity in Kentucky are being considered.

Technologies under consideration include those technologies that have been recommended to Congress as viable under the ACWA demonstration program. However, Public Law 106-398, section 151, limits the alternative technologies that can be considered for destruction of the stockpile at the Pueblo Chemical Depot to those demonstrated before May 1, 2000 – a limitation that has the effect of excluding consideration of Demonstration II technologies at Pueblo. The ACWA pilot tests will not halt or delay the operation or construction of any baseline incineration facility currently in progress.

During scoping meetings, PMACWA identified significant issues related to the proposed action. Information was gathered on concerns regarding the testing and/or operation of multiple technologies at these sites, the scale of the pilot test facilities, impacts on local land use and business, and impacts on health and the ecosystem.

The ACWA EIS has been coordinated with two other EIS documents for the destruction of the chemical stockpile at Pueblo, Colorado, and Blue Grass, Kentucky. The PMCD Pueblo site-specific EIS has been coordinated with the ACWA Program EIS on schedule, environmental analysis criteria, and internal and external review agencies. The PMCD Blue Grass site-specific EIS has been coordinated in a similar fashion. The schedule for the PMCD Blue Grass site-specific EIS, however, lags behind the schedule for the ACWA Program EIS by approximately six months due to the publication of the NOI for the Blue Grass site-specific EIS in December 2000.

2. Schedule of NEPA Activity

The NOI for the ACWA Program EIS was published April 14, 2000 for a 30-day public comment period. Scoping meetings were held at the four candidate alternative technology sites during May 2000. Public comments on the NOI were recorded as part of the administrative record.

The first internal review of the draft EIS will take place in mid-February 2001. An early draft will be provided to the EPA, the Department of Fish and Wildlife, the Department of Health and Human Services, and each state of the corresponding site. A notice of availability of the draft EIS is scheduled to be published in March 2001 for public comment, at which time the ACWA staff will be available for onsite public meetings if requested by local citizens or elected officials. These public meetings will be held during a 45-day public comment period that begins with the publication of the draft EIS.

A Notice of Availability of the final EIS is scheduled to be published in the Federal Register in July 2001. Documentation of the DOD and Army decisions will follow in the ROD approximately one month later.

V. BROAD AGENCY ANNOUNCEMENT

At the May 1997 Dialogue Meeting in Colorado Springs, the Dialogue recommended that DOD issue a Broad Agency Announcement (BAA) to prevent the exclusion of any potential and promising partial alternative technologies that cannot meet the "total program solution" requirement of the Go/No-Go Criteria. In an effort to do this, a BAA was issued and PMACWA received over 25 proposals from technology providers.

A BAA Work Group, comprised of Dialogue members and ACWA technical staff, was formed to track and evaluate the BAA proposals and assess their merit for the ACWA Program. This work group included six members from the Dialogue and two participants from ACWA with help from the ACWA support contractors, SBR Technologies and Arthur D. Little.

The BAA Work Group concluded that none of the proposals merit investment by the ACWA Program.

VI. NATIONAL RESEARCH COUNCIL

At the request of PMACWA and as required by Public Law 105-261 (1999), the National Research Council (NRC) Committee on Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons: Phase 2 (ACW II Committee) is conducting independent scientific and technical assessments for the ACWA program. This effort is divided into three tasks. For the first task, the NRC will review and evaluate demonstration test (Demonstration II) results for three technologies that offer an alternative to incineration for destroying assembled chemical weapons located at U. S. weapons sites. Each of these technologies has previously passed the PMACWA threshold (Go/No-Go) criteria. Based on its present evaluation, the NRC will determine if the demonstration test results of these technologies indicate a readiness level sufficient for pilot-scale testing. Tasks 2 and 3, EDS Pueblo and EDS Blue Grass, involve the assessment of Engineering Design Packages based on two previously demonstrated alternative technologies that have potential for implementation at storage sites in Pueblo, Colorado, or Blue Grass, Kentucky. The results of each study will be described in three NRC reports scheduled for completion in July (EDS Pueblo), August (Demonstration II), and December (EDS Blue Grass) of 2001. The reports concerning the site-specific engineering design packages are expected to play a critical role in the DOD Records of Decision for the selection of a technology for chemical agent destruction at Pueblo, Colorado, and Blue Grass, Kentucky.

The NRC ACW II Committee consists of 14 distinguished scientists and engineers that are highly regarded for their work in chemical process engineering, safety and risk analysis, environmental waste management, biochemical engineering, hazardous waste treatment, energetics, and public involvement. The former ACW I Committee chair, Dr. Robert Beaudet, has agreed to hold this position for the ACW II Committee. Approximately two thirds of members of the initial ACW Committee were nominated and approved by the NRC to serve on the ACW II Committee. The ACW I Committee provided the first NRC reports on alternative technologies for assembled chemical weapons.

The full NRC committee met three times this year for the purposes of gathering information and formulating early drafts of their reports. During one of these meetings, the committee received extensive briefings from the six technology providers involved in this work. Members of the CATT for the ACWA program have also addressed the ACW II Committee. In addition to its meetings, the committee has conducted visits to three assembled weapons storage sites and three unit cell operation sites to observe equipment demonstration tests. During the site visits, technology provider personnel have been available to discuss operational developments and observations with committee members. Representatives from NRC and the committee have also attended the PMACWA Industry Day, PMACWA-sponsored meetings at Aberdeen, Maryland, and meetings of the Citizens Advisory Commission and ACWA Dialogue Group in Pueblo, Colorado. The ACW II Committee has also participated in PMCAWA's working meetings and reviews of the proposed technologies. At this time, outlines for all three reports and initial drafts for chapters in the first two reports have been completed.

VII. NEXT STEPS

A. Demonstration II Technology Evaluation

The assessment of the Demonstration II technologies will be performed by ACWA's Program Evaluation Team (PET) in conjunction with representatives from the Dialogue. Using the previously approved program implementation criteria, the PET and Dialogue representatives will assess each of the Demonstration II technologies in the same manner as performed on the Demonstration I technologies. The information for these assessments will come from the demonstration data, ACWA milestone reports, the technology provider's report, and all documentation previously submitted by the technology providers. The assessment will strive for consensus by all members of the PET and the representatives from the Dialogue. The process will assess each technology independently against the implementation criteria. At the completion of the assessment process a detailed report with conclusions and recommendations will be prepared and submitted to PMACWA.

B. Supplemental Report

The Supplemental Report to Congress will include the results of the Demonstration II testing program. Each technology provider's data from the demonstration program will be evaluated against the program implementation criteria. PMACWA will provide conclusions to Congress on those technologies that are successfully demonstrated and have a high likelihood of being implemented at the full-scale level. In summary, these would be technologies that, at a minimum, meet or exceed the following goals defined in the implementation criteria:

- Performance – demonstrated ability to destroy chemical munitions in a safe and environmentally acceptable manner,
- Schedule – comparable schedule to that of baseline,
- Cost – comparable cost to that of baseline, and
- Public Acceptance – community willingness to accept technology.

Technologies would be viable to advance to the next phase – pilot-scale testing – depending on the degree to which they meet, exceed, or fall below these goals.

C. Engineering Design Studies II

Engineering Design Studies are planned for FY01 on the alternative technologies that are validated under the ACWA Demonstration II Test Program. PMACWA has budgeted $50M in FY01 to conduct Engineering Design Studies II (EDS II). These technologies can include AEA Technology (SILVER II™), Foster Wheeler/Eco Logic (neutralization followed by SCWO and GPCR), and Teledyne-Commodore (SET™). The objectives of EDS II will be the same as EDS I and are as follows:

- Support the certification decision of the Under Secretary of Defense for Acquisition, Technology, and Logistics as directed in Public Law 105-261 for a full-scale facility with respect to:
  - Total life cycle cost,
  - Schedule, and
  - Safety; and
- Support the contract Request for Proposal for a full-scale pilot facility.

PMACWA has identified a strategy and a projected schedule for EDS II that will be conducted in the next fiscal year. The schedule for EDS II is aggressive, but it can be accomplished. In accordance with Public Law 105-261, the alternative technologies must be validated under the ACWA Program and must be certified in cost, schedule, and safety by the Under Secretary of Defense for Acquisition, Technology and Logistics. The Notice of Intent for Pueblo was published in April 2000; therefore, the ROD is expected in August 2001. Because Public Law 106-398, section 151, precludes consideration of technologies demonstrated after May 1, 2000, and Demonstration II occurred from July to October 2000, these technologies cannot be considered in the NEPA process for the Pueblo Chemical Depot.

The NOI for Blue Grass will be published in early December 2000. The ROD for Blue Grass is expected in April 2002, 18 months after the NOI for the preparation of an EIS. It is expected that the certification process will take approximately six months after delivery of the Final Draft Engineering Design Package. In order to meet the April 2002 ROD date and requirements for certification, the Final Draft Engineering Design Package must be submitted in September 2001. The Final Draft Engineering Design Package includes engineering drawings and documents, life cycle cost estimates, life cycle schedules, and a preliminary hazards analysis.

PMACWA has established a projected schedule for EDS II and initiated planning for the EDS II testing and engineering design packages based on the projected ROD date for Blue Grass. PMACWA is working with the technology providers to finalize what testing is necessary for EDS II if those technologies are indeed validated.

PMACWA has already begun plans for executing the EDS II test program in advance of the submission of the Supplemental Report to Congress. These plans include contract awards for long lead items and development of detailed study plans. In October 2000, PMACWA requested a technical and cost proposal from the Demonstration II technology providers. It is anticipated that long lead design and procurement will be authorized in December 2000. It is also anticipated that the EDS II contracts could be awarded after the completion of the technical evaluation. In most cases, the test equipment from Demonstration II will be used in EDS II with some modification and optimization. The goal of EDS II testing is to complete all the required testing to finalize the preliminary full-scale designs prior to the delivery of the Draft Final Engineering Design Package in September 2001.

Appendix A

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Dialogue on Assembled Chemical Weapons Assessment
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Appendix B

Demonstration II Alternative Technology Descriptions

Demonstration II Alternative Technology Descriptions

AEA Technology/CH2MHill

The approach proposed by AEA Technology and CH2MHill for a total solution for the destruction of all assembled chemical weapons uses baseline reverse assembly (projectiles and mines) or modified reverse assembly (rockets) for chemical access, AEA Technology's patented SILVER II™ process for destroying chemical agent and energetics, a Metal Parts Treater for the treatment of metal parts, and a Rotary Dunnage Treater for the treatment of dunnage.

Modifications to reverse assembly for accessing rockets include water jet cutting, burster washout, propellant push-out and milling. Rockets are punched and drained to remove the chemical agent. The agent is treated in the SILVER II™ process. Fuzes and warhead are sheared in the baseline Rocket Shear Machine and then deactivated in the Energetics Deactivation Chamber. The burster is then washed out. Once the propellant is exposed, it is pushed out and milled. The washed out burster and milled propellant are treated in the SILVER II™ process.

The energetics are treated in a separate SILVER II™ unit. The metal fragments are processed in the Metal Parts Treater. Shredded dunnage is treated in a Rotary Dunnage Treater. The concept of the Metal Parts Treater and the Rotary Dunnage Treater is similar to the unit operations tested under Demonstration I in 1999.

The SILVER II™ process uses an electrochemical cell containing nitric acid to generate silver (II) ions. Energetics and agents are oxidized either directly by the silver (II) ions or by other oxidizing compounds produced from reactions involving silver (II) ions. The process operates at 190°F and near atmospheric pressure (14.7 psia). All effluents from the SILVER II™ process will be contained and tested to be agent free before release, recycling or disposal.

Foster Wheeler/Eco Logic

The approach proposed by Foster Wheeler/Eco Logic for a total solution for the destruction of all assembled chemical weapons uses modified reverse assembly to separate agent, energetics, and metal parts; chemical neutralization followed by supercritical water oxidation (SCWO) of the liquid and gas phase chemical reduction (GPCR) of the gas for treatment of the agent/energetics; and GPCR for treatment of the metal parts and dunnage.

The method chosen for munitions access is slightly modified from that used in the baseline incineration process. For projectiles, a horizontal punch and drain mechanism is utilized. For rockets, the rocket is sheared so the propellant can be pushed out of the casing and subsequently masticated/ground while under caustic solution. The neat agent and energetics undergo caustic hydrolysis in separate stirred tank vessels.

Once the agent and energetics are neutralized, agent and energetic hydrolysates are combined and fed to the SCWO system. The Foster Wheeler technology uses a transpiring wall reactor to prevent corrosion and plugging due to salt deposition. A continuous supply of clean water is introduced at the inside surface of a detached reactor liner. This water creates a continuous film on the liner protecting it from corrosion and salt deposition. The SCWO process oxidizes the remaining Schedule 2 products and other organic constituents of the hydrolysates in an aqueous, high temperature and pressure environment. Liquid effluent from the SCWO process is sent to an evaporator where the water is recycled and remaining salts are disposed of by landfill. The inherently scrubbed gaseous effluent is sent to charcoal filters before being released to the atmosphere.

The residual, washed out metal parts, dunnage, solid process wastes, and gaseous emissions from the neutralization process are fed to the GPCR system. By heating in a hydrogen-rich atmosphere that also includes steam, metal parts and dunnage items are decontaminated to a 5X level[1] and volatile organic vapors are chemically reduced. The decontaminated solids can then be disposed. The gaseous effluent is scrubbed and used as a fuel to generate steam in the boiler.

Both Foster Wheeler and Eco Logic were originally part of a larger team under the coordination of Lockheed Martin when the original proposal of a "total solution" for assembled chemical weapons demilitarization was submitted in 1997. Foster Wheeler and Eco Logic contributed the two most unique individual components to the Lockheed Martin total solution package; namely, the SCWO and GPCR systems. After the Program Manager for Assembled Chemical Weapons Assessment (PMACWA) chose the first three technology providers for demonstration testing in 1999, the formal Lockheed Martin teaming agreement dissolved. When PMACWA received additional funding and the Congressional mandate to test the three remaining technology providers in 2000, Foster Wheeler and Eco Logic were both willing to demonstrate their respective technologies without Lockheed Martin's involvement. They also agreed to retain their original association and the combination of their individual technologies as part of an overall total solution package. To help in this effort, another former Lockheed Martin team member, Kvaerner John Brown Services, Inc. (Kvaerner), was retained to continue its original role of developing the overall total solution design. Kvaerner is responsible for incorporating test data from the demonstration of Foster Wheeler and Eco Logic's unit operations into the total solution design. Thus, Foster Wheeler, Eco Logic, and Kvaerner together represent a single total solution.

Teledyne-Commodore

The approach proposed by Teledyne-Commodore for a total solution for the destruction of all assembled chemical weapons uses high-pressure fluid jet cutting/washout for munition access, followed by Solvated Electron Technology™ (SET™) for chemical and energetic destruction.

[1] 5X decontamination refers to chemical agent decontamination achieved through treatment at 1000°F for 15 minutes.

The Teledyne-Commodore total solution uses Ammonia Fluid Jet Cutting and Washout to access the chemical agents and energetics from the munitions, and to transfer the materials for downstream processing in the SET™ and oxidation subsystems. The munitions accessing area receives the munitions, places them in a short-term staging area, and provides for the handling and unpacking processes. A pressurized fluid jet is used for accessing agent and energetic within the munitions and separating them from the associated metal parts. The pressurized jet stream exits the orifice of the fluid jet cutting system at very high velocities, producing precise cuts. The exact sequence of the cutting operation is dependent on the munition being accessed. Generally, the sequence includes fuze removal (the fuze is removed to an explosive containment box where it is initiated and the residue transferred to downstream processing) followed by cuts to access the explosives and the agent.

Agent removal is achieved by draining and fluid jet washout of the munition agent cavity. The agent-containing fluid is transferred at a controlled rate for downstream processing. Energetics removal is also achieved by fluid jet washout to erode the explosive materials. Once the energetic material has either been dissolved or slurried, it is transferred from the munition access vessel to a collection vessel for downstream processing.

The metal parts associated with the munitions are transferred to a shredder to be size-reduced and are then processed with SET™ to be decontaminated to a 3X condition[2]. The 3X condition, per Army regulation 385-61, allows shipment to the Army-approved metal recycling facility at Rock Island Arsenal in Illinois. All dunnage (demilitarization protective ensemble suits, wood, fiberglass, carbon, etc.) also are size-reduced in a shredder and decontaminated with SET™. An oxidation step is not conducted for the metal parts or dunnage processing.

The washout materials from the munitions accessing step (agents and energetic materials either dissolved or slurried in ammonia solution) are transferred to collection vessels for subsequent processing with SET™ solution followed by oxidation. The solvated electron reaction is accomplished in a solution prepared by dissolving sodium in anhydrous liquid ammonia. Due to the presence of large amounts of dissociated electrons, the SET™ solution provides a reducing environment capable of breaking covalent bonds.

The Agent SET™ Reactor is designed to operate in a continuous mode and the Energetics, Metals, Fuze Parts, and Dunnage SET™ Reactors are designed to operate in batch mode. The solid and liquid effluents from SET™ Reactors (for agent and energetics only) are treated in a batch mode in their respective Chemical Oxidation Reactors. The residues from the Agent SET™ Reactor and the Energetics SET™ Reactor are oxidized to produce nontoxic stable waste in forms that can be disposed of per U.S. Environmental Protection Agency regulations in a Resource Conservation and Recovery Act (RCRA) landfill. In cases where lead-containing energetics (e.g., M28) are processed, a stabilization step is required prior to disposal in a RCRA landfill. Liquid products, mainly ethanol and isopropanol, are separated downstream of the Oxidation Reactor. Process offgas, generated in the SET™

[2] 3X decontamination indicates an item has been surface decontaminated, bagged, or contained and that appropriate tests have verified that vapor concentrations do not exist above 0.0001 mg/m^3 for GB, and 0.00001 mg/m^3 for VX.

Reactors and containing traces of ammonia, hydrogen, and light hydrocarbons, is held and tested, then passed through a dual-bed charcoal system and used as supplementary fuel for heating. Practically all of the ammonia used in the process is recovered and recycled.

Appendix C

Demonstration II Test Program

Demonstration II Test Program

Demonstration II Planning

The primary product of the demonstration planning process was a Demonstration Test Matrix for each technology provider. These matrices were carefully developed so that the technology demonstrations could meet requirements of Public Law 104-208 and the Conference Report accompanying Public Law 106-79 (House Report 106-371), and be responsive to the Program Implementation Criteria. For each technology, a consensus was reached on the critical unit operations to be tested, and the definition of clear, concise, and measurable test objectives for each of those critical unit operations. Specific elements of the test matrices included the following:

- Unit operations to be demonstrated,
- Feed materials (type and quantity),
- Test location(s),
- Number/duration of test runs,
- Process monitoring parameters,
- Utility requirements,
- Operating personnel requirements,
- Sampling locations/methodologies/frequency,
- Analytical methodologies/validation,
- Quality Assurance/Quality Control (QA/QC) program,
- Data requirements/reduction, and
- Final report requirements.

These test matrices were the core of the Demonstration Study Plan and were essentially the core of each demonstration test. There were several demonstration issues and considerations that were identified during the demonstration planning process that were generic to all the technologies to be demonstrated. The major issues and considerations are summarized below:

- *Polychlorinated biphenyls (PCBs).* PCBs were not tested as part of the demonstration, since doing so would have triggered regulatory requirements under the Toxic Substances Control Act that would have added considerably to the cost and difficulty of the demonstration.
- *Pentachlorophenol (PCP).* PCP was spiked onto all wood used for the demonstration tests for all dunnage treatment technologies to simulate wood preserved with PCP.
- *Baseline Operations*. It was determined that processes used in the baseline operations such as reverse assembly, brine reduction, condensers, gas scrubbers, and carbon filtration were not necessary to demonstrate due to the available database.

Feed material was provided in the configuration anticipated from baseline or modified baseline reverse assembly.

- *Environmental and Regulatory Compliance*. Compliance was achieved at each site following all federal, state, Army, local, and facility environmental regulations. The safety standard operating procedure (SOP) and the pre-operation survey ensured the application of environmental regulations. Operational activities, chemical method development, and waste storage and disposal followed all applicable environmental guidelines. In addition, the demonstrations were conducted under treatability studies coordinated with the states of Utah and Maryland to increase the amount of material that could be treated under the Resource Conservation and Recovery Act treatability study regulation. There were several examples where environmental and regulatory compliance impacted the demonstration tests. As discussed above, PCBs were not tested. Another example was in the method for producing the M28 propellant hydrolysate. The lead stearate from the M28 had to be added to the hydrolysate at the test site rather than at the site where the M28 hydrolysate was produced to prevent the hydrolysate from being considered a hazardous waste by the U.S. Environmental Protection Agency.
- *Treaty Compliance*. All related testing conducted under the Assembled Chemical Weapons Assessment (ACWA) Demonstration Program was done in compliance with the Chemical Weapons Convention and witnessed by treaty inspectors. Transparency measures (to verify and document) dealing with compounds generated in the neutralization processes were approved by the Organization for the Prohibition of Chemical Weapons Executive Council.

Test Facility Support

Due to the limited time to complete the tests (not being able to construct new facilities), the nature of the demonstration program requiring use of agent and energetics, and the need to maintain government independence in conducting the testing, there were a limited number of qualified facilities. The demonstration equipment needed to be configured so that the tests could be carried out in the designated facility and meet all requirements associated with that facility.

Demonstration testing of the proposed technologies was conducted at three Army test sites: Aberdeen Proving Ground, Maryland; Deseret Chemical Depot, Utah; and Dugway Proving Ground, Utah. The Pantex Plant in Amarillo, Texas and Radford Army Ammunition Depot in Radford, Virginia, were used to generate energetics hydrolysates. A summary of the test facilities that were used for the ACWA demonstrations and the unit operations that were demonstrated can be found in Table C-1. All of these facilities had a number of common elements, which were a requirement for the ACWA demonstrations. The facilities had redundant containment mechanisms and safety systems to virtually eliminate the potential for releases to the environment. In addition, protocols were already in place to ensure safe management of any materials used in the demonstrations.

For each test facility, modifications or renovations were completed by test site personnel, their contractors, or the technology providers. The test sites and their contractors assisted the technology providers with the installation and systemization of the test equipment; however, the test sites were solely responsible for conducting the demonstration tests. The technology providers thoroughly trained all test operators. The test sites also prepared the necessary SOPs and test plans, as required by the installation. The test sites were also responsible for the collection and shipment of analytical samples (with the exception of gas samples, which were collected by ACWA contractors).

Table C-1. Summary of Test Facilities for ACWA Demonstrations

Test Site	Unit Operation (Technology Provider)	Test Facility
Aberdeen Proving Ground, MD—Aberdeen Test Center	SILVER II™ – 12 kW Energetics System (AEA Technology/CH2MHill)	Fire Safety Test Enclosure
Aberdeen Proving Ground, MD—Edgewood Chemical and Biological Center	SILVER II™ – 2 kW Agent System (AEA Technology/CH2MHill)	Toxic Test Chamber (Building E3566)
	Gas Phase Chemical Reduction (Eco Logic)	Toxic Test Chamber (Building E3726)
	Neutralization Reactor System for HD (generated by Program Manager)	Chemical Transfer Facility
Deseret Chemical Depot, UT—Chemical Agent Munitions Disposal System	Solvated Electron Technology/Chemical Oxidation - Agent (Teledyne-Commodore)	Chemical Test Facility
Dugway Proving Ground, UT—West Desert Test Center	Rocket Cutting and Washout System (Teledyne-Commodore)	Suppressive Shield Facility (Building 8321)
	Solvated Electron Technology/Chemical Oxidation - Energetics (Teledyne-Commodore)	Suppressive Shield Facility (Building 8321)
	Solvated Electron Technology - Dunnage (Teledyne-Commodore)	Suppressive Shield Facility (Building 832l)
	Supercritical Water Oxidation Unit (Foster Wheeler)	Chemistry Laboratory (Building 4165)
Pantex Plant, TX	Neutralization Reactor System for Comp B and Tetrytol (generated by Program Manager)	Hydrolysis Pilot Plant (Building 11-36)
Radford Army Ammunition Plant, VA	Hydrolysis Reactor Vessel for M28 Propellant (generated by Program Manager)	N/A

Analytical Support

The technology providers were responsible for providing all analytical methods and procedures for the constituents in each test. Any nonstandard methods provided by the technology provider needed to be validated in an independent laboratory designated by the government, prior to their use in the analysis of any demonstration samples. In some cases, samples could not be analyzed because standard methods did not exist, and new methods were not developed.

Prior to demonstration testing, a total of 78 analytical method evaluation studies were conducted. Twenty of these studies, undertaken by government laboratories, involved the analysis of energetics, agents, and associated breakdown products in various matrix solutions prepared to represent the solutions expected from the demonstration tests. The U.S. Army Center for Health Promotion and Preventive Medicine conducted six evaluations; five for the analysis of energetic materials in different mixtures, and one for the analysis of chromium IV in one matrix. The analytical laboratories at Edgewood Chemical and Biological Center and Chemical Agent Munitions Disposal System conducted 14 method evaluation studies for the analysis of agents and Schedule 2 compounds. The remaining 58 method evaluations were undertaken by commercial analytical laboratories. Analytical methods were considered to be validated if they met the precision and accuracy requirements stipulated in the Program Manager's QA/QC plan and/or, based on professional judgment, they could be effectively used to evaluate the technologies tested and provide information to meet the objectives of the demonstration tests.

Summary of Demonstration II Testing

AEA Technology/CH2MHill

Unit Operation: **2-kW Silver II™ System**
Test Location: Edgewood Chemical and Biological Center - Building E3566

FEED	PLANNED		ACTUAL	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)[1]**
Simulants				
CEES (HD simulant)	44 lbs	1 (10 days)	Not Conducted[2]	Not Conducted[2]
DMMP (VX simulant)	31 lbs	1 (7 days)	31 lbs[3]	1 (5 days) [3]
Agent				
HD Agent	35 lbs	1 (7 days)	35 lbs	1 (7 days)
VX Agent	22 bs	1 (7 days)	9 lbs[3]	1 (4 days) [3]
GB Agent	35 lbs	1 (7 days)	35 lbs	1 (7 days)

1. Workup (practice) runs were also planned for CEES and VX. However, the VX workup run was not conducted due to schedule constraints and chlorobenzene was substituted for CEES as the HD workup run.
2. CEES was not conducted due to projected schedule constraints.
3. The quantity of VX agent was reduced due to schedule constraints.

Unit Operation: **12 kW Silver II™ System**
Test Location: Aberdeen Test Center - Fire Safety Test Enclosure

FEED	PLANNED		ACTUAL	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)[1]**

Agent Simulants				
CEES (HD simulant)	220 lbs	1 (9 days)	Not Conducted[2]	Not Conducted[2]
DMMP (VX simulant)	220 lbs	1 (8 days)	88 lbs[3]	1 (7 days)
Energetics				
M28 Propellant	440 lbs	1 (8 days)	308 lbs[3]	1 (8 days)
Tetrytol	220 bs	1 (8 days)	220 lbs	1 (18days)
Comp B	220 lbs	1 (8 days)	Not Conducted[2]	Not Conducted[2]

1. Workup (practice) runs were also planned for CEES and M28 propellant; however, the CEES workup run was not conducted due to schedule constraints.
2. CEES and Comp B were not conducted due to schedule constraints.
3. The quantity of DMMP and M28 propellant was reduced due to schedule constraints.

Foster Wheeler/Eco Logic

Unit Operation: **Foster Wheeler Supercritical Water Oxidation**
Test Location: Dugway Proving Ground - Building 4165

FEED	**PLANNED**		**ACTUAL**	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)[1]**
Agent & Energetic Hydrolysates				
VX Simulant	6,000 lbs	1 (100 hrs)	6,000 lbs	1 (100 hrs)
HD/Tetrytol/Aluminum Hydrolysate	6,000 lbs	1 (100 hrs)	3,300 lbs	1 (55 hrs)[2]
GB/Comp B/Aluminum Hydrolysate	6,000 lbs	1 (100 hrs)	3,000 lbs	1 (50 hrs)[3]
VX/Comp B/M28/ Aluminum Hydrolysate	6,000 lbs	1 (100 hrs)	1,560 lbs	1 (26 hrs)

1. Workup (practice) runs were also conducted for all feeds.
2. HD/Tetrytol Hydrolysate Validation Run was terminated at 55 hours due to schedule limitations and reactor issues. HD hydrolysate was used for the first 19 hours followed by 36 hours with HD hydrolysate simulant. It was necessary to use simulant to maximize use of actual hydrolysate under environmental permit restrictions and obtain long-term runs.
3. GB/Comp B/Aluminum Hydrolysate Validation Run was shortened to 50 hours due to schedule limitations and reactor issues. GB hydrolysate was used for the first 28 hours followed by 22 hours with GB hydrolysate simulant. It was necessary to use simulant to maximize use of actual hydrolysate under environmental permit restrictions and obtain long-term runs.

Unit Operation: **Eco Logic Gas Phase Chemical Reduction**
Test Location: Edgewood Chemical and Biological Center - Building E3726

FEED	**PLANNED**		**ACTUAL**	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)**[1]
Dunnage				
Carbon Trays	50 lb tray	3 (36 hrs ea.)	50 lb tray	3 (9 hrs ea.)
Wood spiked w/ PCP	22 lbs	3 (38 hrs ea.)	22 lbs	3 (24 hrs ea.)
DPE/Butyl Rubber/Bags	18 lbs	3 (46 hrs ea.)	18 lbs	3 (36 hrs ea.)
Fiberglass Firing Tubes	4 lbs	3 (28 hrs ea.)	4 lbs	3 (6 hrs ea.)
Agent				
GB Agent	11 lbs	3 (16 hrs ea.)	8-11 lbs[2]	3 (12 hrs ea.)
Mortar w/ simulated 30% HD Heel	16 lbs metal, 2 lbs HD	3 (25 hrs ea.)	16 lbs metal, 2 lbs HD	2 (9 hrs ea.)[3]

1. Workup (practice) runs were also conducted for all dunnage and GB agent. A workup run was planned for the mortar w/ simulated 30% heel, but it was not conducted due to schedule constraints. Validation runs were shorter than planned due to better than expected system performance.
2. For the GB Validation Runs, approximately 8 lbs were fed for Run #1, >9 lbs for Run #2, and 11 lbs for Run #3.
3. One Validation Run of a mortar with simulated 30% HD Heel was not performed due to schedule constraints.

Teledyne-Commodore

Unit Operation: **Ammonia Fluid Jet Cutting/Washout**
Test Location: Dugway Proving Ground – Suppressive Shield Facility

FEED	**PLANNED**		**ACTUAL**	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)**[1]
Munitions				
M60 INERT Rocket (no energetics; no agent; ethylene glycol removed)	1 rocket	15 (1 hour – cutting only)	1 rocket	15
M61 Rocket (contained Comp B and M28; no agent; ethylene glycol was removed)	1 rocket	3 (4 hours – cutting and washout)	Not Conducted[2]	Not Conducted[2]

1. Workup (practice) runs were also conducted for M60 rockets (4) and M61 rockets (2)
2. Validation runs for the M61 rocket were not conducted due to the energetic ignition of the M28 propellant during Workup Run #2 and schedule constraints.

Unit Operation: **SET™/Oxidation - Energetics**
Test Location: Dugway Proving Ground – Suppressive Shield Facility

FEED	**PLANNED**		**ACTUAL**	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)[1]**
Energetics				
Comp B from M61 rockets	3.14 lb	3	Not Conducted[2]	Not Conducted[2]
M28 Propellant from M61 rockets	19.1 lb	3	Not Conducted[2]	Not Conducted[2]
Bulk Tetrytol	15 lbs	3	Not Conducted[2]	Not Conducted[2]
Cement Stabilization of Oxidation Products of M28 Processing	2 gallons	3	Not Conducted[2]	Not Conducted[2]

1. One workup (practice) run was conducted for the Comp B and M28 Propellant.
2. Energetics were not conducted due to the energetic ignition of the M28 propellant during Workup Run #2 and schedule constraints.

Unit Operation: **SET™ – Dunnage/Metal Parts**
Test Location: Dugway Proving Ground – Suppressive Shield Facility

FEED	**PLANNED**		**ACTUAL**	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)[1]**
Dunnage/Metal Parts – Feed Preparation				
DPE/Butyl/Bags	500 lbs	1 (as req'd)	518 lbs	1
Wood Pallets	30 lbs	1 (as req'd)	52 lbs	1
Fiberglass Firing Tubes	40 lbs	1 (as req'd)	54 lbs	1
M42A1 4.2-inch Mortars	350 lbs	1 (as req'd)	362 lbs[2]	1
Dunnage/Metal Parts – Process Operation				
Shredded DPE/Butyl/Bags spiked with Simulant	5 lbs	3 (8 hours)	5 lbs	3 (<8 hours)
Shredded Wood Pallets spiked with Simulant & Pentachlorophenol (PCP)	5 lbs	3 (8 hours)	5 lbs	3 (<8 hours)
Carbon spiked with Simulant	5 lbs	3 (8 hours)	5 lbs	3 (<8 hours)
Shredded Fiberglass Firing Tubes spiked with Simulant	5 lbs	3 (8 hours)	5 lbs	3 (<8 hours)
Shredded M42A1 4.2-inch Mortars spiked with Simulant	5 lbs	3 (8 hours)	5 lbs	3 (<8 hours)

1. No workup (practice) runs were planned nor conducted.
2. The quantity of mortars was reduced to 350 lbs since the weight of 40 mortars was lower than expected.

Unit Operation: **SET™/Oxidation - Agent**
Test Location: Chemical Agent Munition Disposal System – Chemical Test Facility

FEED	PLANNED		ACTUAL	
	Quantity per Validation Run	**# of Validation Runs (Duration)**	**Quantity per Validation Run**	**# of Validation Runs (Duration)[1]**
Agent				
GB Agent	10 liters (24 lbs)	3 (~5 hrs SET, ~4 hrs Oxidation)	Not Conducted[2]	Not Conducted[2]
VX Agent	10 liters (22 lbs)	3 (~5 hrs SET, ~4 hrs Oxidation)	Not Conducted[2]	Not Conducted[2]
HD Agent	5 liters (14 lbs)	3 (~5 hrs SET, ~4 hrs Oxidation)	Not Conducted[2]	Not Conducted[2]

1. Two workup (practice) runs were planned for each agent but not conducted.
2. No agent testing was conducted due to cost overruns and schedule constraints.

Appendix D

Acronyms/Abbreviations

ACRONYMS/ABBREVIATIONS

ACWA	Assembled Chemical Weapons Assessment
AFJC&W	Ammonia Fluid Jet Cutting and Washout System
APG	Aberdeen Proving Ground (Maryland)
BAA	Broad Agency Announcement
BGCDF	Blue Grass Chemical Agent Disposal Facility
BIF	Boiler and Industrial Furnace
CAMDS	Chemical Agent Munitions Disposal System (Utah)
CatOx	Catalytic Oxidation
CATT	Citizens' Advisory Technical Team
CDPHE	Colorado Department of Public Health and Environment
CEES	Chloroethyl Ethyl Sulfide
CO_2	Carbon Dioxide
CST	Continuous Steam Treater
CWC	Chemical Weapons Convention
DAE	Defense Acquisition Executive
DCD	Deseret Chemical Depot (Utah)
DMMP	Dimethyl Methylphosphonate
DOD	Department of Defense
DPE	Demilitarization Protective Ensemble
DPG	Dugway Proving Ground (Utah)
DRE	Destruction and Removal Efficiency
DSHS	Dunnage Shredding and Hydrolysis System
DWG	Demonstration Working Group
ECBC	Edgewood Chemical and Biological Center (Maryland)
EDS	Engineering Design Studies
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERH	Energetics Rotary Hydrolyzer
FY	Fiscal Year
GPCR	Gas Phase Chemical Reduction
H_2O	Water
ICB™	Immobilized Cell Bioreactor
IIPT	Integrating Integrated Process Team
IITRI	Illinois Institute of Technology Research Institute
kW	Kilowatt
NEPA	National Environmental Policy Act
NOI	Notice of Intent
NRC	National Research Council
PCBs	Polychlorinated Biphenyls
PCD	Pueblo Chemical Depot
PCP	Pentachlorophenol
PET	Program Evaluation Team
PMACWA	Program Manager Assembled Chemical Weapons Assessment
PMCD	Program Manager Chemical Demilitarization

PUCDF	Pueblo Chemical Agent Disposal Facility
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
ROD	Record of Decision
SCWO	Supercritical Water Oxidation
SET™	Solvated Electron Technology
SOP	Standard Operating Procedure
TNT	Trinitrotoluene
U.S.	United States
WIPT	Working Integrated Process Team