ENGINEERING DESIGN TEST RESULTS FOR THE IMPROVED LARGE ITEM TRANSPORTABLE ACCESS AND NEUTRALIZATION SYSTEM (LITANS)

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Introduction. The Large Item Transportable Access and Neutralization System (LITANS) is a transportable chemical agent accessing and neutralization system with the capability to treat one-ton agent container fills or large recovered chemical warfare materiel (RCWM) outside the scope of current Project Manager for Non-Stockpile Chemical Materiel (PMNSCM) mobile systems. LITANS is presently in the U.S. Army System Development and Demonstration acquisition lifecycle phase.

This paper provides detailed information regarding the Engineering Design Test (EDT) of the LITANS at Aberdeen Proving Ground-Edgewood Area, Maryland between 15 May and 28 July 2006. During the first phase of the EDT, water-filled items were accessed and had their contents transferred to prove the systems ability to move liquid fills. The second phase of the EDT saw phosgene-filled bottles accessed and their gaseous fills transferred to the reactor for neutralization. Data was collected to support the assessment of the system against established criteria. The primary test objective was satisfied; namely, it was demonstrated that the chemical fill in a munition could be safely and effectively transferred to a reactor where it could then be neutralized.

Background. The Project Manager for Non-Stockpile Chemical Materiel (PMNSCM) has the responsibility for disposal of the U.S. Army's recovered chemical warfare materiel (RCWM). Public Law 99-145 requires the U.S. Army[1] to carry out the chemical demilitarization mission while providing maximum protection to the public, workers, and environment. Similarly, House Appropriations Report 101-822, which accompanied the fiscal year 1991 Defense Appropriations Act (Public Law 101-510), established the Non-Stockpile Chemical Materiel Project (NSCMP). The NSCMP is responsible for providing centralized management and direction for the safe destruction of all non-stockpile chemical materiel in the United States in accordance with all applicable federal, state, and local laws and regulations.

In 2003, the PMNSCM obtained operational approval for the Explosive Destruction System (EDS) Phase 1. This system provides the capability to safely treat single and multiple munitions that are less than 27 inches in length and contain less than 1.5 pounds of explosives (including donor charge). In addition, the EDS Phase 2, which received operational approval in 2004, provides the capability to treat single and

[1] The responsible organization is the U.S. Army Chemical Materials Agency (CMA) Program Manager for the Elimination of Chemical Weapons (PM ECW), which was previously known as the Program Manager for Chemical Demilitarization (PMCD).

multiple munitions that are less than 45 inches in length and contain less than 4.8 pounds (including donor charge) of explosives. These systems do not provide the capability to treat large munitions, such as 500- and 1,000-pound bombs, nor do they provide the capability to treat bulk one-ton containers.

To address this mission area, PMNSCM has developed the LITANS, a transportable chemical agent accessing and neutralization system with the capability to treat one-ton agent container fills and large munitions, with or without explosives. Following neutralization and RCWM decontamination, waste materials are removed from the neutralization system and transported to an approved treatment, storage, and disposal facility (TSDF) for final disposal.

LITANS Development. The current LITANS design was developed following a failed test program with a previous system of the same name. The original LITANS system, while sharing the "LITANS" moniker, has little in common with the current design except the MMIC-designed Mk6 Munition Access Device (MAD). Hardware issues, processing rates, and safety concerns plagued the original system.

When the first LITANS design was abandoned in 2004, PMNSCM was still in need of a system to handle the on-site treatment and/or destruction of large RCWM that were too large for existing mobile systems to process. In 2005, PMNSCM turned to the Tennessee Valley Authority to design the next LITANS unit (briefly called LITANS II).

LITANS System Description. The current LITANS, developed by TVA, is comprised of the following subsystems:

- Glovebox Subsystem
- Reagent Skid Subsystem
- Process Skid Subsystem
- Engineering Controls Subsystem
  - LITANS Glovebox/Process Skid Enclosure Air Filtration System
  - Environmental Enclosure Air Filtration System

Glovebox Subsystem. The Glovebox controls any emissions and/or leaks from the item while it is being accessed and having its contents transferred to the Process Skid. The item is brought into the environmental enclosure on a munition transfer cart. It is secured onto a munition-specific cradle on the cart prior to being loaded into the Glovebox (one-ton containers are placed directly on the munition transfer cart). The Glovebox is constructed of 316 stainless steel (SS) with polycarbonate viewing panels on all four sides, and includes the Mk 6 MAD, munition heaters, the agent removal pump, and in-line strainers.

LITANS Glovebox

The Mk 6 MAD provides a system for accessing and sampling chemical-filled items. It uses a pneumatically-powered drilling assembly that can penetrate steel, plastic, or composite material walls with a thickness from 0.1 to 0.8 inches (3 to 20 millimeters) and install a sealed probe capable of withstanding internal pressures up to 100 pounds per square inch gauge (psig) while permitting access to the contents of the item. The drill is mounted on a stainless steel A-frame that is equipped with two feet (vacuum pads) that attach the drill to the item using a Venturi vacuum system. Drilling power is supplied by a high-performance air motor, and an electronic interface provides the necessary pneumatic control and safety interlocks.

Mk6 Munition Accessing Device

The Mk 6 MAD components include the drilling head, main control unit (MCU), and remote control which allows operation of the Mk 6 from the MCU or from up to 328 feet (100 meters) away.

Reagent Skid Subsystem. The Reagent Skid provides reagent and water to the Process Skid for treating the chemical fill and to the Glovebox for decontamination and rinsing. It also provides compressed air to operate the Mk 6 MAD, nitrogen for purging the item, and liquid waste storage. The Reagent Skid consists of two 350-gallon totes for reagent and water, waste drums, a drum pump, two centrifugal magnetic drive pumps to transfer reagent and water to the Process Skid or Glovebox, an in-line heater, transfer piping, an air compressor, and nitrogen bottles.

Process Skid Subsystem. The Process Skid is used to chemically treat the fill removed from the item. The Process Skid, which is partially enclosed by a frame with bolted-on panels to contain and assist in the monitoring of any possible agent releases, consists of a 575-gallon 316 SS jacketed stirred-tank reactor with an internal sparger for gaseous agents and an immersion heater; a process cooler; a 193-gallon 316 SS (liquid agent) holding tank with external heaters; two progressive cavity metering pumps to transfer liquid agent from the holding tank to the reactor; two centrifugal magnetic drive recirculation/waste transfer pumps; and an eductor and a Static Mixer for drawing gases back into the reactor for further neutralization.

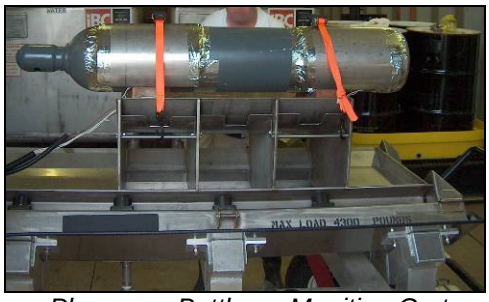

Exterior of LITANS Process Skid

Engineering Controls Subsystem. Engineering controls for the LITANS consists of an environmental enclosure with associated filtration system and a dedicated air filtration system for the Glovebox and Process Skid Enclosure vents. Each of the air filtration systems provides a negative pressure within the structures relative to the outside air, and serves to capture any chemical agent vapors that may result from operations. The LITANS air filtration system also serves to control emissions from the holding tank and

the reactor if venting from these vessels is necessary due to the build up of pressures during neutralization.

Engineering Design Test. The overall objectives for the LITANS EDT were as follows:

a. Demonstrate that munitions[2] can be safely and effectively accessed
b. Demonstrate that 95 percent or more of munition's fill (all that the dipleg can contact and aspirate, whether the fill is liquid or gaseous) can be transferred from the munition
c. Demonstrate that the LITANS can treat the chemical fill to the treatment goal[3]
d. Achieve all of these objectives without undue risk to the operators and without releasing hazardous materiel or waste outside of engineering controls
e. Collect operational and logistics data to support future testing and deployments of the LITANS.



Phosgene Bottle on Munition Cart (and Cradle) During LITANS EDT

Critical test issues were identified based on the overall objectives. These issues, not all of which are quantifiable, were used to develop subtest criteria, identify data to be collected, and aid in the decision-making process.

a. Can the operators demonstrate their ability to safely and effectively operate and maintain the LITANS?
    (1) Can the LITANS be successfully operated by a team of six (or fewer) personnel wearing appropriate levels of personal protective equipment (PPE)?
    (2) Is training adequate to perform LITANS operations?
    (3) Is the Standing Operating Procedure (SOP) technically correct and adequate for use?
    (4) Can the LITANS operators use and follow the SOP?
    (5) Can LITANS withstand repeated use with only minimal onsite maintenance?[4]
    (6) Can engineering controls capture hazardous vapors released from the munition being accessed and undergoing neutralization?
    (7) Can the system withstand assault from caustic solutions and corrosive vapors?
    (8) Can the system be adequately decontaminated?

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[2] Manufactured items are used as munition substitutes. The terms "munition" or "item" are generically used to mean RCWM, NSTE, chemical-filled bottles/cylinders, and/or ton containers.

[3] Analytical results should be pH > 7 for phosgene (CG).

[4] Defined as minor system adjustments, component changeouts, recharging, or similar operations that can be performed onsite by the system operator and support personnel.

b. Can the operators safely and effectively access and transfer the contents of the munition?
   (1) Can large-diameter munitions be accessed? In particular, can munitions as large as an AN-M79 1,000-pound bomb (with a length of 69.5 inches, a diameter of 18.8 inches, and a wall thickness of up to 0.5 inch) be accessed?
   (2) Can the accessing equipment be operated remotely from a distance of up to 328 feet (100 meters)?
   (3) Can the contents of an accessed munition be sampled?
   (4) Can 95 percent or more of the munition's contents be transferred? In particular for liquid-filled items, can all fill that the dipleg can contact and aspirate be transferred?
   (5) Can an item be verified as being "empty" with "empty" being defined as only residues of the fill remaining after transfer?
   (6) When required, can the accessing equipment be detached safely and without difficulty from the munition?

c. Can the chemical fills be neutralized in the LITANS to acceptable levels?
   (1) Can chemical fills be treated to the treatment goal (pH greater than 7 for phosgene [CG])?
   (2) Can the wastes be safely and accurately packaged for transport to a TSDF?

Test Overview. EDT of the LITANS consisted of subtests for pre-operations (setup), operations, and closeout. Testing included the use of water-filled NSTE munitions and CG contained in manufactured bottles/cylinders, as follows:


AN-M79 1000-lb NSTE Item

- One 500-pound NSTE bomb (AN-M78) filled with water (access and transfer only – three trials)
- One 1,000-pound NSTE bomb (AN-M79) filled with water (access and transfer only – three trials)
- One Livens-sized Department of Transportation (DOT) bottle filled with 26.5 pounds of CG (cooled in an ice bath prior to accessing)
- One Livens-sized DOT bottle filled with 32.5 pounds of CG (accessed at ambient conditions)
- One DOT bottle filled with 40 pounds of CG (accessed at ambient conditions)
- One DOT bottle filled with 42 pounds of CG (chilled).

A system manager was appointed from PMNSCM to oversee all aspects of the test. Operators for the LITANS consisted of government personnel from the Edgewood Chemical Biological Center (ECBC). The operators conducted operations dressed in appropriate PPE, as outlined in the test's Health and Safety Plan (HASP). ECBC also performed operator-level maintenance, air monitoring, and laboratory support. The test was conducted following approved procedures developed by PMNSCM and Science Applications International Corporation (SAIC). SAIC also provided operator training, test documentation, and data collectors. Army Materiel Systems Analysis Activity and Mitretek Systems personnel were the independent evaluators.

LITANS EDT occurred on the grounds of the Prototype Detonation Test and Destruction Facility (PDTDF). At the PDTDF, the LITANS was set up within an Environmental Enclosure with engineering controls. The particular Environmental Enclosure that was used, also known as a Vapor Containment System (VCS), is a steel arch design 30 feet wide by 60 feet long by 17 feet tall equipped with a built-in ventilation system including an exhaust stack. Figure 1 shows the LITANS EDT Layout.

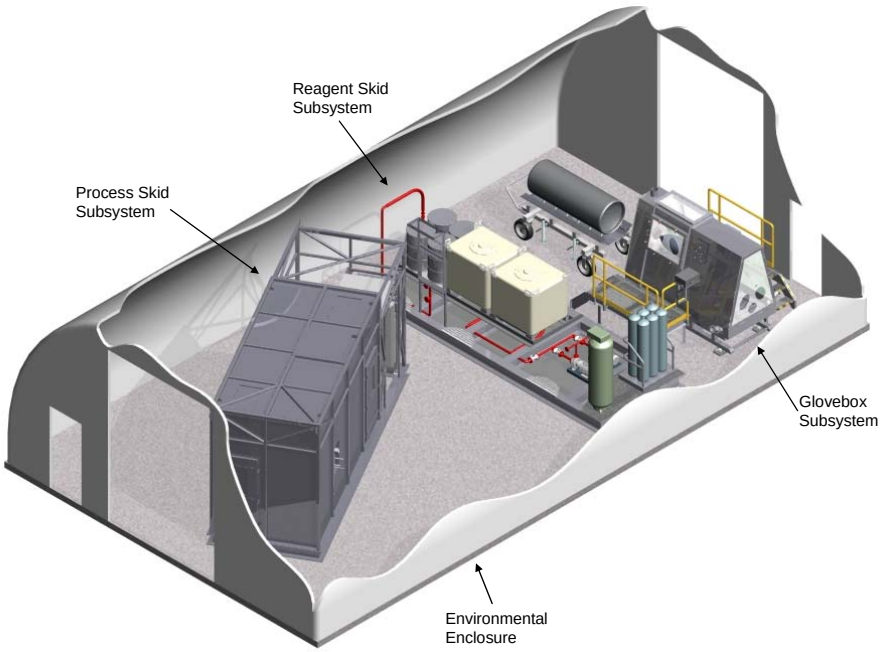

Figure 1. LITANS Layout for EDT

In accordance with the *Monitoring Plan for the Large Item Transportable Access and Neutralization System Engineering Design Test*, monitoring data was collected to protect the safety and health of both the workers and public. The air monitoring strategy relied on the use of MINICAMS® for low-level near real-time (NRT) air monitoring and CG dosimeter badges for confirmational air monitoring.

Table 1 lists the exposure limits for CG. The MINICAMS® monitors were calibrated to this Permissible Exposure Limit. Low-level NRT monitoring was conducted using ECBC-provided MINICAMS® to monitor the following locations:

- At the unpack area/Glovebox exhaust (using a stream selector)
- Above the Glovebox (over the worker space)
- Within the Process Skid exhaust
- At the midbed and exhaust of the VCS Carbon Filtration System (CFS)
- At the midbed and exhaust of the LITANS CFS.

Table 1. Exposure Limits for Phosgene

	Permissible Exposure Limit as 8-hour TWA		IDLH	
Chemical	**mg/m^3**	**ppmv[a]**	**mg/m^3**	**ppmv[a]**
Phosgene[b] (CG)	**0.4**	**0.1**	**8.1**	**2**

Notes:
[a] Parts per million at 20°C and 1 atmosphere.
[b] National Institute for Occupational Safety and Health, *Pocket Guide to Chemical Hazards.*

IDLH = immediately dangerous to life and health
mg/m^3 = milligrams per cubic meter
ppmv = parts per million volume
TWA = time-weighted average

Confirmational monitoring using dosimeter badges was conducted at 9 locations. These locations include being co-located with all MINICAMS® sampling points, as well as individual dosimeter badges worn by the operators.

Test Results. The test results from the LITANS EDT are summarized in Table 2 and Table 3. Comments and/or issues affecting the outcome of the test are also shown in the tables.

Table 2. LITANS EDT Water-Filled NSTE Trials

NSTE Items Processed	Date	Transfer Time	Comments/Issues
LITANS-M78(NSTE)-01 to 03	15 May 06	23 minutes (Average)	Water sent back to water tote, not to Process Skid (per test protocol)
LITANS-M79(NSTE)-01 to 03	16 May 06	45 minutes (Average)	Same as above

Table 3. LITANS EDT Phosgene Trials

CG-Filled DOT Bottle	Date	Transfer Time	Comments/Issues
LITANS-CG(DOT)-01 26.5 lbs of CG (chilled)	17 May 06	6:02 hours (4.4 lbs/hr)	Difficulty with munition heaters
LITANS-CG(DOT)-02 32.5 lbs of CG (ambient)	23 May 06	7:06 hours (4.6 lbs/hr)	Leaking Mk 6 MAD seal, difficulty with munition heaters, EDT suspended
LITANS-CG(DOT)-03 40 lbs of CG (chilled)	27 July 06	3:40 hours (10.9 lbs/hr)	System worked as designed
LITANS-CG(DOT)-04 42 lbs of CG (ambient)	28 July 06	4:13 hours (10 lbs/hr)	System worked as designed; difficult Mk 6 MAD seal installation, electrical issues

EDT Conclusion. The LITANS demonstrated its ability to access, transfer, and treat the contents of large chemically-filled items. The LITANS was successfully used to access and transfer the simulant fill of AN-M78 and AN-M79 NSTE bombs. The LITANS was also able to successfully access, transfer, and treat the contents of CG-filled bottles. Although some equipment problems occurred, the identified problems were either resolved during EDT or were corrected with a hardware modification or improvement in the timeframe leading up to Developmental/Operational Testing in April 2007. Pending successful DT/OT results, the system is expected to receive limited operational approval for treating non-explosively configured M78 and M79 (500 and 1000 lb.) CG-filled bombs in August 2007.