75-mm and 4.2-Inch Munitions Processed Through the Munitions Assessment and Processing System (MAPS) Facility

Cheryl A Kyle
US Army Edgewood Chemical Biological Center, APG 21010, MD.

Introduction

The Munition Assessment and Processing System (MAPS) facility (Aberdeen Proving Ground [APG], MD) was designed to process non-explosively and explosively configured recovered chemical munitions that are safe for handling and storage. The primary functions performed at the facility are (1) separation of liquid payload from munition components, (2) decontamination of munition components, (3) transfer of liquid fill into U.S. Department of Transportation (DOT) bottles, and (4) destruction of munition carcasses. Decontaminated explosive components are destroyed in a commercial detonation chamber within the facility, and the chemical payload is then transferred to other APG facilities for destruction.

Fig 1. Process Room – Glovebox A and B and Plenum

Background

A 75 mm projectile was unearthed in the Spring Valley Area of Washington, D.C. On 14 January 2014, the projectile was assessed with a standard Portable Isotopic Neutron Spectroscopy (PINS) chemical-assay system ([PINS-49] Idaho National Laboratory, Idaho Falls, ID). The radiographs revealed that the shell of this projectile was the shrapnel version, although it did not contain any explosive or lead shrapnel. The radiographs also showed that the munition contained a solid material that formed approximately 90% of its volume. The PINS spectra depicted moderate hydrogen and arsenic peaks. A strong magnesium peak at 1368 keV was observed in the spectra. No other key elements were detected above background levels. The moderate arsenic and hydrogen peaks were consistent with the presence of an arsenic-based chemical. The absence of chlorine excluded several possible arsenicals (i.e., diphenyl-chloroarsine, adamsite, lewisite, and phenyldichloroarsine; all four chemicals contain chlorine). From the 1386-keV magnesium peak, it was determined that the fill was probably magnesium arsenide. This was verified through PINS assessment. The projectile was transported to APG for characterization and destruction.

In addition, a 4.2 in. mortar was unearthed at APG, and on 22 September 2014, this munition was also assessed with the use of the PINS-49. The PINS spectra showed moderate chlorine, hydrogen, and sulfur peaks. No other key elements were detected. Based on the PINS assessment data, it was determined that the fill was frangible grenade (FS) smoke. The munition was stored until characterization and destruction could be conducted.

The aim of this project was to drill, sample, and characterize the fill in each munition. The characterization was used to verify the PINS-assessment results.

Drill and Sample

Spring Valley 75-mm (SVM-14-196). The U.S. Army Chemical Materials Activity ([CMA], APG, MD) and ECBC members discussed the MARB findings and determined the best course of action for accessing the chemical fill of the 75 mm projectile. Based on PINS analyses, the fill was determined to be magnesium arsenide, and the 90% solid-material chemical-fill weight was estimated to be around 630 g (approximately 1.4 lbs). The projectile was not fuzed and contained no energetics. On 12 February 2015, the projectile was transferred to the MAPS facility for drilling and sampling operations (Fig. 1). The munition was removed from the multiple round container (MRC) overpack and placed in glovebox A. While it was still in glovebox A, the projectile was removed from the plastic bags (Fig. 2). It was then transferred to glovebox B for installation on the drill trolley (Fig. 3) and eventually placed in the drill box (Fig. 4).

Figure 2. Munition unpacked in glovebox A

Figure 6. Drilled holes sealed and wrapped with duct tape.

Abstract

The U.S. Army Edgewood Chemical Biological Center (ECBC) received a request to perform Portable Isotopic Neutron Spectroscopy (PINS) chemical-assay verification of two munitions. A 75 mm projectile was unearthed in the Spring Valley Area of Washington, DC. Using PINS assessment, the projectile's chemical fill was determined to be magnesium arsenide. Also, a 4.2 in. mortar was unearthed at Aberdeen Proving Ground (MD), and using PINS assessment, its chemical fill was determined to be frangible grenade (FS) smoke. The munitions were drilled and sampled at the ECBC Munition Assessment and Processing System facility. Solid samples were obtained from the 75 mm projectile and a liquid sample was obtained from the 4.2 in. mortar. The samples were characterized by ECBC Environmental Monitoring Laboratory members who confirmed that the fills were magnesium arsenide and FS smoke, respectively.

Figure 5. One of the holes drilled into the munition for sample access .

Four holes were drilled into the projectile at 90^{o} angles to demilitarize it (Fig. 5). A solid sample of approximately 8 g of magnesium arsenide was removed and placed in sample bottles. Each hole was plugged with a wax plug, and the munition was wrapped with duct tape and repackaged in the original MRC (Fig. 6). The sample was taken to the ECBC Environmental Chemical Monitoring Laboratory (ECML) for characterization. The repackaged munition was replaced in the N-field bunker until it could be disposed of at the appropriate waste facility.

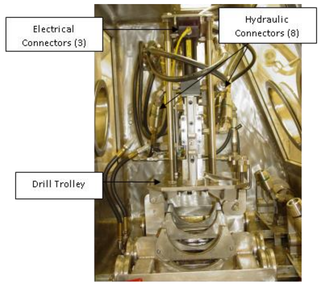

Figure 3. Drill trolley

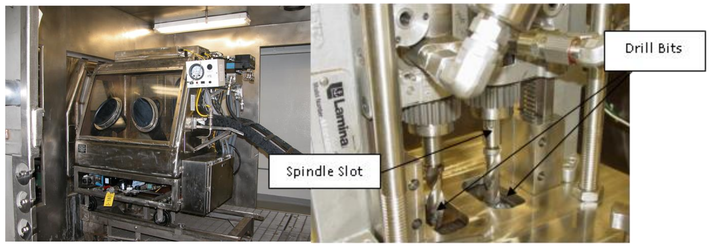

Figure 4. Drill box and drill.

4.2 – inch Mortar (APG-14-590). The CMA and ECBC teams held a table-top discussion about the MARB findings for the 4.2 in. mortar to determine the best course of action for accessing its chemical fill. The following characteristics were observed:

- It contained 70% liquid fill. (Based on PINS analysis, the fill was determined to be FS smoke)
- It was unfuzed
- It contained energetics

Drill and Sample (cont'd)

On 12 February 2015, the mortar was transferred from the N-field bunker to the MAPS facility for drill and sample operations. The mortar was removed from the MRC overpack and placed in glovebox A. While in glovebox A, the mortar was removed from the plastic bags and transferred to glovebox B for installation on the drill trolley and then placed in the drill box. Because the mortar contained energetics, the drill box was placed in the explosive containment chamber (ECC) and drilled remotely.

Figure 7 4.2-inch mortar removed from plastic bags.

Two holes were remotely drilled in the mortar to access the chemical fill. The drill box was removed from the ECC, and the mortar was transferred to glovebox B for sample extraction. A 5 mL sample was removed from the mortar and placed in a sample bottle; the remaining fill was transferred to a DOT bottle. The round was flushed with water, dried, and repacked in its original MRC.

Characterization

Spring Valley 75-mm (SVM-14-196) Analysis. On 12 February 2015, the three solid samples that were obtained by the ECBC MAPS team were taken to the ECML for assessment. On 26 March 2015, the samples and associated quality controls were analyzed using Graphite Furnace Atomic Absorption Spectroscopy, following the procedures specified in ECBC IOP MT-42. On 27 March 2015, the three solid samples and associated quality controls were analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy, following the procedures specified in ECBC IOP MT-43. The samples for arsenic were prepared according to the digestion procedures specified in IOP MT-43.2 The same digestions were processed for both IOPs. Arsenic, copper, iron, and magnesium were detected in all of the samples at concentrations above the laboratory limit of detection.

4.2 – inch Mortar (APG-14-590) Analysis. The liquid sample that was obtained on 12 February 2015 was taken to the ECML for assessment. It was described as a dark brown liquid that produced white smoke when exposed to air. The liquid reacted exothermically when dropped into water. The resulting pH of the water was 0. These characteristics are typical of FS smoke.

A sample of the liquid was placed in a gas cell and analyzed by Fourier transform infrared spectroscopy. The best library matches for the sample spectra were sulfur trioxide and sulfuryl chloride (Figure 8). A good quality library match was difficult to obtain because the mixture contained FS smoke.

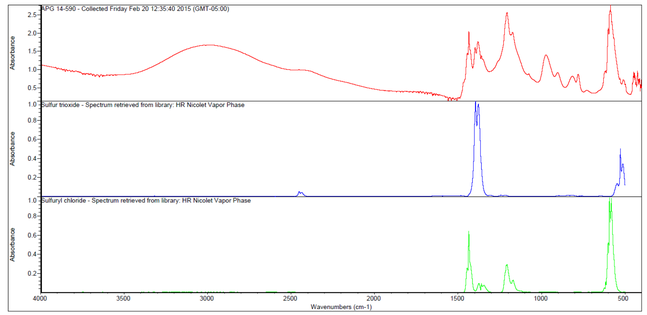

Figure 8. FTIR spectra comparison.

Conclusions

The ECBC analyses of the munition samples were used to confirm the identity of the chemical fills and validate previously obtained data by the PINS non-intrusive threat detection system. The detailed chemical characterization conducted by ECBC team members ensured that key elements were not overlooked during field analyses.

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