PRELIMINARY LIST OF POTENTIAL TECHNOLOGIES FOR THE DESTRUCTION OF M6 AT CAMP MINDEN, draft 2/26/15
DRAFT – FOR DISCUSSION PURPOSES ONLY

Name And Vendor	ESB Lists[1]	Location Availability/ Space Requirements	Technology Type/Process	History and/or applicability With M6	Destruction Efficiency	Nature Of Residue And Recycle/ Disposal	Nature Of Emissions And Monitoring, Capturing, Testing	Capacity And Throughput
General DDESB Staff comment. Army JPEO's Project Manager Demilmilitarization (Chemical Systems) TNT Equivalent	None of these systems have specifically been tested for large-scale M6 destruction. For the scale being considered, testing systems to be used with the actual material is the right thing to do. From a throughput and capacity perspective, these systems are simply not designed for the large scale industrial-type operation required to address the Minden problem. Using a system not designed for large-scale destruction would fatigue the system over time and could likely lead to some sort of undesired event for the quantities envisioned. Even if a system existed that was designed specifically for this type of large-scale operation the time required to destroy the M6 would far exceed the stabilizer life of the propellant. In the DDESB's Staff's opinion the time required to destroy M6 by using a system not designed specifically for large-scale destruction of the M6 increases the risk of an adverse event. For those systems design to process chemical munitions or agents a number of actions would be required prior to use, if the system is able to be used at all. Safe handling of the propellant and design of an effective means for delivering propellant to the destruction system will be major safety issues. Finally, none of these challenges can be accomplished within the schedule the Settlement Agreement outlined (approximately 13 months). TNT Equivalent for M6 is roughly 60 percent.							
Industrial Waste Processor (IWP) and Caffee Road Thermal Decontamination Area (CRTDA)	AE	Indian Head, MD			Processes explosives contaminated materials from an initial "trace explosives-contaminated" to a final "releasable to the public" condition		Emission factors for this technology were not available at least in literature reviewed for M6. Ambient and direct plume monitoring	Net Explosive Weight (NEW) for the IWP is 2 to 10 lbs NEW for the CRTDA is 1 lb.

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							would be recommended.	

Ammunition Peculiar Equipment (APE)-1236 Rotary Kiln Incinerator (Deactivation Furnace) (Ref 7)	AE	CAAA(Crane), TEAD (Tooele), MCAAP (McAlester), HWAD (Hawthorne) El Dorado Engineering (Explosive Waste Incinerator Rotary Kiln) **Not available for use.**	An explosive waste rotating incinerator with afterburner and baghouse located at the discharge end Developed specifically for conventional end-item munitions		DRE >99.99% for 2,4-DNT & HCB **Army: The Army's Program Executive Office - Ammunition (PEO Ammo) indicated the APE (Ammunition Peculiar Equipment) 1236 is not a mobile system. It would take significant construction to emplace a new system (6 – 12 months), and possibly longer to deconstruct a system, move and emplace it at a new location.**		Emission factors for this technology were not available at least in literature reviewed for M6. Ambient and direct plume monitoring would be recommended.	**DDESB and Army: Up to 600 lbs/hour for certain propellants p explosives, and pyrotechnics (PEP) (Bulk High Explosives – Comp B, TNT, Tetryl, Octyl, Black Powder, etc.; Bulk Single & double based propellants and composites; Bulk Pyrotechnics - signal flares, illuminating candles.) The type material determines the actual feed rate. On average the feed rate approximates 250 lbs/hour. The weight of the material processed is not limited to the net explosives weight (i.e., it includes other materials, such as metal parts.)** **A heavily modified kiln, which is not the current APE 1236 system configuration, could potentially maintain a feed rate of 400 lbs/hour hour maximum (3.2M lbs maximum per year).**

Static Detonation Chamber (SDC) 1200 CM Vendor is UXB under the Dynasafe name	AE 2/12	Anniston, Alabama	Designed for thermal decomposition/controlled deflagration and burning reactions of high explosives and propellants (Ref 1)		**Army: The SDC can process propellants and can process M6 propellant.** **Does not appear optimal for use for large quantities (millions of pounds).**		Gasses are largely destroyed by explosive effects and pyrolysis in the main chamber. Remaining pyrolysis products and gasses from the explosives are further treated to remove pollutants. Emission factors for this technology were not available at least in literature reviewed for M6. Ambient and direct plume monitoring would be recommended.	**Army: The SDC has very limited throughput - the maximum detonable quantity allowed inside at any one time is 5.29 lbs of TNT equivalent material (approximately 11 pounds of M-6).** **The SDC cannot process extremely large amounts of propellant (M6). For example, the Anniston SDC could process (rough estimate) 325,000 pounds of propellant annually.** Has very limited throughput because the maximum detonable quantity allowed inside at any one time is 5.29 lbs of TNT equivalent material. (Ref 1)

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Vacuum Integrated Chamber (DA VINCH DV -60) Vendor is Kobe Steel under the DA VINCH DV -60 name **Capable of destroying chemical munitions – not DDESB approved for such.**	AE 2/12	Blue Grass AD, KY; Pueblo CD, CO	Designed for fragmenting munitions and solid rocket motors; method used for destruction by detonation. (Ref 1) **Is an explosive destruction technology (EDT) system.**	Destruction Technologies for Specific Munitions at the Blue Grass and Pueblo Chemical Agent Destruction Pilot Plants (2009).	**Uses detonation as a means for Destruction.** **Is not intended for the destruction of bulk propellants.**		This is a vacuum detonation followed by cold plasma. No emission factors were available in literature reviewed for M6.	The DV65 system has a 65 kg capacity (31 kg TNT equivalents), of which only the fraction 8.8/22.2 (40%) was the subject material for destruction, the rest being an explosive donor material. (Ref 1) DoD did a test on HD projectiles and it was successful; 9 projectiles per 10 hour day would take up to 5.3 years to process 15,000 projectiles. Disposal of 1,200 bombs in 3 years. Stated capacity of 65 kg TNT equivalent per batch. Capacity for M6 not available. (Ref 3)

Explosives Destruction System (EDS) **Phase 1 and Phase 2 Units** **Phase 2 (Retrofit)**	AE	Various locations Not available Phase 2 (Retrofit is at Pueblo Chemical Depot).	**Designed for chemical munitions destruction by external (implosion) detonation** **EDS are capable of treating chemical munitions with a variety of different fills (e.g., treat Mustard, Phosgene, G-series agents, VX, Lewisite, Cyanogen Chloride, Hydrogen Cyanide, and Chloropicrin.)**	The U.S. Army Chemical Materials Agency's (CMA) Non-Stockpile Chemical Material Project (NSCMP) designed the Explosive Destruction System (EDS) with Sandia National Laboratories to provide on-site treatment of chemical warfare material. Successfully completed missions at Aberdeen Proving Ground, Md., Spring Valley, Washington, D.C., Dover Air Force Base, Del.,	**Army: Not suitable for destruction of M6 or other bulk propellants.**		Emission factors for this technology were not available at least in literature reviewed for M6. Ambient and direct plume monitoring would be recommended	**The containment vessels is designed to handle munitions containing a TNT-equivalent of explosives as listed below:** **Phase 1 = 1.5 lbs** **Phase 2 = 4.8 lb** **Phase 2 (Retrofit) = 9 lbs** **Phase 1 can processes three items at once including: 4.2-inch mortars, 75 mm artillery shells, livens projectiles and bomblets.** **Phase 2 and Phase 2 (Retrofit) can processes six munitions at one time, including: 4.2-inch mortars, 75 mm artillery shells, 105 mm projectiles, 155 mm projectiles and 8-inch projectiles.** **(Ref 5)**

				Former Camp Sibert, Ala., Pine Bluff Arsenal, Ark., Rocky Mountain Arsenal, Colo., and Redstone Arsenal, Ala. Testing for the EDS was conducted at Porton Down, United Kingdom and Aberdeen Proving Ground, Md. (Ref 5)				
Tactical Missile Demilitarization (TMD)	AE	Letterkenny Army Depot	System used to section and destroy large tactical missiles ; Recover high value energetics from propellant and warhead feedstocks (Ref 2)				Emission factors for this technology were not available at least in literature reviewed for M6. Ambient and direct plume monitoring would be recommended	Disposal of up to 10,000 lbs. of ammunition per day through demilitarization, burning, or processing through a deactivation furnace. (Ref 6)

Controlled Detonation Chamber (also referred to a Donovan Chambers) **Transportable Controlled Detonation Chambers- (Models T-10, T-25, T-30 and T-60)** **(T60C is approved for use for destruction of certain chemical munitions)**	2/12	CH2M Hill/Demil International	Systems are self-contained and mobile. Have been used to destroyed conventional munitions and explosive components. Each system is approved for various net explosive weights.) Demonstrated the ability to destroy 105mm HE munitions. (Ref 4) **T-10 - 13 pounds TNT equivalency (up to 81mm mortar)** **T-25 – 16.7 lbs TNT equivalency (up to 4.2 in mortar or 4.5 in rocket)** **T-30 – 40 lb TNT equivalency (up to 155 mm projectile)** **T-60 - 40 lb TNT equivalency (up to 155 mm projectile** **DDESB approved for use at Schofield Barracks, HI, for the destruction of certain chemical munitions.**		**Not suitable for destruction of M6 or other bulk propellants as designed and approved.**		Emission factors for this technology were not available at least in literature reviewed for M6. Ambient and direct plume monitoring would be recommended	**Varies based on type munition and CDC used**. Example: T-10 used at Fort Hunter Liggett, Mare Island, Seal Beach, and Camp Roberts. 28,858 munitions of explosive concern and code H munitions destroyed in 15 days. Typical throughput is 25 munitions per day. Systems are transportable. (Ref 4) **System intended for emergency use and not a production environment**

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Super Critical Water Oxidation Vendor is General Atomics	2/12	There is a system currently at Camp Minden, also McAlester AAP, OK	Water at conditions above its thermodynamic critical point of 374°C (705°F) and 3,206 psi (pounds per square inch), allowing complete oxidation of organic materials (Ref 1)	M6 would need a preparation step such as grinding or alkaline hydrolysis to prepare aqueous waste stream			CO_2, H_2O, and salts, with NOX, SOX, and particulate concentrations at or below detection limits, all without any post-treatment	
FDHS - Field Deployable Hydrolysis System (FDHS)	2/12	Edgewood, MD **Army: Can be up and running within 10 days of arriving on a site.**	Destroys chemical warfare agents in bulk and can be up and running within 10 days of arrival on site.		**Army: Not suitable for M6.** **Designed to destroy chemical warfare agents in bulk**	Possible liquid waste stream		**Army - FDHS is not configured to handle flammable liquids or explosive mixtures. Additionally, M6 propellant is made up of relatively insoluble solids; therefore, is unsuitable for a process which relies on being able to mix the intended destruction material with an aqueous liquid.**
Humic Acid Processing Vendor is Arctech under the Actodemil name	2/12	Could be placed on site.	Humic Acid reacts with hazardous chemicals in a reaction vessel at 160 to 180º F. (Ref 1)	Has been tested on M6		Neutralized material available for disposal or reuse	No emissions according to manufacturer	Pre-designed units of 100, 200 or 500 pounds per batch. Batches take between 2 and 4 hours.

Open Burning	Site specific approval		Industrial-level burns are normally a RCRA-permitted process. Operations are governed by DoD explosives safety criteria (DoD 6055.9M Vol 1 to 8, DoD Ammunition and Explosives Safety Standards:	Used extensively for demilitarization of excess, obsolete or unserviceable propellants and other energetic material.	Extremely efficient. (Will have to get a definitive answer based on testing and experience estimate, but expect in the 95 + % range)			Varies by site. Quantity to be processed generally restricted by permit, approved operating procedures, and DDESB-approved site plan

NOTES
1. AE denotes the DDESB approved system for ammunition and explosives. 2/12 identifies technologies that were shared at the 2/12 dialogue meeting as from a chemical weapons process, but we are still seeking an official list designation for these technologies.

Manufacturer websites (incomplete list; provided as reference only; no endorsement implied)
SWCO: www.ga.com/supercritical-water-oxidation
Humic Acid Processing: www.arctech.com/actodemil.html
Rotary Kiln (APE 1236): www.eldoradoengineering.com, General Dynamics (http://www.gd-ots.com/munitions/company.html)
CDC: CH2M Hill (http://www.ch2m.com/corporate/markets/environmental/munitions.asp), http://demilinternational.com
SDC: UXB International (http://uxb.com/pages/demil.html)

Department of Defense Explosives Safety Board (DDESB)

The DDESB's role in the review of AE demilitarization systems is defined by DoD policy and limited to validating that:

(1) Personal protection criteria are met; and

(2) A system may be used in lieu of 100-percent independent dual inspections to determine whether material to be demilitarized may be documented as safe prior to its transfer within or release from DoD control.

b. The DDESB does not evaluate systems for other types of feasibility (economic, environmental, etc.).

DDESB REVIEW AND APPROVAL PROCESS

A. Review of Demilitarization Systems for Personnel Protection

The DDESB's role in the review of systems that may be used to support AE demilitarization operations is limited to the explosives safety aspects of those systems (vice an evaluation of whether the system will ensure an item has been adequately demilitarized). For a given quantity of AE to be processed in a system at a given time, the DDESB reviews and approves safety distances and compensatory measures associated with the system.

The DDESB will review U.S. Military Component submissions of AE demilitarization systems in accordance with DoDI 6055.161 that meet the requirements of DoDM 6055.092 for personnel protection from thermal, blast and fragmentation effects. Criteria are established based on accidental or intentional detonations or burns of the AE and the associated safety distances. A DoD Component may submit for review and approval systems that have demonstrated (e.g., by testing) that the proposed system meets DoD criteria for personnel protection.

B. DDESB Review of Systems for Material Documented as Safe (MDAS)

DoDI 4140.623 requires that material to be transferred within or released from DoD control must be assessed and documented as either safe or as having a known or suspected explosive hazards based on the following two conditions:

(1) After 100-percent inspection and an independent 100-percent reinspection.
(2) After processing by a DDESB-approved means with an appropriate post-processing inspection.

A DoD Component may propose a system to the DDESB, with appropriate justification, to indicate material processed through the system does not require the inspections specified in (1) above. The justification must show that over its lifetime the system will achieve a commensurate level of safety without the need for costly or potentially hazardous 100-percent inspection and independent reinspection. This type of approval would apply to, among other materials, AE where energetic material (e.g., the explosive fill) is removed from the material.

[1] Department of Defense Instruction (DoDI) 6055.16, "Explosives Safety Management Program", July 29, 2008, Incorporating Change 1, December 8, 2011
[2] Department of Defense Manual (DoDM) 6055.09, "DoD Ammunition and Explosives Safety Standards", date varies by volume.
[3] Department of Defense Instruction (DoDI) 4140.62, "Material Potentially Presenting an Explosives Hazard", November 25, 2008, Incorporating Change 1, February 19, 2014

References:

1. Preliminary List of Potential Technologies/Evaluation Framework, draft 2/22/15
2. Defense Explosives Safety Board's Role in Approving Demilitarization Technology for Ammunition and Explosives Information Paper, January 23, 2015
3. Evaluation of Monitoring Emissions, and Modeling Technologies Proposed for Camp Minden, LA site
4. Current Status of Transportable Controlled Detonation Chambers, CH2MHill Demilitarization, Inc., May 2007
5. Explosive Destruction System Overview Fact Sheet, U.S. Army Chemical Materials Agency
6. GlobalSecurity.org website (Letterkenny Army Depot)
7. "Results of Trial Test Burns on Army Deactivation Furnaces Upgraded to Meet RCRA" (DDESB seminar paper), August 1992, Tooele Army Depot.

"General Instructions for Demilitarization/Disposal of Conventional Munitions", TM 9-1300-277, March 1982 (rev. March 2001), Dept. of the Army.

Hazardous Waste Incinerator APE 1236M2 promotional flyer, Tooele Army Depot (www. Tooele.army.mil).

McAlester Army Ammunition Plant (MCAAP) Munitions Deactivation Furnace (APE 1236M2), Permit No. 2005-301-TV, with Evaluation of Permit Application, Oklahoma Department of Environmental Quality Air Quality Division, October 31, 2006.