Destruction of Syria's Chemical Stockpile Aboard the MV Cape Ray
Field Deployable Hydrolysis System Design and Deployment

Timothy A Blades, Adam P Baker, Raymond A Diberardo, Brian J O'Donnell, Robert J Malone, and Lloyd A Pusey

US Army Edgewood Chemical Biological Center, APG, MD 21010

Introduction

In late 2012, as the armed conflict in Syria spread into the region, Department of Defense officials recognized that they lacked a deployable technology for destroying large amounts of chemical warfare materiel such as the Syrian chemical weapons stockpile. While the international community engaged with the Syrian government relinquish its stockpile, JPEO-CBD and ECBC formed a team to bring decades of chemical weapons destruction experience to bear on the problem. Other team members came from the Defense Threat Reduction Agency and the U.S. Army Contracting Command. The hydrolysis system was a fast-track acquisition project initiated officially in February 2013. Within six months, the team had conceived, designed, built and systemized a one-of-a-kind deployable system. By mid- to late-2013, with no nation willing to permit Syrian chemical agents to be destroyed on its soil, the team quickly adapted and installed two field-deployable hydrolysis units aboard the 648-foot Maritime Administration Ready Reserve ship MV Cape Ray.

Capabilities Assessment

On December 27, 2012, a Capabilities Assessment was requested by Threat Reduction Advisory Committee to identify technologies that were currently available, or those that could be available within 6-12 months. with the capability to destroy bulk liquid chemical agent or precursors and operate in a remote location in a semi-permissive or uncertain environment.



Production Decision

On Jan 28, 2013, ECBC and the Joint Project Manager Elimination were directed to demonstrate a suitable technology by July 31, 2013. Neutralization (hydrolysis) was selected as the only technology that could be demonstrated in this time frame (Fig. 1). On February 15, 2013, a scope and schedule change expedited the requirement to produce and demonstrate a full deployable capability by a July 1, 2013 deadline.

Design/Production Team

CBARR	JPM-E	ADM	ECBC R&T	DTRA	ACC
• ECBC chem/bio operations division • Overall project management responsibility • Assembled reactor and hydrolysis skids and other components	• JPEO-CBD CW elimination experts • Co-designers with ECBC • Funded second and third FDHS prototypes	• ECBC rapid-prototyping unit • Computer-aided drafting, simulation support, and fabrication of parts	• ECBC's research and technology directorate • Bench-scale chemistry and analysis of waste	• CBDP R&T funding organization • Funded first FDHS prototype	• Edgewood branch of Army Contracting Command • Dedicated Contracting Officer support

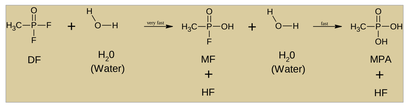
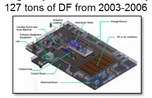


Figure 1. Neutralization of CWA by hydrolysis.

Requirements

- Destroy bulk liquids in metric ton quantities
- Destroy HD, DF, possibly other precursor compounds
- Achieve 99.9% destruction efficiency
- Achieve throughput rate of at least 3 metric tons/day
- Operate 24 hours/day; 7 days/week
- Be transportable by standard modes of transportation
- Operate at remote sites
- Be operable within 10 days of equipment arriving on site

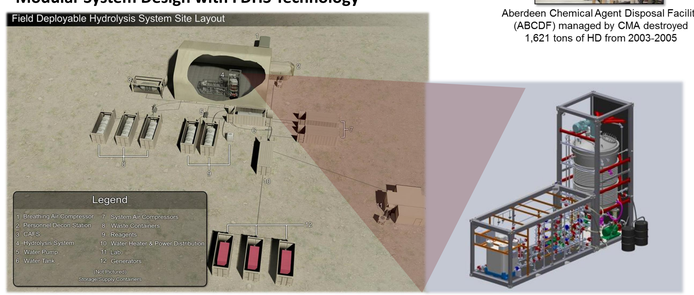
Binary Destruction Facility (BDF) managed by CMA/NSCMP destroyed 127 tons of DF from 2003-2006



Destruction and Throughput Requirements

Aberdeen Chemical Agent Disposal Facility (ABCDF) managed by CMA destroyed 1,621 tons of HD from 2003-2005

Modular System Design with FDHS Technology

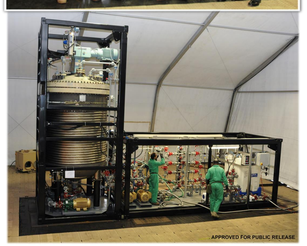


FDHS Project Timeline
From Concept Design to Operational Model in Six Months

1QFY13	2QFY13	3QFY13	4QFY13	1QFY14	2QFY14	3QFY14	4QFY14	1QFY15
12/27	2/4	6/27	8/21	12/2	1/27		7/2 8/17	
Capabilities Assessment	FDHS Funding Received	Prototype Demonstration	Ghouta Chemical Attack	Cape Ray Installation Start	Cape Ray Departure		Receipt of Syrian CW / Destruction Complete	Cape Ray Return to ROS-5

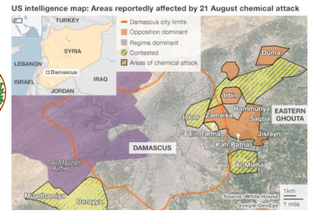
Transition and Planning

A government team comprised of ECBC, DTRA, JPEO-CBD, CMA and the U.S. Army Contracting Command was responsible for the design, procurement, fabrication, testing and training of the FDHS. The fast-track acquisition project was initiated in February 2013 with the first system delivered less than six months later. The FDHS technology transferred from DTRA to JPEO on June 27, 2013. The Concept of Operations strategy consisted of 6 systems deployed at 2-3 sites within the country where table-top exercises and materiel releases for active duty operators were conducted. The capability demonstration and validation was conducted September 16-22, 2013 with concurrent procurement and fabrication of 7 FDHS systems through May 2014.

Sarin Attacks on Ghouta and Aftermath

On August 21, 2013, the Syrian conflict escalated with a chemical weapons attack on the outskirts of Damascus with estimates ranging from a few hundred to over 1,000 deaths. The Assad regime was accused of orchestrating the attack. On September 14, 2013 Syria agreed to turn over their CW stockpile by signing the Chemical Weapons Convention with destruction of all CWM by June 30, 2014.



Cape Ray Decision and Concept of Operations

Since no country volunteered to accept the Syrian CW for destruction, the feasibility of ship-based destruction with two FDHS platforms on board was raised by JPEO/ECBC/DTRA. A shipboard destruction would provide an ample water supply and security. The design team visited ships in September 2013 in Baltimore and Portsmouth. In November 2013, the Cape Ray, part of the Maritime Administration's Ready Reserve Fleet, was selected for the mission. The Concept of Operations required 100% inspection of Syrian containers, concurrent DF operations in both systems, HD operations in one system, and 24/7 operations with ramp-up to full throughput and shift work.

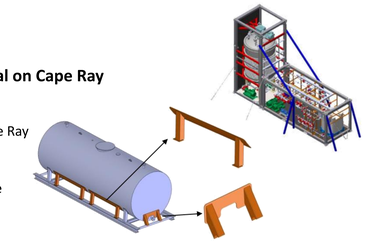

FDHS Installation Team

CBARR / ADM / NAVSEA	MARAD	DTRA	Keystone	
• FDHS design and production team • Installed equipment on Cape Ray • Analyzed sea state effects on system integrity	• DOT organization that runs the Ready Reserve Fleet • Coordinated all modifications to Cape Ray	• Organization that runs the Cooperative Threat Reduction (CTR) program • Provided funding and planning support	• Contractor that operates the Cape Ray • Assisted in installation • Integrated all on-board installations	• DoD approval authorities • Guided installation process and issued approvals for operation

Maritime Operational Challenges

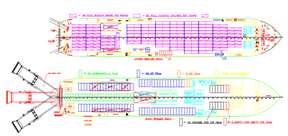
Problem: Loading and storing all equipment and material on Cape Ray
- 269 total ISO containers (6,000 gal each) on board
- 78 shipping containers full of Syrian CW
- Limited capability for equipment transfer within and to/from Cape Ray
- Distribution of loads changing daily during operations

Approach:
- Collaboration on initial and predicted load planning with Keystone
- Real-time adjustments to load plan throughout operations
- pH adjustment system designed to allow safe long-term storage



Problem: Prevent agent liquid or vapor release to the environment

Approach:
- FDHS equipment and all Syrian CW stored on Main Trailer Deck
- Only reagent and effluent pass between decks – no agent
- Existing ventilation system retrofitted with carbon filtration
- Multiple levels of environmental controls:
  - Reaction occurs in closed system of FDHS
  - FDHS located within ventilated environmental enclosure (EE)
  - EE located within Main Trailer Deck with ventilation/filtration system



Problem: Ship setting imposed unusual forces on equipment
- Vibration effects of ship's propeller
- Forces caused by ship movement, "sloshing" of liquid

Approach:
- ADM, AMSAA, and Navy personnel performed analysis
- Additional bracing installed for primary FDHS skids and holding tanks
- Ship roll/pitch limits implemented to halt operations in worst conditions

Cape Ray Ops Team

NAVEUR		Keystone	Parsons	OPCW	DTRA
• US Naval forces Europe (subordinate to EUCOM) • Overall mission responsibility	• FDHS Operational Team • Conducted agent ops and provided oversight of all chemical ops	• Contractor that operates the Cape Ray • Performed all standard ship management functions	• Contractor for DTRA's CTR program • Provided non-agent operational support to FDHS ops team	• Organization charged with enforcing CWC • Observed agent operations and certified CWC compliance	• Organization that runs the CTR program • Funded all Cape Ray operations

Mission Success: United Nations/Organisation for the Prohibition of Chemical Weapons

The success of the FDHS and the Cape Ray in the destruction of the Syrian chemical weapons stockpile was made possible by the collaboration of many government and contractor organizations providing diverse expertise to accomplish a remarkable mission in extraordinarily short timeframes. **CBARR had 46 civilian personnel support the mission from inception to close out.** Agent operations started July 7, 2014 and were completed August 17, 2014. A total of 580 metric tons of DF and 20 metric tons of HD was destroyed in 42 days. Offloading of waste was completed September 5, 2014, and the Cape Ray returned to Portsmouth on September 17, 2014. The Cape Ray was cleared to WPL before the first waste discharge at Finland. All equipment was removed in Portsmouth and is now stored at APG-EA. The Cape Ray will be cleared to GPL and returned to Ready Reserve Fleet in the near future.

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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