



U.S. Army Research, Development and Engineering Command

Field Deployable Hydrolysis System Design and Deployment



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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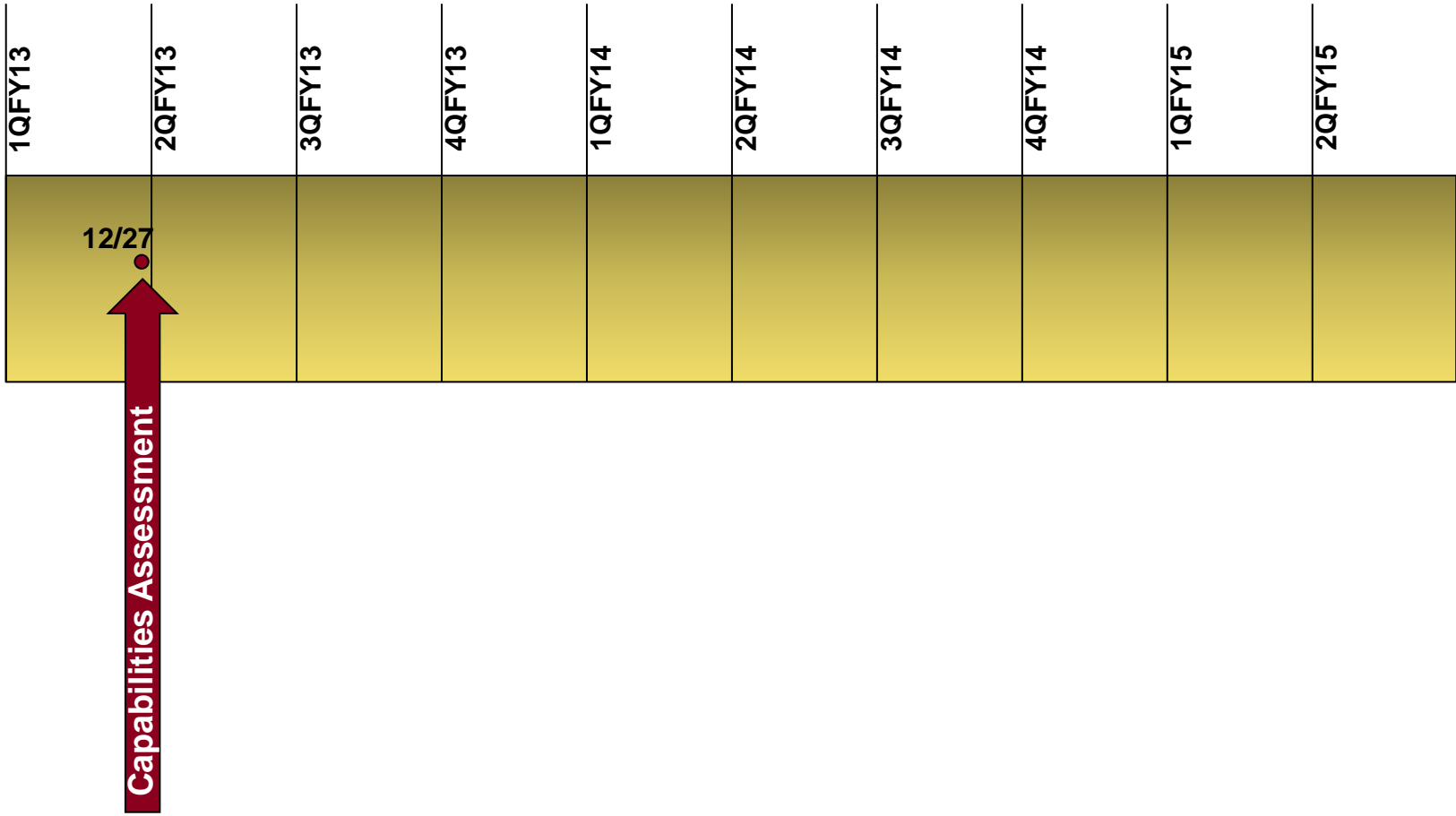


- **Project Genesis**
- **FDHS Design and Production**
- **FDHS Installation on Cape Ray**
- **Destruction of Syrian CWM**
- **Return and Decommissioning of Cape Ray**





FDHS Project Timeline



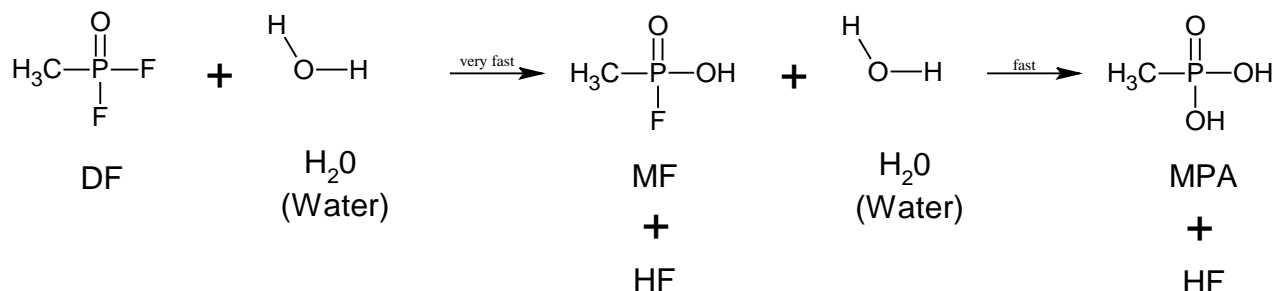
- **Capabilities Assessment requested by Threat Reduction Advisory Committee (TRAC) on December 27, 2012**



- **Identify technologies that are currently available, or could be available within 6-12 months, capable of:**
 - **Destroying bulk liquid chemical agent or precursors**
 - **Operating in a remote location**
 - **Operating in semi-permissive or uncertain environment**

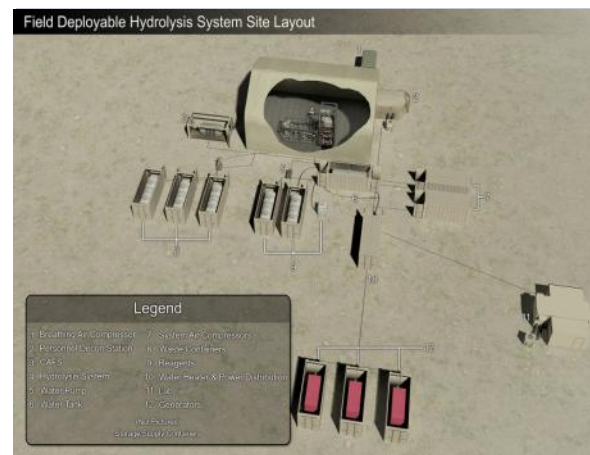


- **28 Jan 2013: ECBC and JPM-E directed to demonstrate a suitable technology by 31 Jul**
- **Neutralization (hydrolysis) was selected as the only technology that could be demonstrated in this time frame**



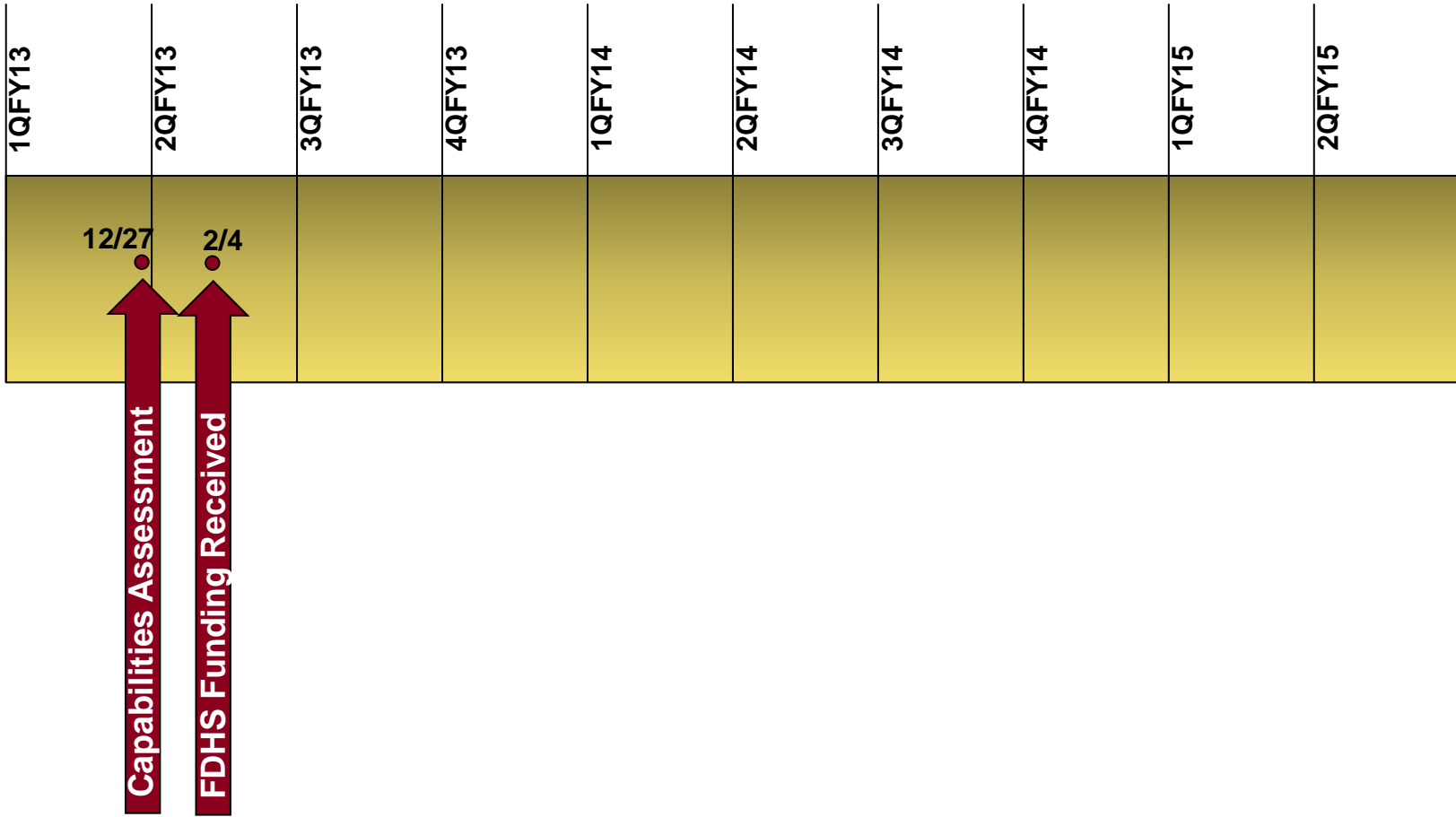
- **15 Feb 2013: Scope and schedule changes:**

- **Required to produce and demonstrate a full deployable capability**
- **Deadline moved to 1 Jul 2013**





FDHS Project Timeline





CBARR



- ECBC chem/bio operations division
- Overall project management responsibility
- Assembled reactor and hydrolysis skids and other components

JPM-E



- JPEO-CBD CW elimination experts
- Co-designers with ECBC
- Funded second and third FDHS prototypes

ADM



- ECBC rapid-prototyping unit
- Computer-aided drafting, simulation support, and fabrication of parts

ECBC R&T



- ECBC's research and technology directorate
- Bench-scale chemistry and analysis of waste

DTRA



- CBDP R&T funding organization
- Funded first FDHS prototype

ACC

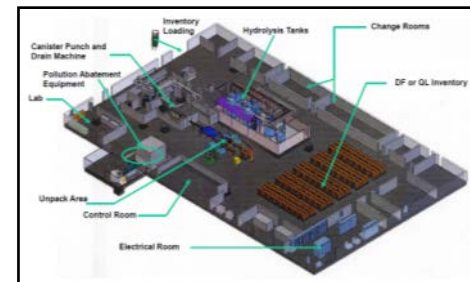


- Edgewood branch of Army Contracting Command
- Dedicated Contracting Officer support



- **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 MT/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



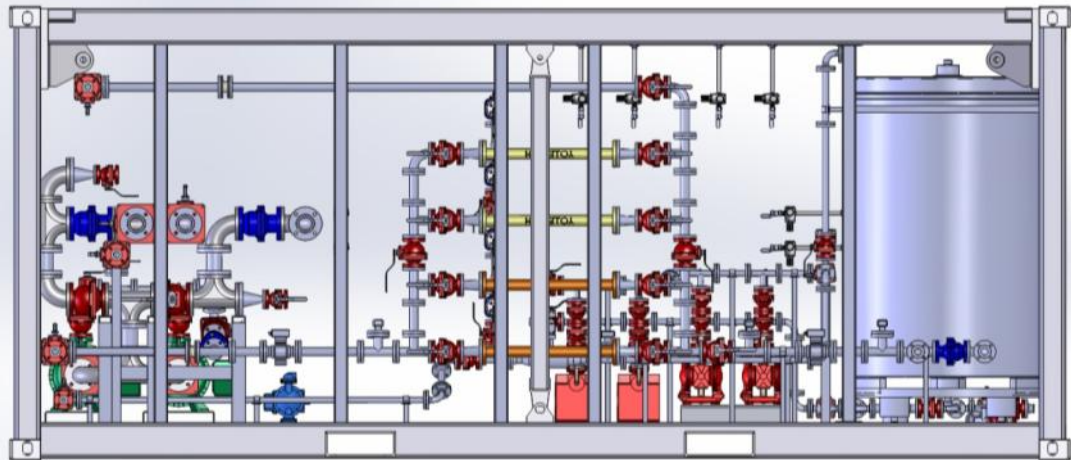
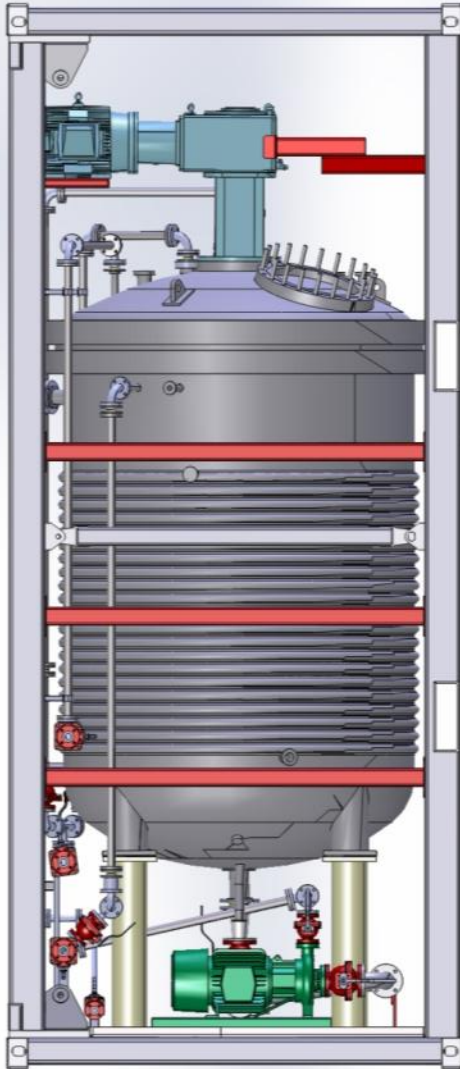
Requirement	Characteristics	Achieved By
Destruction/ Throughput	<ul style="list-style-type: none"> • Reliance on proven technology • Process flexibility 	<ul style="list-style-type: none"> • Basing process flow and chemistry on ABCDF • Using 2 surplus reactor vessels from ABCDF • Designing for varying recipes and flow rates • Using chemical -resistant materials of construction
Transportability	<ul style="list-style-type: none"> • Modular design 	<ul style="list-style-type: none"> • Designing system to fit within 20' ISO frames • Selecting ancillary systems that fit within 20' ISO containers
Remote Location	<ul style="list-style-type: none"> • High availability • Operator-level maintenance • Self-sufficiency 	<ul style="list-style-type: none"> • Installing redundant components • Using flanged connections • Procuring generators and water heaters • Designing custom electrical and air distribution systems
10-Day Setup/ Systemization	<ul style="list-style-type: none"> • "Plug-and-play" setup • Simplicity 	<ul style="list-style-type: none"> • Designing transport configuration to be very similar to operational configuration • Quick disconnects and easy-to-install flexible connections between components • Color-coding and component labeling



CAD modeling of primary skids by ADM (March 2013)

Reactor
Skid

Hydrolysis
Skid

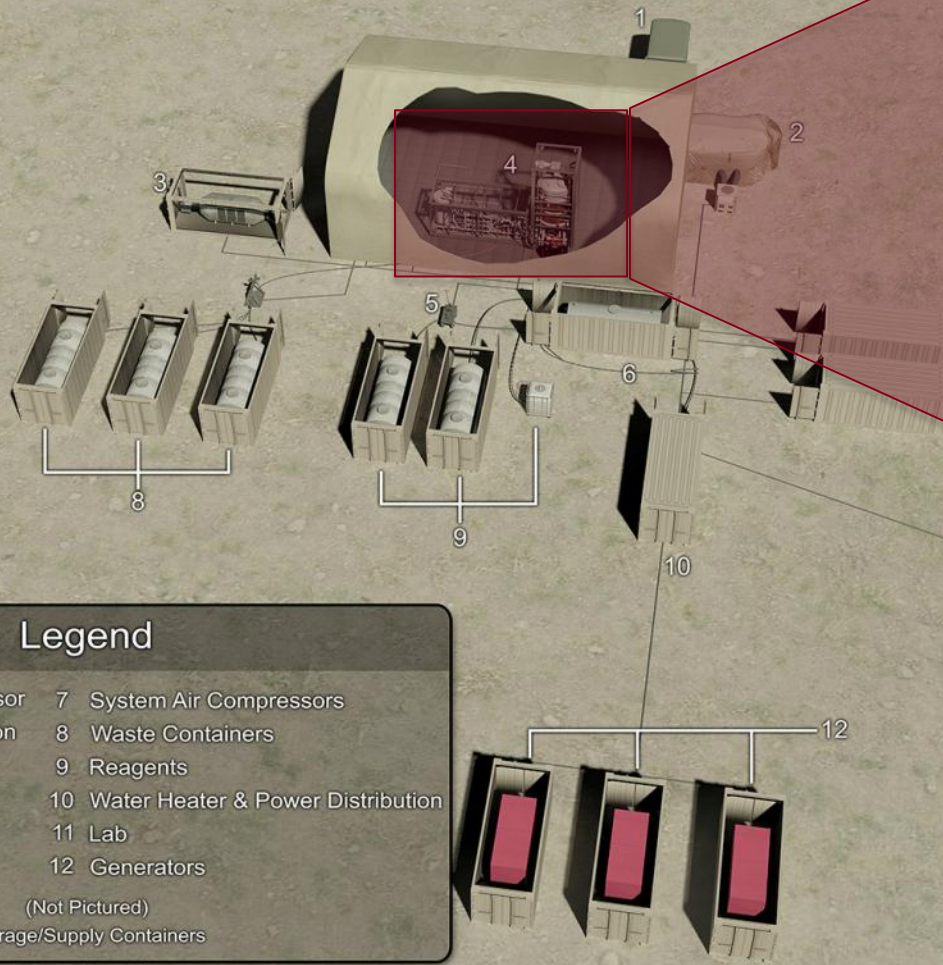




Modular System Design with FDHS Technology



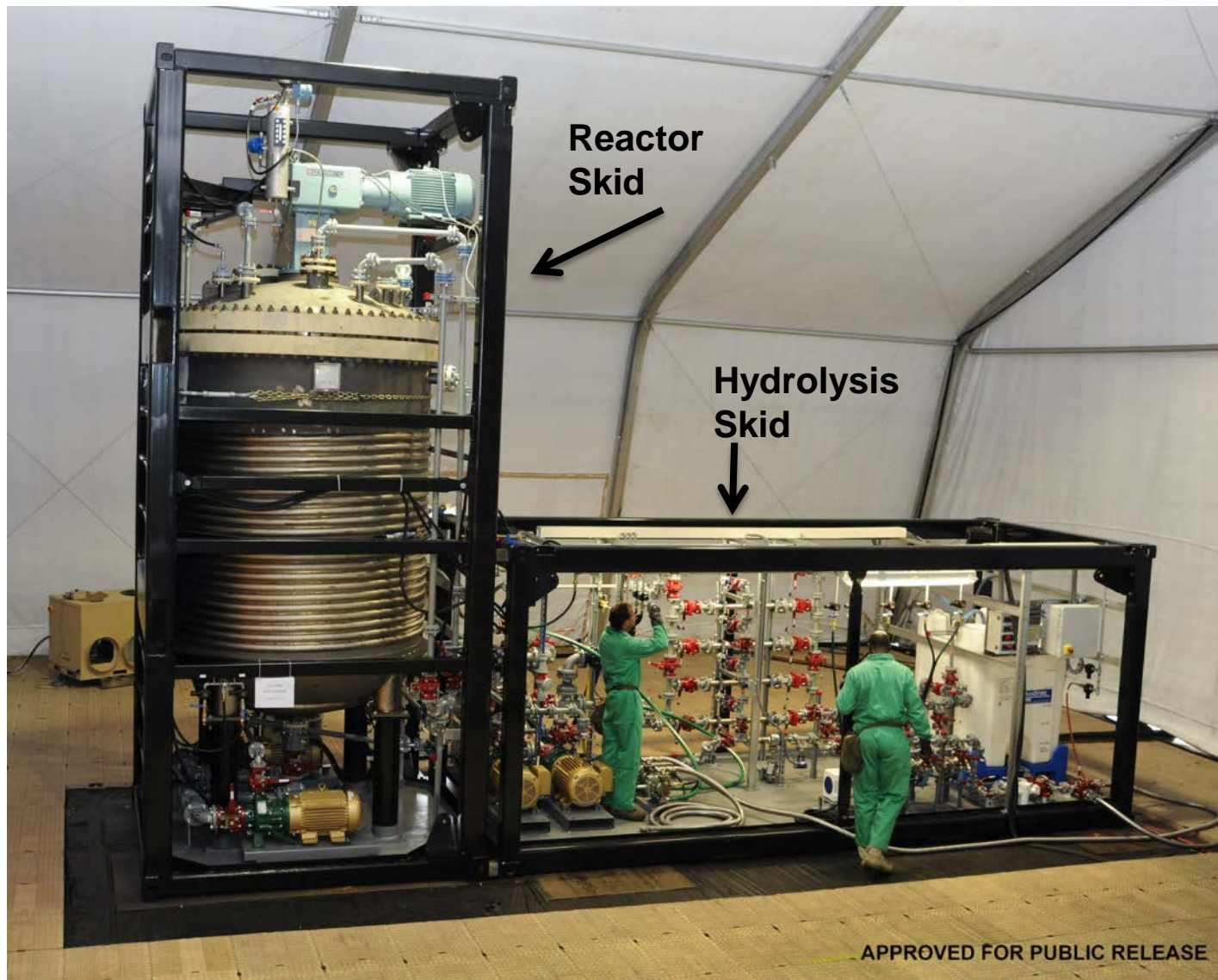
Field Deployable Hydrolysis System Site Layout



Legend

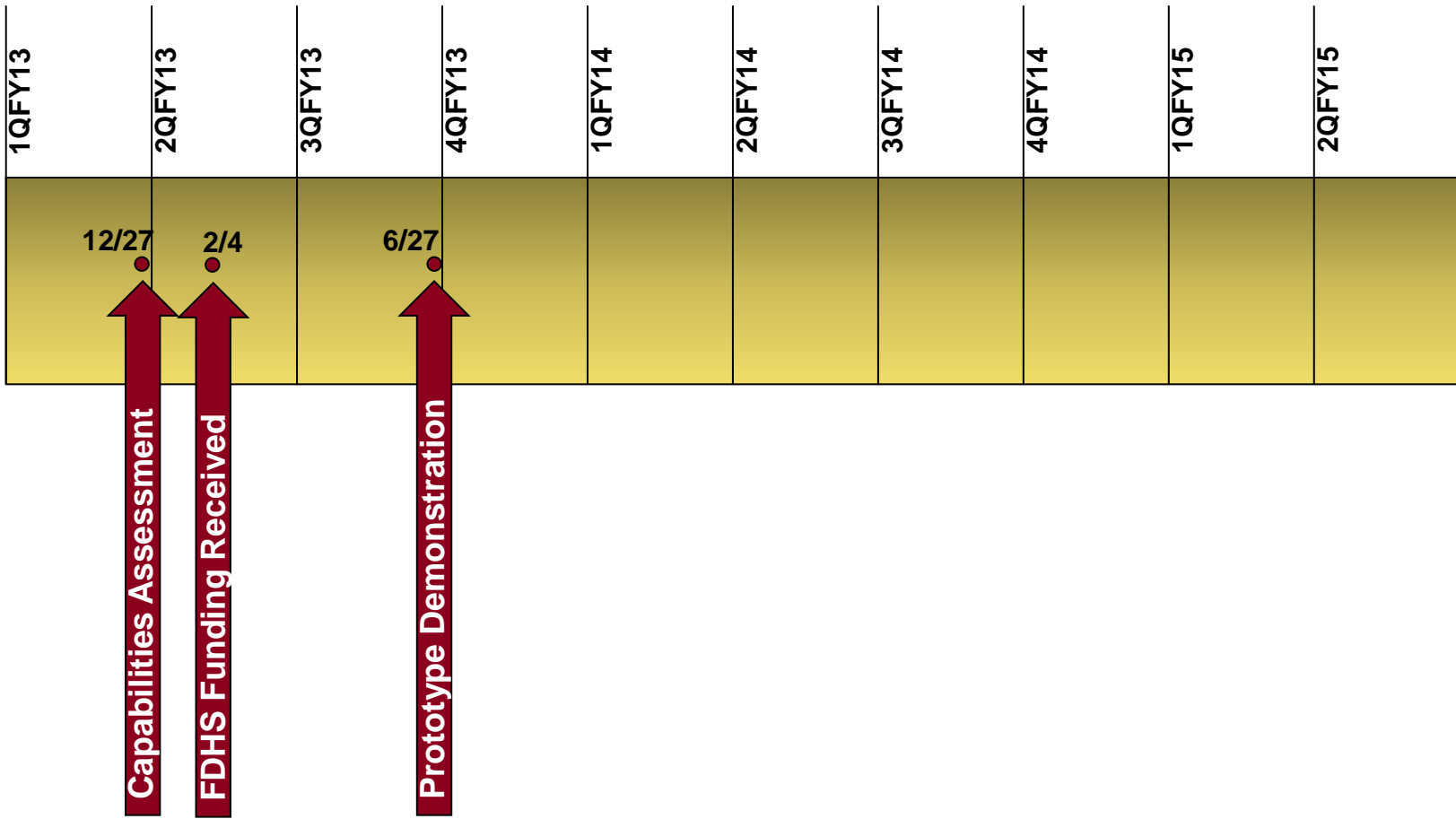
1 Breathing Air Compressor	7 System Air Compressors
2 Personnel Decon Station	8 Waste Containers
3 CAFS	9 Reagents
4 Hydrolysis System	10 Water Heater & Power Distribution
5 Water Pump	11 Lab
6 Water Tank	12 Generators

(Not Pictured)
Storage/Supply Containers





FDHS Project Timeline



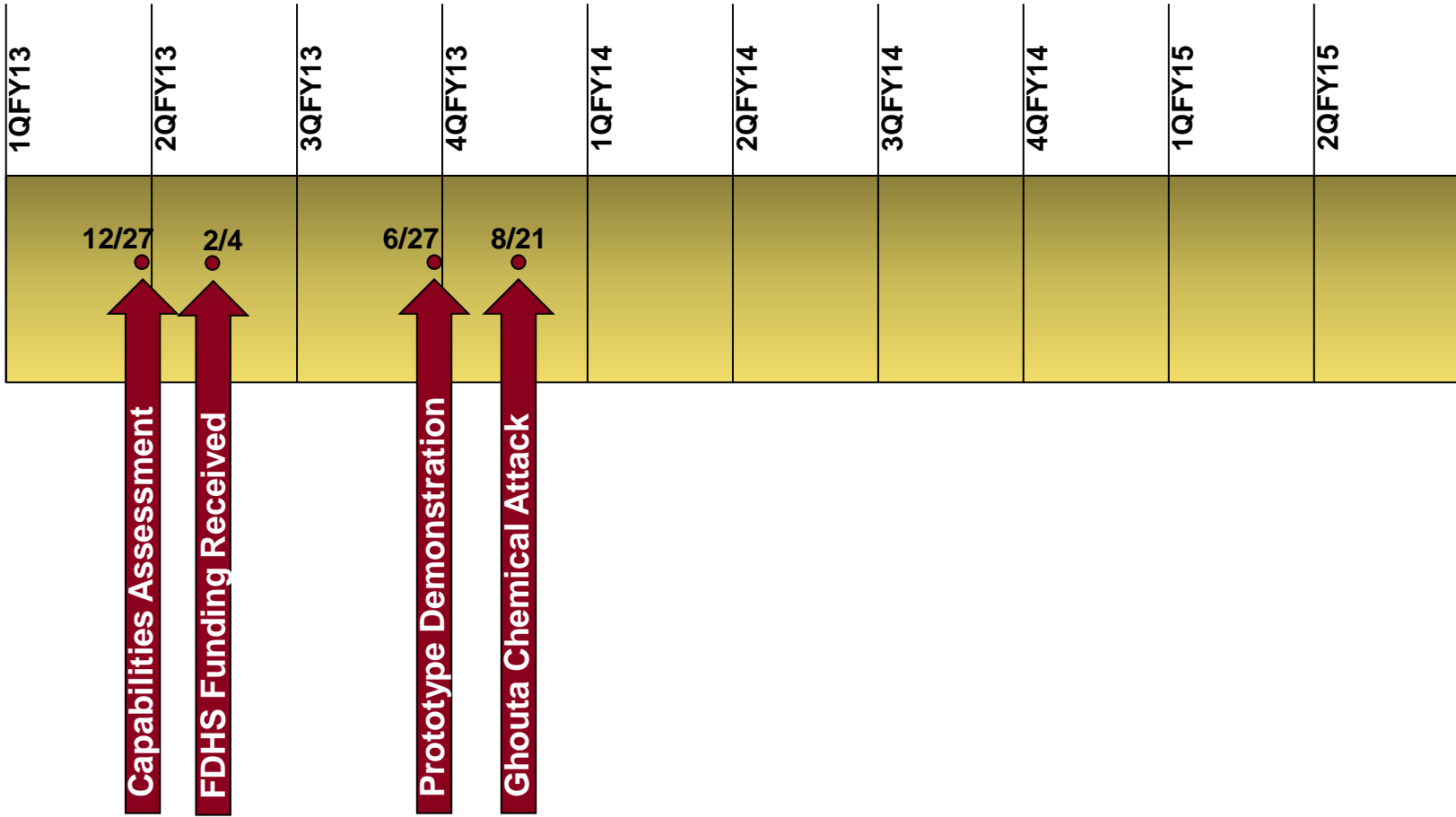


- **FDHS technology transferred from DTRA to JPEO on June 27, 2013**
- **Concept of Operations planning**
 - **6 systems deployed at 2 or 3 sites in country**
 - **Tabletop exercises**
 - **Materiel release for active duty operators**
- **Capability demonstration and validation conducted September 16-22, 2013**
- **7 FDHS systems procured/fabricated through May 2014**





FDHS Project Timeline





August 21, 2013

Sarin (GB) attacks on Ghouta

- Estimates range from a few hundred to over 1,000 deaths
- Assad regime accused of orchestrating attack

September 14, 2013

Syria agrees to turn over CW Stockpile



- Syria to sign Chemical Weapons Convention
- All CWM to be destroyed by June 30, 2014



Syria conflict: 'Chemical attacks kill hundreds'



The BBC's Frank Gardner says the footage shows people gasping for breath and convulsing

Chemical weapons attacks have killed hundreds on the outskirts of Damascus, Syrian opposition activists say.

Rockets with toxic agents were launched at the suburbs of the Ghouta region early on Wednesday as part of a major bombardment on rebel forces, they say.

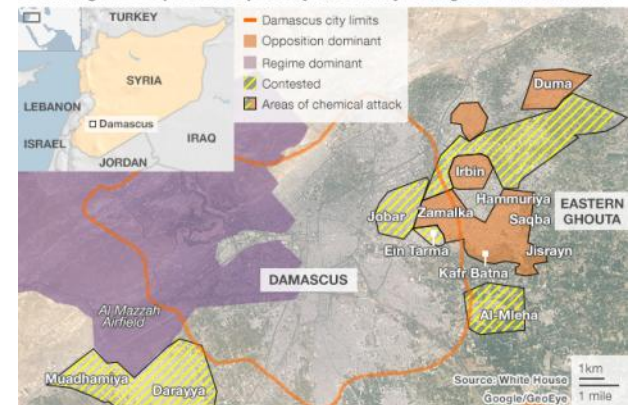
The Syrian army says the accusations have been fabricated to cover up rebel losses.

Syria conflict

'No-one cares'
'Till the last drop of blood'

Suffering in west Aleppo

US intelligence map: Areas reportedly affected by 21 August chemical attack





- **Possibility of ship-based destruction raised by JPEO/ECBC/DTRA, with two FDHS platforms on board**
 - Provides ample water supply
 - Provides security
- **Design team visited ships in September 2013 in Baltimore and Portsmouth**
- **No countries volunteered to accept Syrian CW for destruction**
- **Cape Ray, part of the Maritime Administration's Ready Reserve Fleet, selected for mission in November 2013**





MARAD



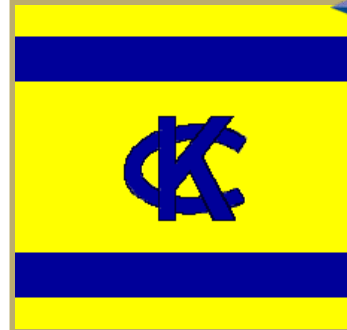
- DOT organization that runs the Ready Reserve Fleet
- Coordinated all modifications to Cape Ray

DTRA



- Organization that runs the Cooperative Threat Reduction (CTR) program
- Provided funding and planning support

Keystone



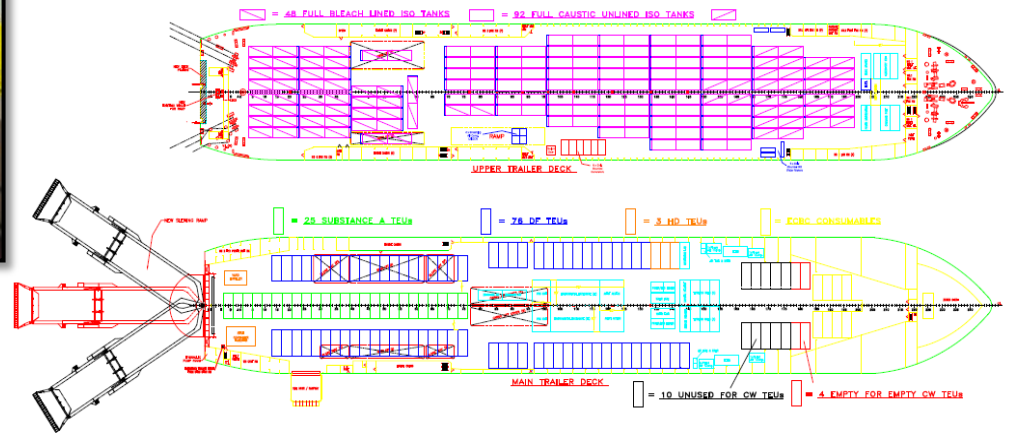
- Contractor that operates the Cape Ray
- Assisted in installation
- Integrated all on-board installations



- DoD approval authorities
- Guided installation process and issued approvals for operation

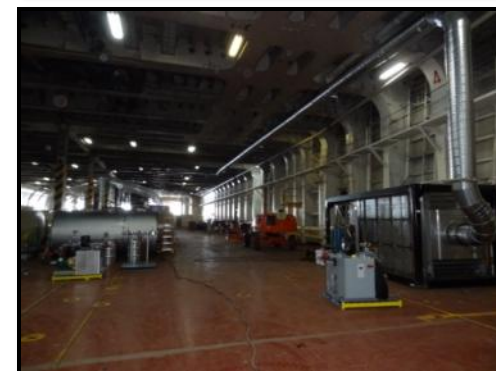


- **Problem: Loading and storing all equipment and material on Cape Ray**
 - 269 total ISO containers (6,000 gal each) on board
 - 78 shipping containers full of Syrian CW
 - Very limited capability for transfer of equipment within and to/from Cape Ray
 - Distribution of loads changing daily during operations



- **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

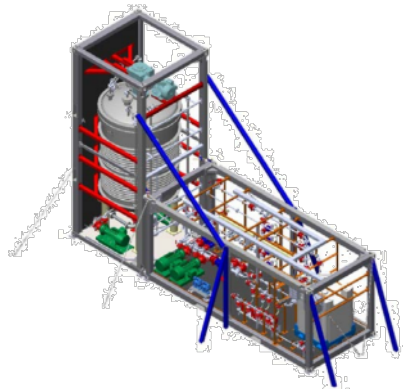
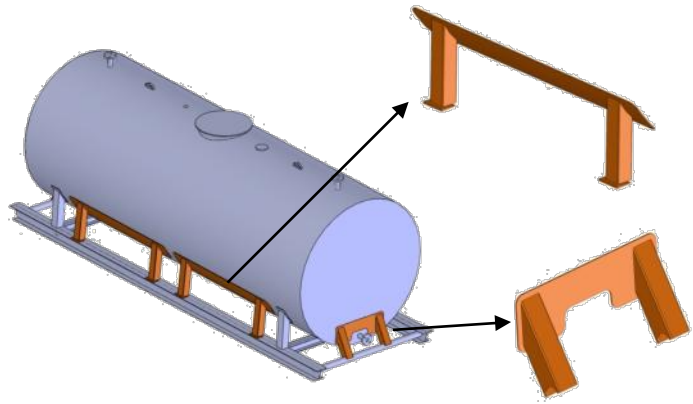
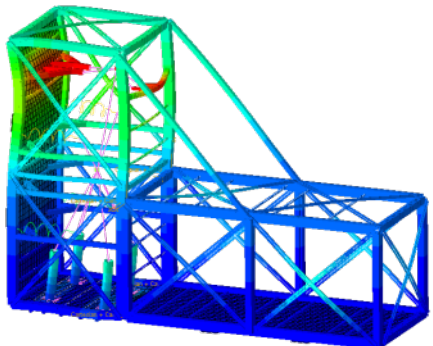
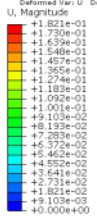
- **Problem: Requirement to prevent agent liquid or vapor release to the environment**
- **Approach:**
 - **FDHS equipment and all Syrian CW stored on Main Trailer Deck**
 - **Only reagent and effluent pass between decks – no agent**
 - **Existing ventilation system retrofitted with carbon filtration**
 - **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**





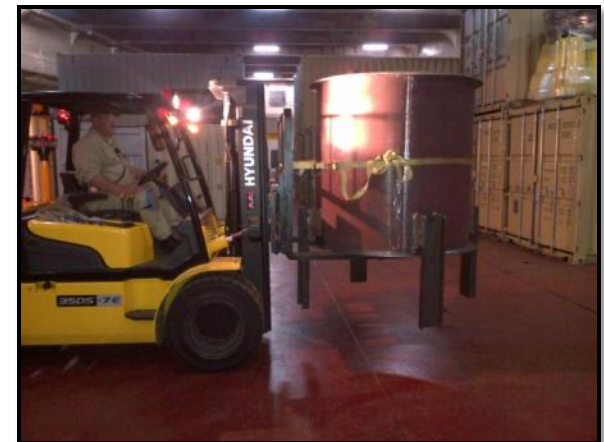
- **Problem: Ship environment imposes unusual forces on equipment**
 - Vibration effects of ship's propeller
 - Forces in multiple directions caused by ship movement, “sloshing” of liquid
- **Approach:**
 - ADM, AMSAA, and Navy personnel performed analysis
 - Additional bracing installed for primary FDHS skids and holding tanks
 - Ship roll/pitch limits implemented to halt operations in worst conditions

OCB: F9H0-Quad-Freq_ToLash-FTI.cdb Abaqus/Standard 6.12.2 Wed Dec 11 22:37:35 Eastern Standard Time 2013
 Step: Step-Frequency
 Mode: 19 Value = 7332.2 Freq = 13.994 (cycles/min)
 Primary Var: U, Magnitude
 Deformed Var: U, Deformation Scale Factor: +1.000e+02



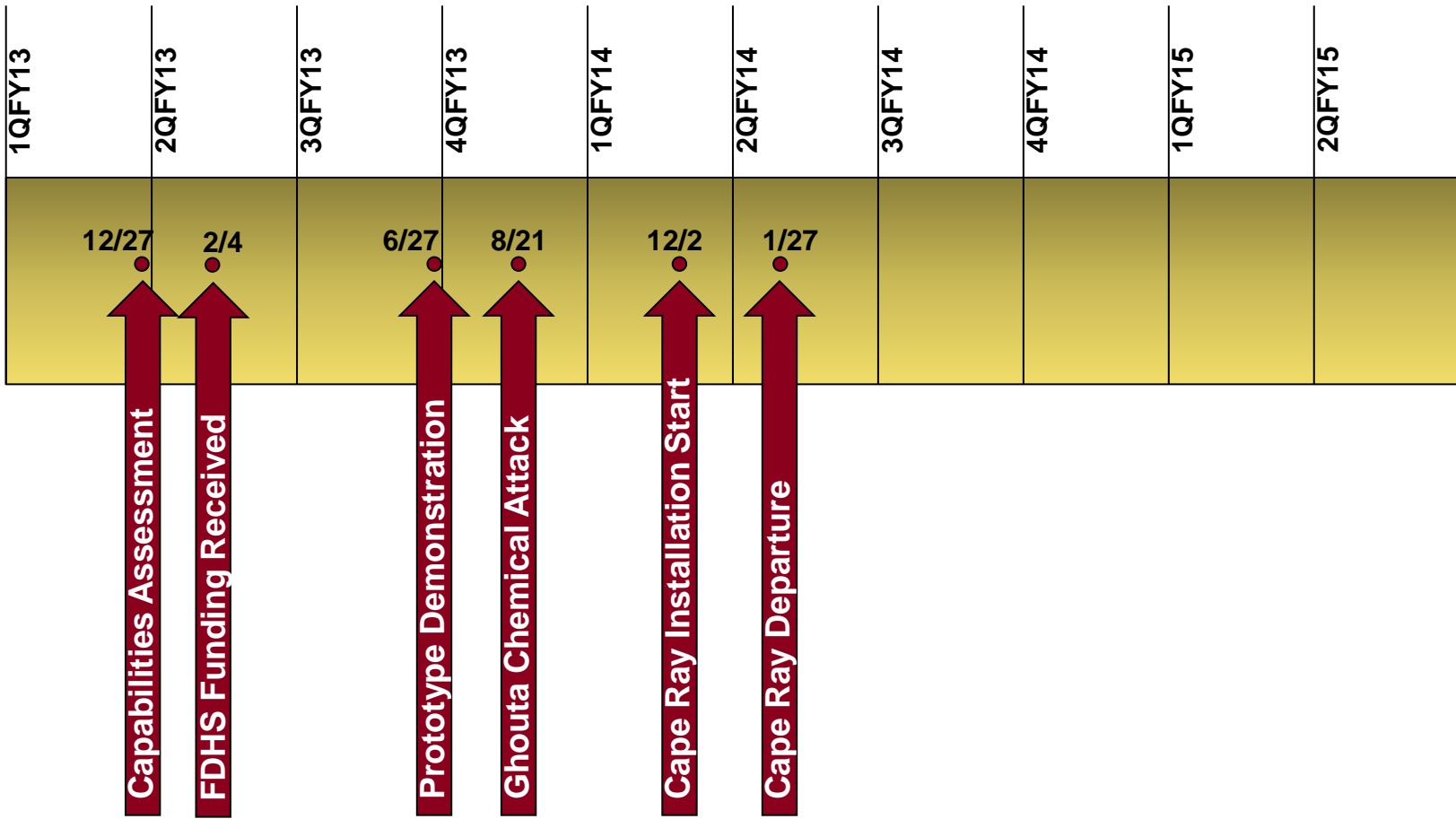


- **Problem: Movement of Syrian DF tanks**
 - Weight of tanks over 8,000 lbs each
 - Aisle space between containers and FDHS equipment ~ 8 feet (severely limits forklift movement)
- **Approach:**
 - Container movement system developed by CBARR and ADM engineers/operators
 - Allowed for movement of containers without personnel inside shipping container or in path of movement
 - Positive control maintained on front and rear side of tank, mitigating effects of ship movement
 - Minimized risk of spill or injury





FDHS Project Timeline





Operate FDHS and Cape Ray



Mission Leadership



Accept CWM at Latakia



Provide Port for Transload



Facilities Contracted for Industrial Chemical and DF Waste Disposal



Destroy V-series Precursors



Security Support



HD Waste Disposal





NAVEUR

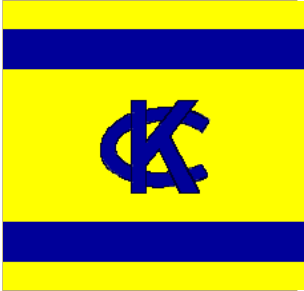


- US Naval forces Europe (subordinate to EUCOM)
- Overall mission responsibility



- FDHS Operational Team
- Conducted agent ops and provided oversight of all chemical ops

Keystone



- Contractor that operates the Cape Ray
- Performed all standard ship management functions

Parsons



- Contractor for DTRA's CTR program
- Provided non-agent operational support to FDHS ops team

OPCW



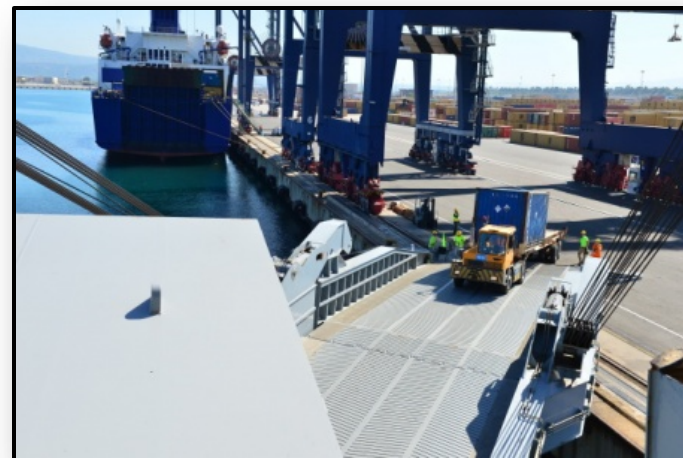
- Organization charged with enforcing CWC
- Observed agent operations and certified CWC compliance

DTRA



- Organization that runs the CTR program
- Funded all Cape Ray operations

- **100% inspection of Syrian containers**
- **Concurrent DF operations in both systems**
- **HD operations in one system**
- **24/7 operations**
- **Ramp-up to full throughput and shift work**

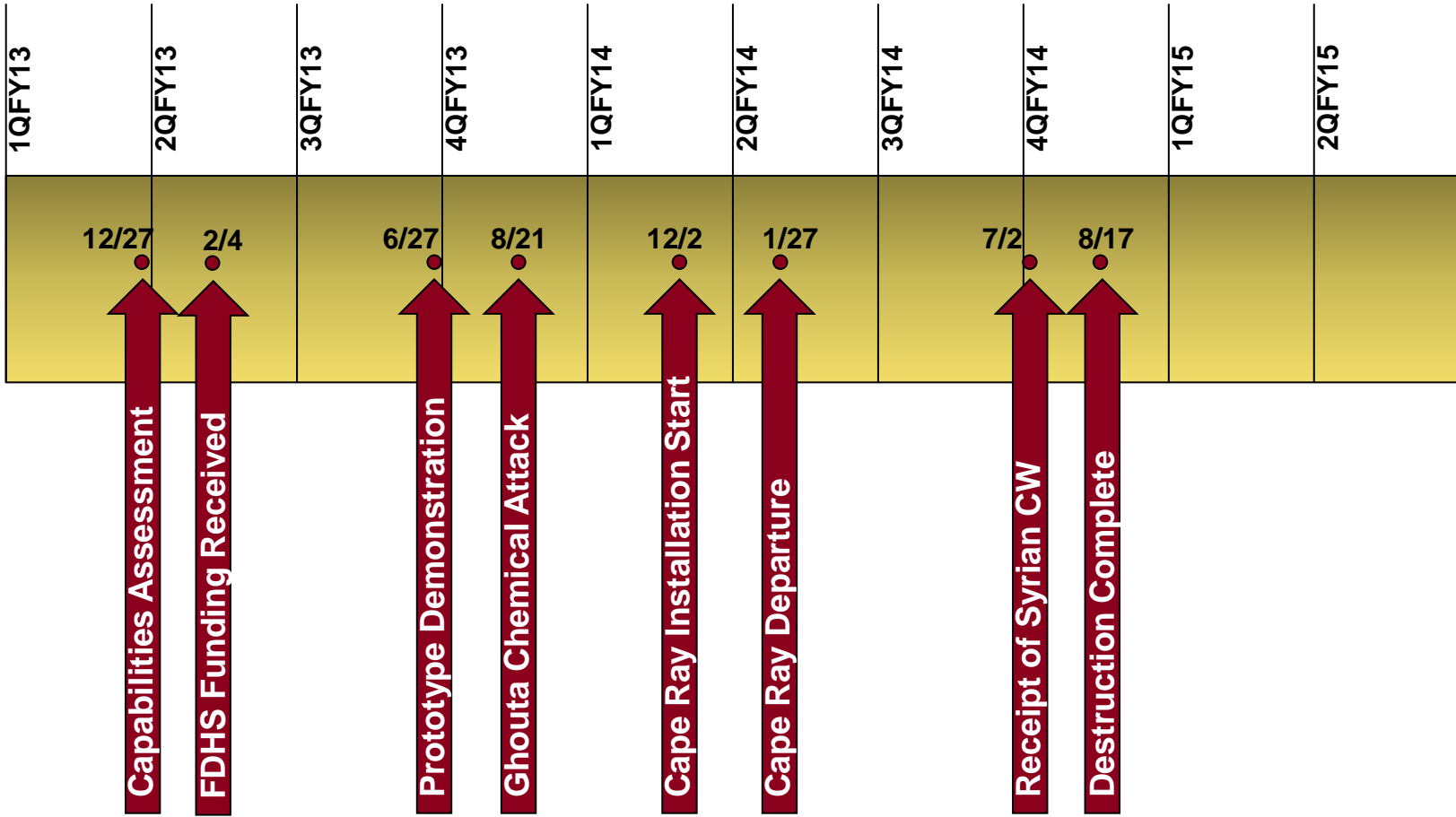


- **Buildup of solids in pH adjustment tanks**
- **High temperatures in work area**
- **Effluent management and near-real-time load plan adjustments**





FDHS Project Timeline





- **Agent operations started July 7, 2014**
- **Agent operations completed August 17, 2014**
- **580 MT of DF and 20 MT of HD destroyed in 42 days**
- **Offloading of waste completed September 5, 2014**
- **Cape Ray return to Portsmouth September 17, 2014**
- **Cape Ray operations area cleared of DF/HD January 14, 2015**

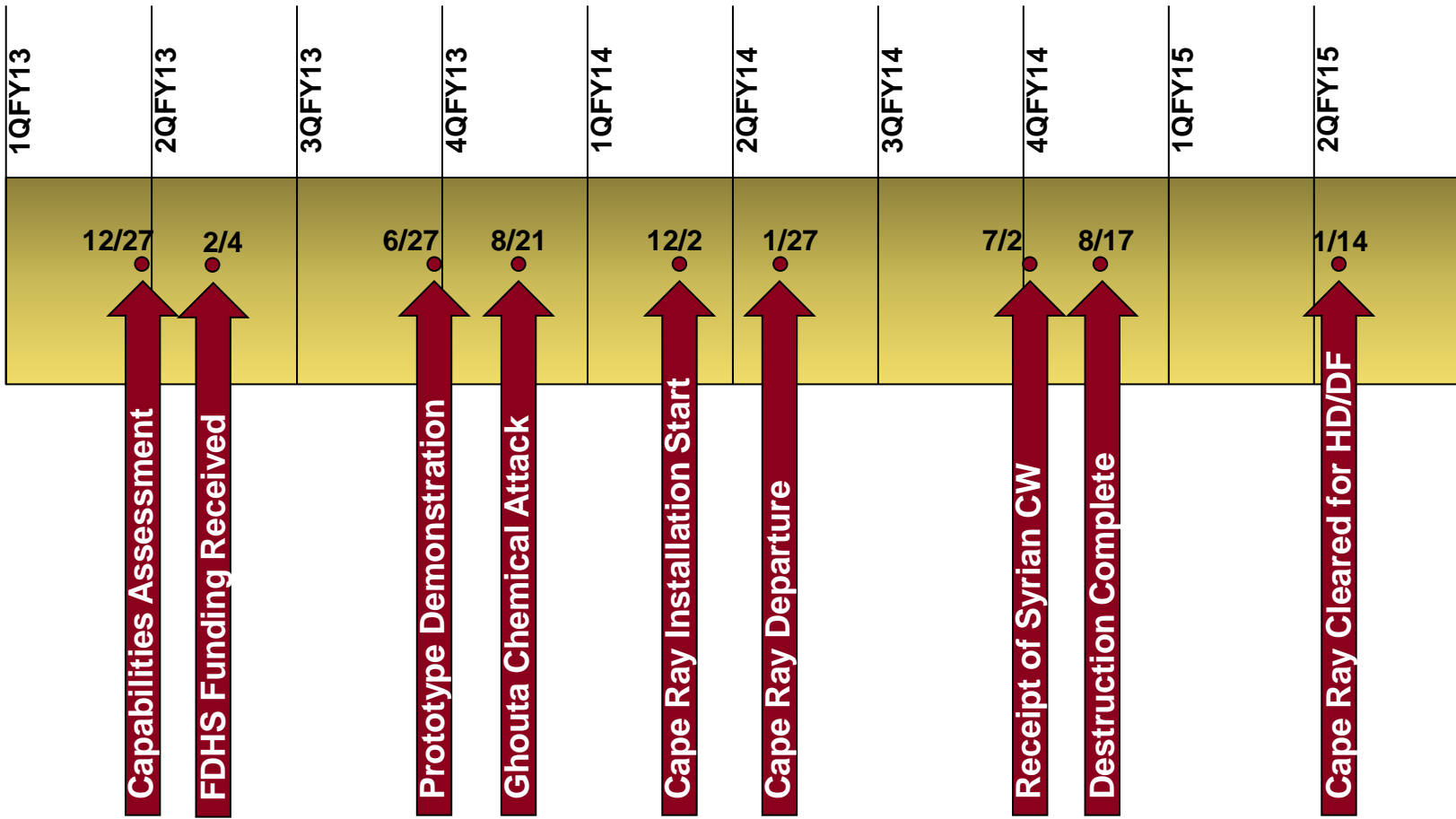
Next Steps:

- **All FDHS equipment stored at APG-EA awaiting future use**
- **Cape Ray to be returned to Ready Reserve Fleet**





FDHS Project Timeline





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 with varied expertise, accomplishing remarkable things in extraordinarily short timeframes.



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