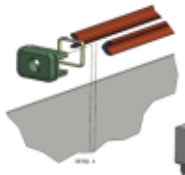
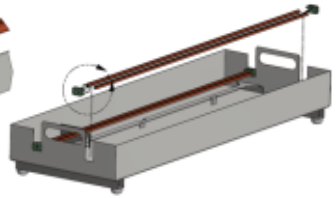
SAND2019-5182C

Sandia National Laboratories

Chemical Agent Identification Set Demilitarization in the Explosive Destruction System





PRESENTED BY

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22nd Annual International Chemical Weapons Demilitarisation Conference
May 22-24, 2019 | London, United Kingdom

RCMD

U.S. DEPARTMENT OF ENERGY | NNSA

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Background

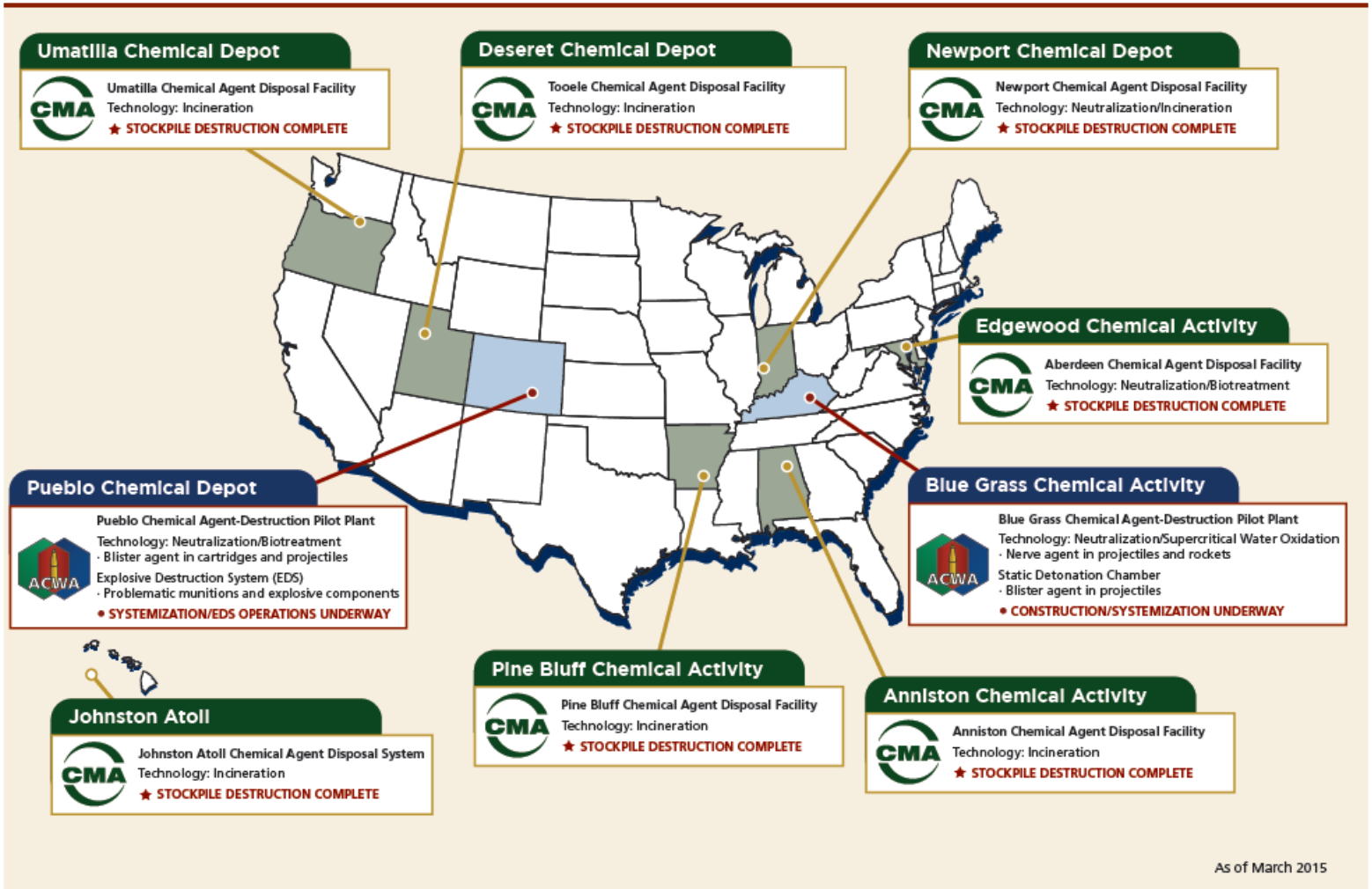
Historical Disposal of Chemical Warfare

- The United States disposed of chemical warfare materiel by burial, an approved and internationally accepted disposal method until the 1970s.
- Chemical warfare items are periodically recovered at formerly used defense sites or active military installations.

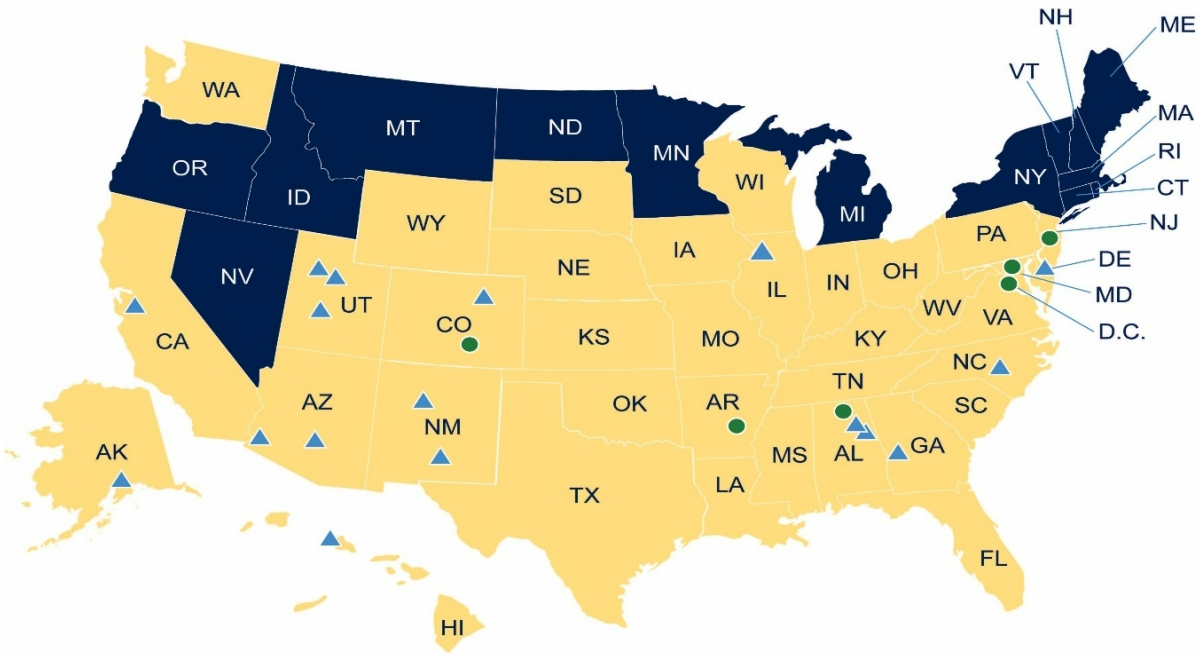
Demilitarization of Chemical Weapons

On behalf of the U.S. Department of Defense, the U.S. Army Chemical Materials Activity (CMA) Recovered Chemical Materiel Directorate (RCMD) provides centralized management for assessment and disposal of recovered chemical warfare materiel (RCWM) in a safe and environmentally sound manner.

U.S. Chemical Stockpile Demilitarization



RCMD Achievements



Key

from 1994 - 2018

- Assessment missions performed to identify contents of items with unknown liquid fills.
- No assessment or treatment missions performed
- Destruction operations of chemical warfare materiel
- Ongoing operations

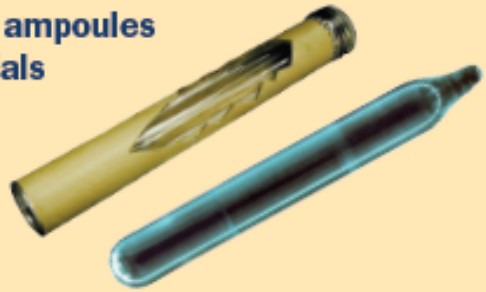
Not all assessments result in a finding of recovered chemical warfare materiel. If the item does not contain chemical warfare materiel, it is disposed of locally.

Treatment Locations

Location	Years	System
Fort Richardson, AK	2003	RRS
Camp Sibert, AL	2002, 2010	EDS
Former Fort McClellan, AL	2003, 2007	SCANS
Redstone Arsenal, AL	2009 (SCANS), 2010 (EDS)	SCANS & EDS
Pine Bluff Arsenal, AR	2005 - 2006 (RRS), 2006 - 2010, 2003, 2018 (EDS)	RRS & EDS
Former Williams AFB, AZ	2011	SCANS
Yuma Proving Ground, AZ	2016	SCANS
Livermore, CA	1999, 2001, 2002, 2005	EDS
Pueblo Chemical Depot, CO	2015 - 2016, 2018	EDS
Rocky Mountain Arsenal, CO	2001	EDS
Spring Valley, Washington, D.C.	2003, 2010	EDS
Dover AFB, DE	2004 - 2006, 2008 - 2009, 2012, 2014	EDS
Fort Benning, GA	2006	SCANS
Schofield Barracks, HI	2008 (TDC), 2015 (EDS)	TDC & EDS
Savanna Army Depot, IL	2017	EDS
Aberdeen Proving Ground - Edgewood Area, MD	2002 (SCANS), 2001 - 2005, 2008 - 2011 (EDS), 2017 (MAPS)	SCANS, EDS & MAPS
Fort Bragg, NC	2007	SCANS
Joint Base McGuire-Dix-Lakehurst, NJ	2016	EDS
Albuquerque, NM	1998, 2005	EDS
Holloman AFB, NM	2004	SCANS
Deseret Chemical Depot, UT	2001	RRS
Dugway Proving Ground, UT	2004, 2009	EDS
Tooele Army Depot-South, UT	2016	EDS

Chemical Agent Identification Sets (CAIS)

- Used 1928 - 1969 to train soldiers and sailors in the safe handling, identification, and decontamination of chemical warfare agents.
- Consist of chemical agents placed in glass ampoules, vials, and bottles.

CAIS CONFIGURATIONS	
Glass ampoules and vials 	**Could contain:** • 5% lewisite in chloroform • Pure phosgene • GA-simulant • 5% sulfur mustard in chloroform 10% nitrogen mustard in chloroform Pure cyanogen chloride • 50% chloropicrin in chloroform
Glass bottles 	**Could contain:** • Pure sulfur mustard • Lewisite on charcoal • Chloropicrin on charcoal • Solid chloroacetophenone • Sulfur mustard on charcoal • Nitrogen mustard on charcoal • Solid triphosgene • Solid adamsite

Progression of Technologies for CAIS Destruction

- In the early 1980s, the Army destroyed approximately 21,000 CAIS by incineration.
- The Rapid Response System (RRS) was used to destroy more than 5,300 CAIS items at Pine Bluff Arsenal (PBA) Aug 2005 – Nov 2006.
- Since then, CAIS are typically recovered in the single digits.

  The Single CAIS Access and Neutralization System (SCANS) was developed to destroy individual CAIS bottles.

RRS

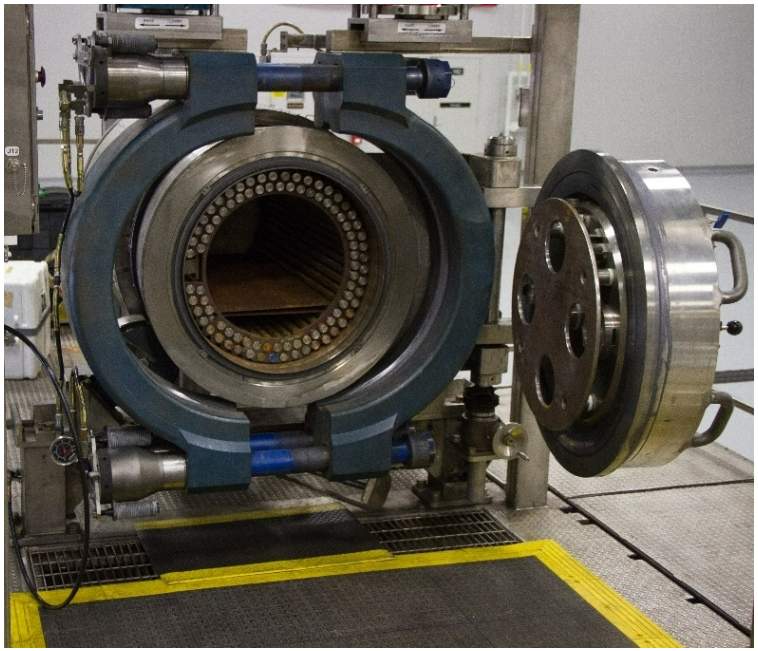
SCANS

Recent CAIS Recoveries

- During remediation activities at Pine Bluff Arsenal in February 2017, The US Army Corps of Engineers (USACE) recovered 7,101 CAIS K-941 bottles containing mustard.
- SCANS would not be sufficient to handle such a large quantity in a reasonable amount of time and the RRS was no longer operable.
- RCMD engaged SNL to develop a method for destroying the CAIS using the Explosive Destruction System (EDS).
- All CAIS items were successfully destroyed in 2019.

Recovered CAIS

Explosive Destruction System (EDS)



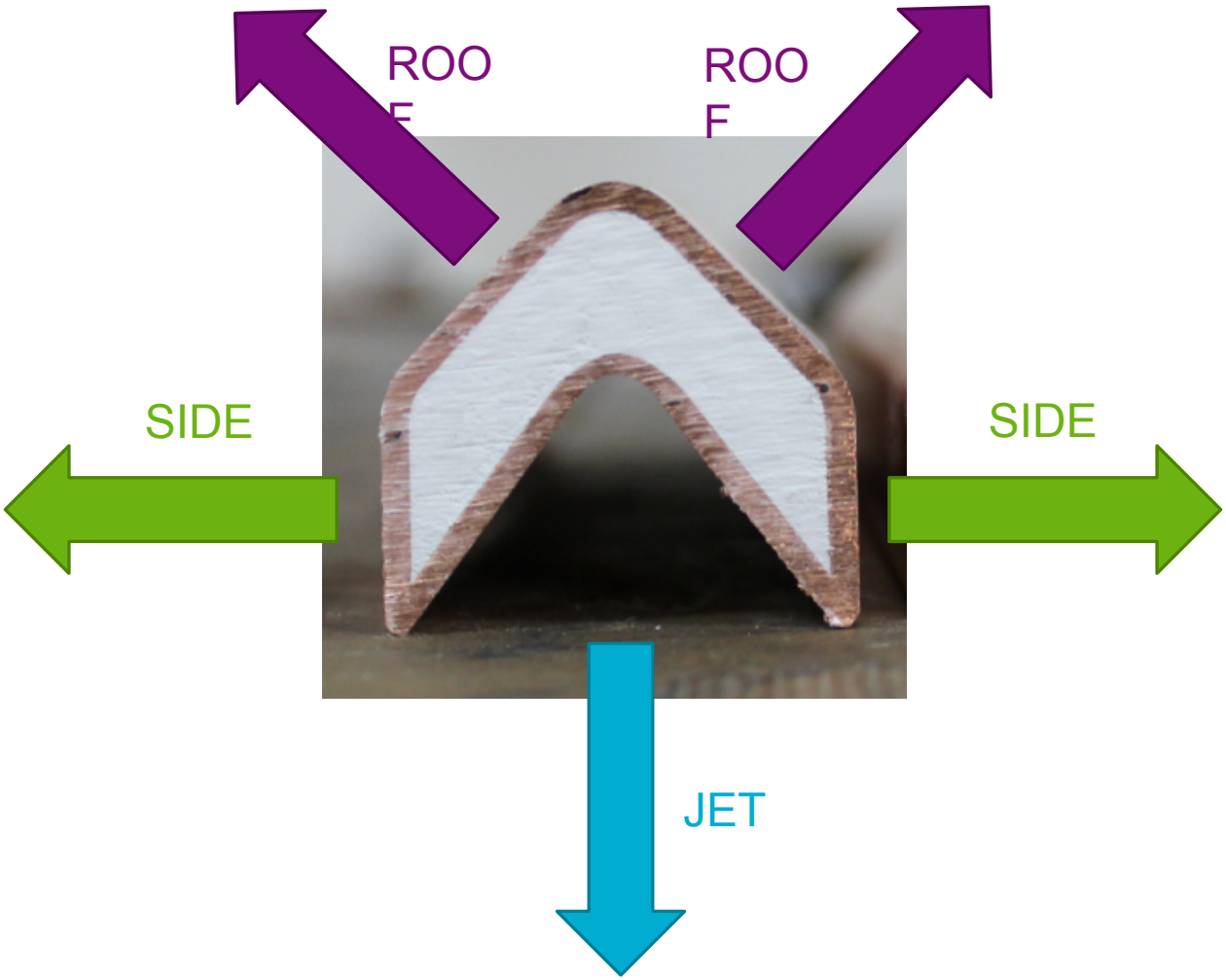
- The Army's premiere technology for destroying RCWM
- Provides a safe, innovative alternative to open detonation of explosively configured munitions
- Operates within an environmental enclosure under negative pressure and with carbon filters to ensure no agent or vapor release into atmosphere
- Uses shaped charges to cut open chemical munitions and eliminate their explosive capacity before neutralizing the chemical agent
- The sealed, stainless steel vessel contains all blast, vapor, and fragments from the process
- Waste produced is suitable for commercial disposal

Initial Testing

Initial Testing

- Several explosive tests performed to answer questions about recovered bottle containment and packing methods
- Linear shaped charge (LSC) was selected due to operator experience, LSC availability, and pre-existing permits
- Bottles were filled with a 24% by weight solution of Epsom salt ($MgSO_4$) in tap water to simulate the density of HD
- Widely available 4-ounce Boston round glass bottles were used
- Since field containment/packing methods varied, multiple scenarios were tested:
  - Bare bottles
  - Bottles bagged in a single Ziploc bag
  - Bottles double-bagged and taped
  - Bottles double-bagged and placed inside cardboard tubes
  - Other variations in bagging methods

Does LSC jet, “roof” jacket, or side jacket break more bottles?



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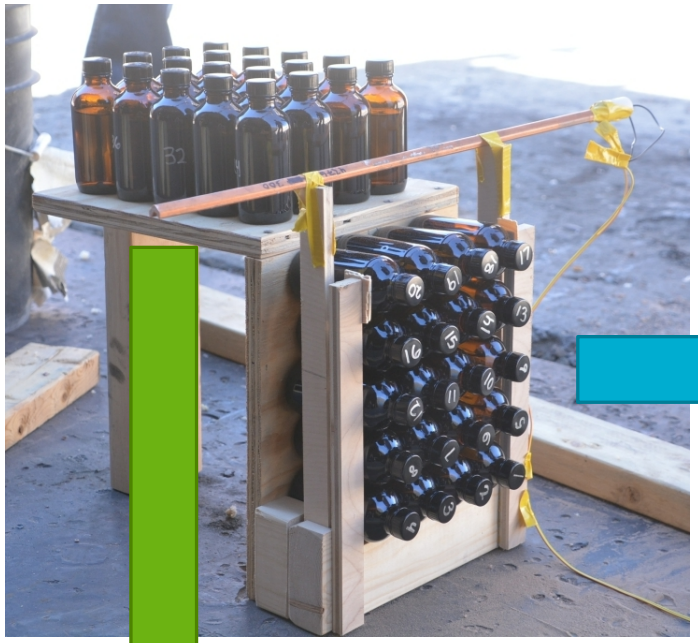


Standoff: 2.375”

SIDE

JET

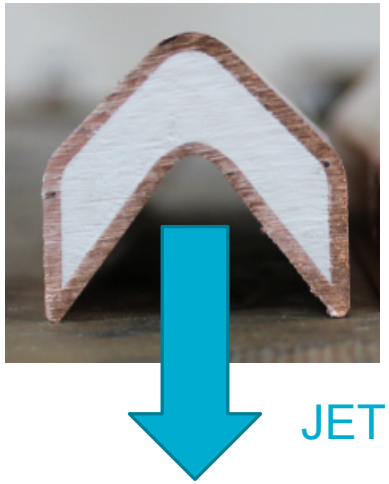
Does LSC jet, “roof” jacket, or side jacket break more bottles?

ROOF

Standoff: 0.375”

Does LSC jet, “roof” jacket, or side jacket break more bottles?

Fragment direction	Rows of complete destruction	Rows of nearly complete destruction	Total affected rows
JET	1	2	5
SIDE	1	1	4
ROOF	2	1	5

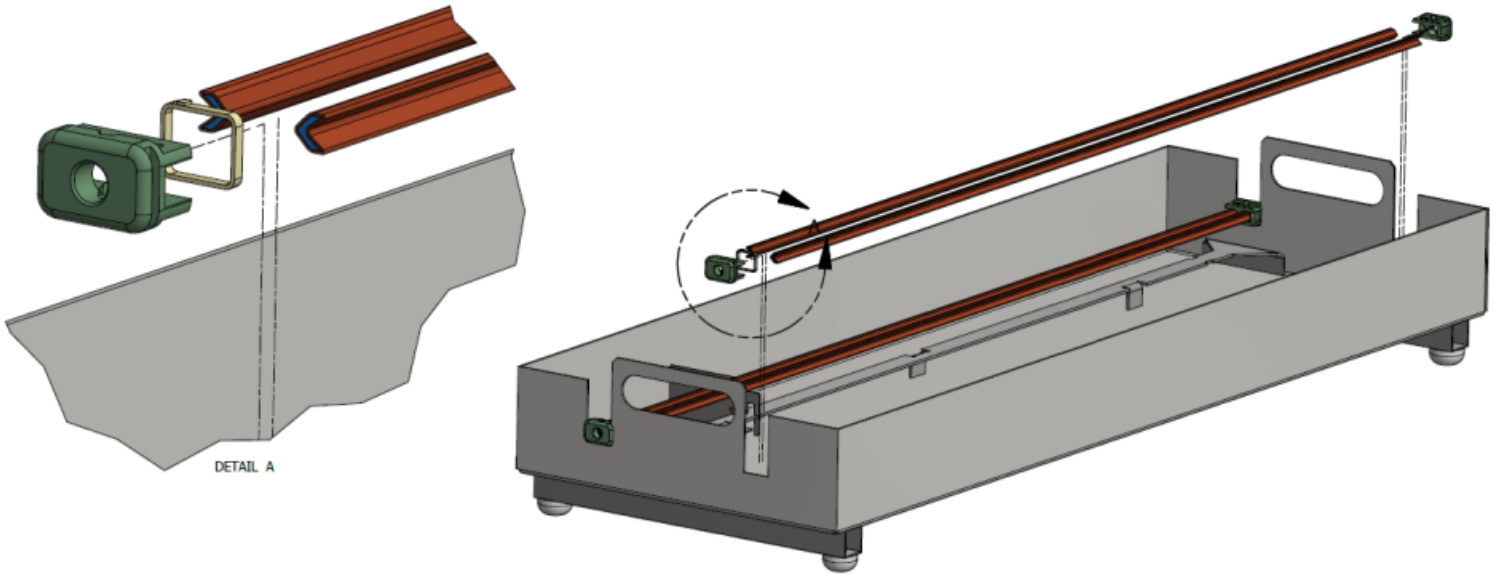


Can LSC jet open bagged vials inside of cardboard tubes?

Can one detonator initiate two charges?

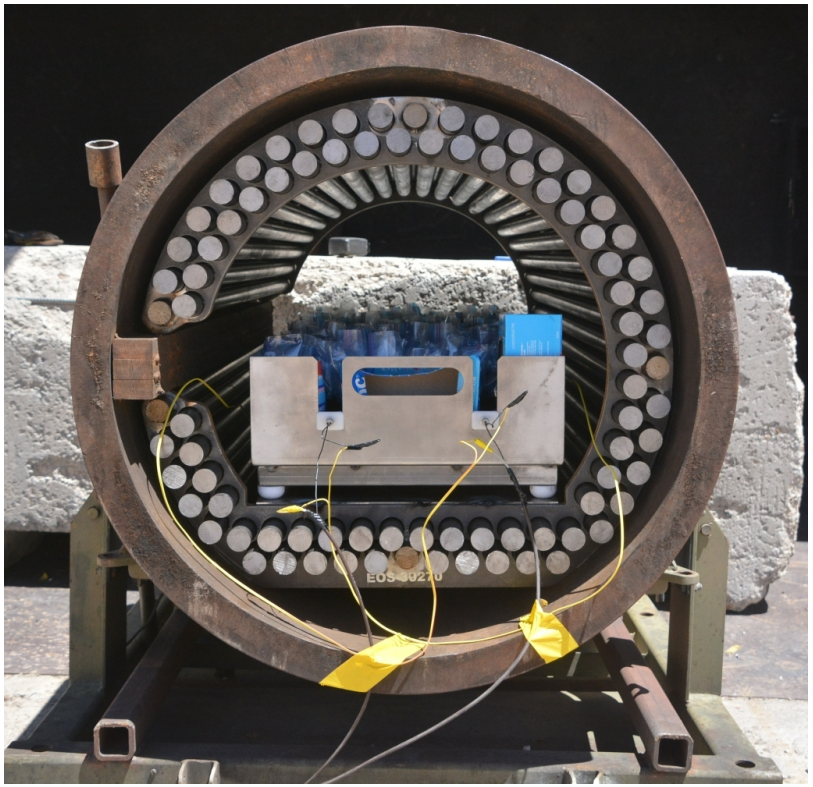
Yes!

CAIS Holder Design



- Holder uses four 4-foot long pieces of 300 GPF LSC
- Each detonator initiates two charges at the same time
- Bottles positioned in sections of 2-4-2 bottles wide

Does the design access double-bagged bottles?



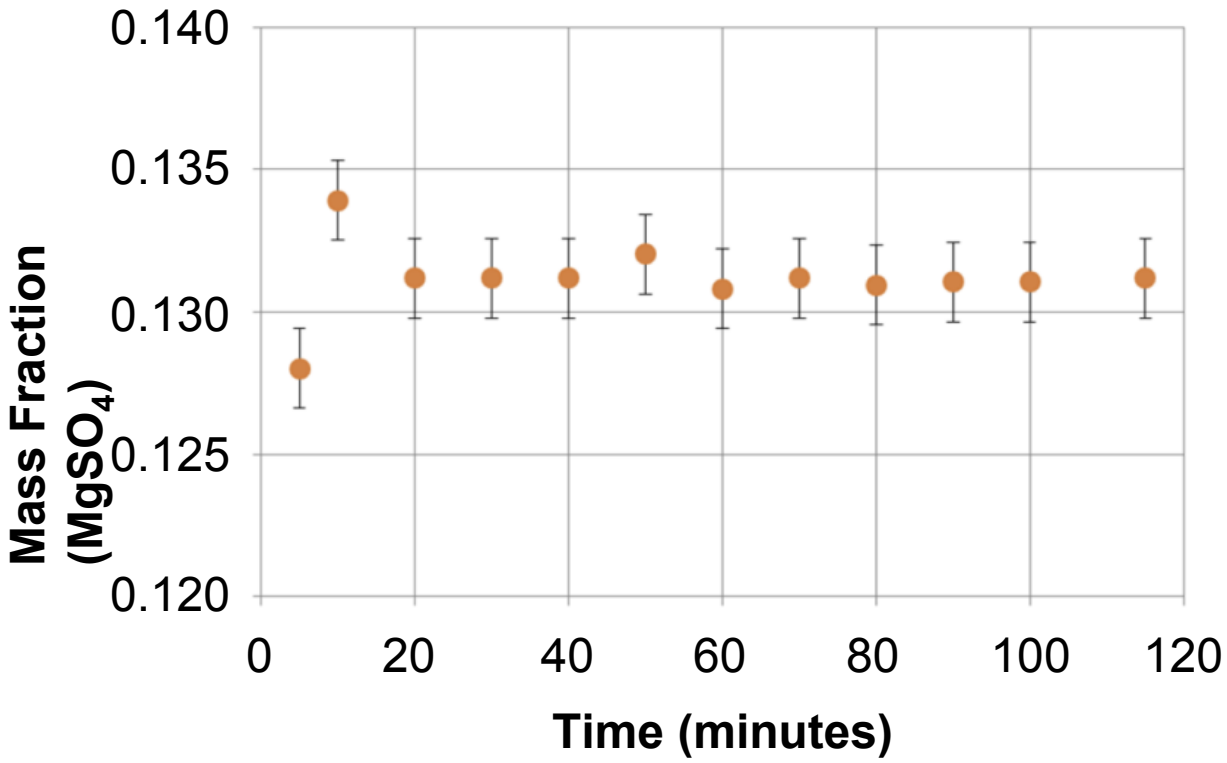
Test performed in mock EDS vessel

All bottles were double-bagged, rolled, and taped (worst-case)

Does the design access double-bagged bottles?

Yes! No bottles were intact. Every bag was accessed.

Can the neutralent access the occluded agent?



Salt (surrogate) concentration was determined by measuring the ionic conductivity of the neutralent. Most of the salt was extracted from the debris within 30 minutes. Testing showed that 8.2±4% of the salt remained occluded in the plastic bags.

Will the EDS be able to drain effectively?

- Surrogate testing showed that the debris did not impede the draining process
- The bag debris stayed in the advanced fragment suppression system (AFSS) bars
- The image shows an example of granular glass accumulation near a drain port

Operational Testing

Operational Testing by RCMD

- Four operational tests were performed by RCMD at Aberdeen Proving Ground
- Only issue that occurred was the liquid sample adapter clogging
  - Bottle cap liner blocked the liquid sample port—coincidentally, they're the same size!
- There were no issues draining the vessel
- Bottles and bags were successfully accessed in each test
- Debris easily cleared between shots
- Addition of vermiculite did not cause issues

Destruction at Pine Bluff Arsenal Using the EDS

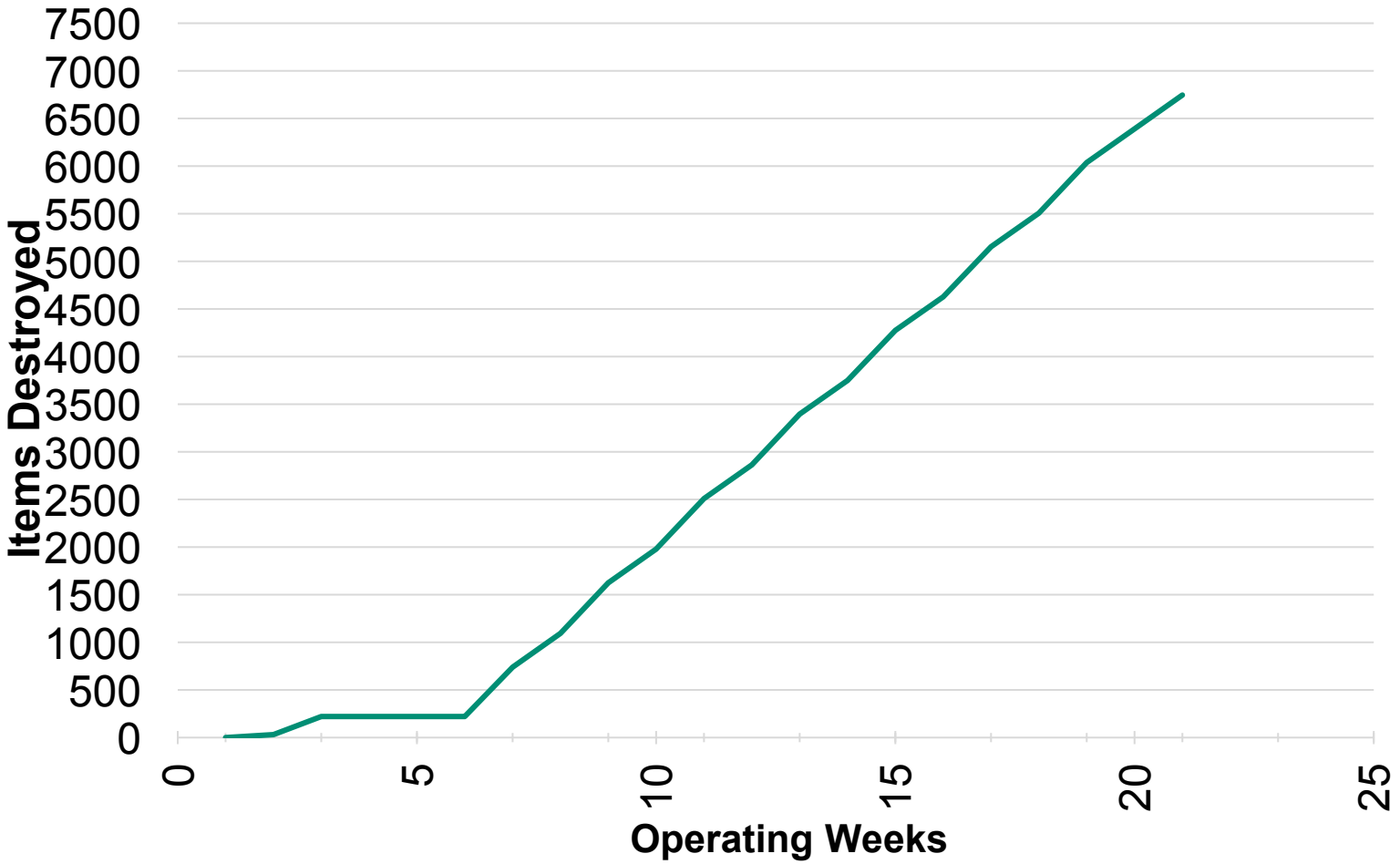
Destruction at Pine Bluff Arsenal Using the EDS

- EDS with CAIS bottle holder can destroy up to 188 CAIS bottles.
- The Pine Bluff Arsenal permit limits EDS operation to 50 lbs of mustard per shot, the equivalent of 178 full CAIS bottles.
- Pine Bluff Explosive System Destruction (PBEDS) operational schedule alternated between accomplishing two shots in one week and three shots in the next.

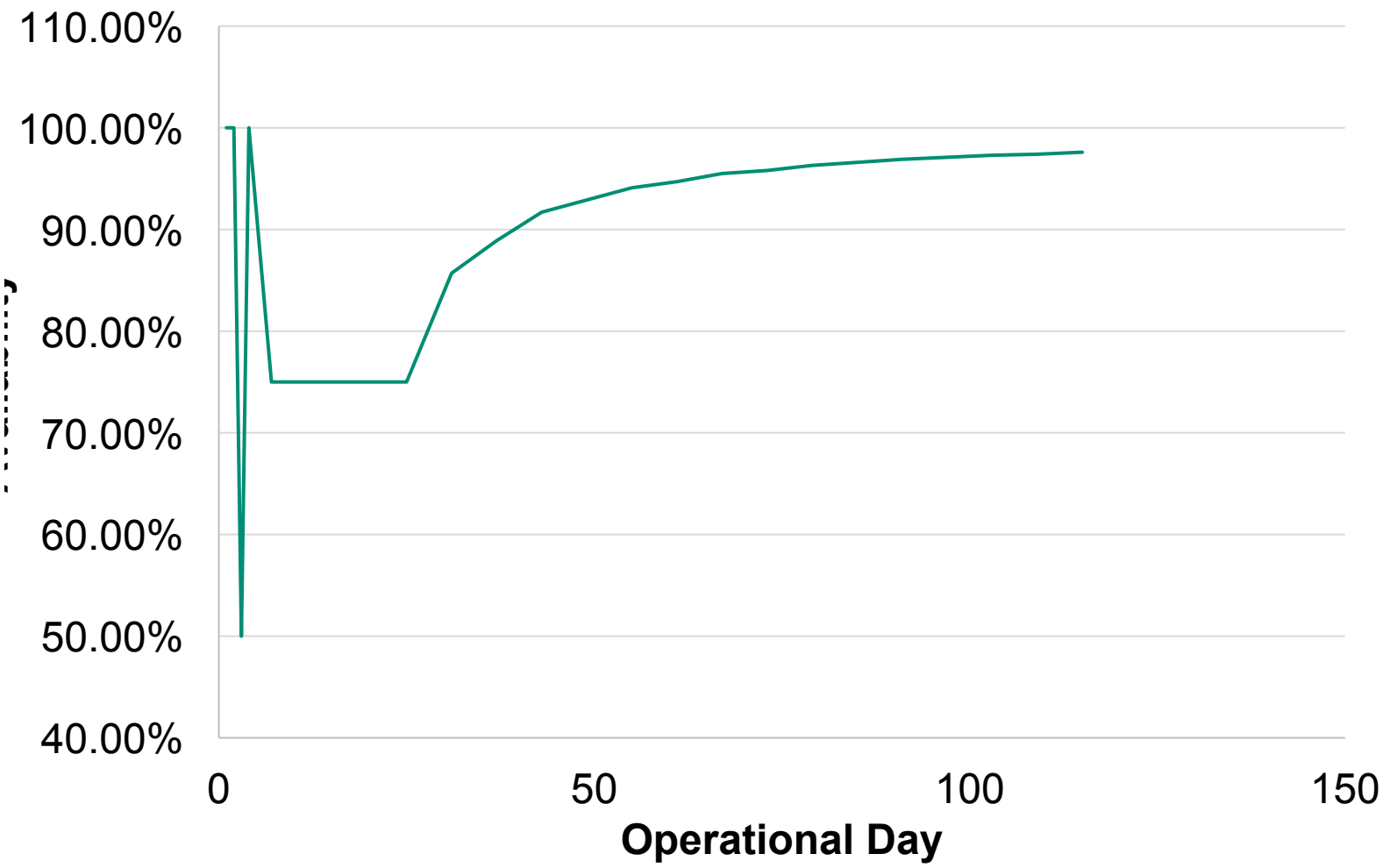
Destruction at Pine Bluff Arsenal Using the EDS

- CAIS destruction activities commenced 10 December 2018 and concluded 27 April 2019.
- A total of 42 shots were executed during the campaign.
- Problem encountered during filling and draining of the vessel
  - Problem occurred less than 15% of the time (6 of 42 shots)
  - Mitigated by back-flushing with helium or water to clear the blockage and thoroughly cleaning the door parts and feed-throughs on Day 2 of each shot
- All CAIS were successfully destroyed.

PBEDS CAIS Destruction Progress



PBEDS Operational Availability



Questions?