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Mustard Incineration Challenges: Strategy and Status

Presentation to:
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Outline

- Background and introduction
  - U.S. mustard stockpile
  - Mustard challenges
  - Mustard strategy
- Contingencies and needs
- Five key investigations
  - Historical survey of HD production
  - Mercury process monitor for stack emissions
  - Non-intrusive analysis of Mercury (Hg) using neutron activation analysis
  - Screening of sorbents for mercury abatement from flue gas
  - Mustard solids (heel) reduction
- Conclusions and path forward

US Chemical Stockpile Distribution By Storage Location

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100% of Stockpile Now Under Contract for Destruction

Original Stockpile: 31,498 US Tons
Current Stockpile: 17,636 US Tons
Tons Destroyed: 13,862 US Tons
Percent Destroyed : 44.01%
As of: 1 Apr 07

Umatilla, Oregon UMCDF
HD – TC
GB – P,~~R,B~~
VX – P,R,M,ST

Tooele, Utah TOCDF
H – P; HT – C,
HD – C,TC
~~GB – C,P,R,B,TC~~
~~VX – P,R,M,ST,TC~~
GA – TC
L – TC

Johnston Atoll (JACADS)
~~HD – TC, P,C~~
~~GB – P,C,R,B,TC~~
~~VX – P,R,M,TC~~
100%
Agent Destroyed

Pueblo, Colorado PCAPP* (Design)
HD – C,P
HT – C

Pine Bluff, Arkansas PBCDF (Operational)
HD – TC
HT – TC
GB – R
VX – R,M

Anniston, Alabama ANCDF (Operational)
HD – C,P,TC
HT – C
~~GB – C,P,R~~
VX – P,~~R~~,M

Blue Grass, Kentucky BGCAPP* (Design)
H – P
GB – P,R
VX – P,R

Newport, Indiana NECDF (Operational)
VX – TC

Aberdeen, Maryland ABCDF (Operations Complete)
~~HD – TC~~
100% Agent Destroyed

Hawaii

Operational

Design

Operations Complete

States Participating in Chemical Stockpile Emergency Preparedness Program

* **Program Manager Assembled Chemical Weapons Alternatives**

GA, GB, VX, H, HD, HT, L = Chemical Agent

B = Bombs
C = Cartridges
M = Mines
P = Projectiles
R = Rockets
ST = Spray Tanks
TC = Ton Container

- Challenges
  - Hg (Mercury Contamination)
  - Heels (Mustard Solids)
  - Hydrogen (Ton Container Pressurization)

- Optimization and maximal use of as-built baseline incineration components
  - Systemized and operational with a proven record of successful and safe agent destruction
  - Liquid incinerators (LIC)
  - Metals parts furnace (MPF)
- Modifications required for HD incineration
  - Mercury characterization/segregation
  - Emissions monitoring and process control
  - Mercury abatement in flue gas using fixed-bed carbon adsorption filter
  - Ton container solids (heels) reduction or removal

Historical Survey of HD Production

- Rocky Mountain Arsenal Production History & Stockpile Characterization
  - Production of distilled mustard (HD) at RMA was a batch process ("lots").
  - Reviewed historical records to determine potential origins (and potential form) of mercury contamination in RMA mustard.
- Identified potential entry points of Hg into system
  - Pre-existing mercury contamination in HS feedstock
  - Cross-contamination from former Lewisite production equipment and system
  - Cross-contamination from used ton containers (Lewisite TCs)
- Conclusions
  - Identified certain ranges of TC serial and lot numbers that were:
    - » almost certainly mercury-free
    - » likely contaminated with mercury
- Currently developing a model based on scenarios to enable prediction of Hg contamination as a function of lots
  - Model predicts results from continued invasive sampling
  - Results shared across CMA (impact to future sampling needs)

SAIC From Science to Solutions

- Needed a method to measure metal parts furnace mercury emissions on a batch feed timescale to assist in feed control to maintain compliance when processing low Hg ton containers
- Distinct from compliance monitoring
- Identified Ohio Lumex thermal analyzer for rapid analysis of stack gas monitoring carbon sorbent traps
  - Thermal desorption of mercury from carbon sorbents
  - Zeeman shift spectroscopy to quantify mercury
  - Demonstrated in power industry applications (constant, low mercury concentrations)

- Test program with Shaw Environmental and Ohio Lumex
- Determined instrument performance
  - Reliability
  - Precision
  - Accuracy
  - Repeatability
- Identified and implemented needed improvements
- Developed standard operating procedure and maintenance protocols
- Employed since start of mustard campaign

Ohio Lumex Comparison with Compliance Monitoring

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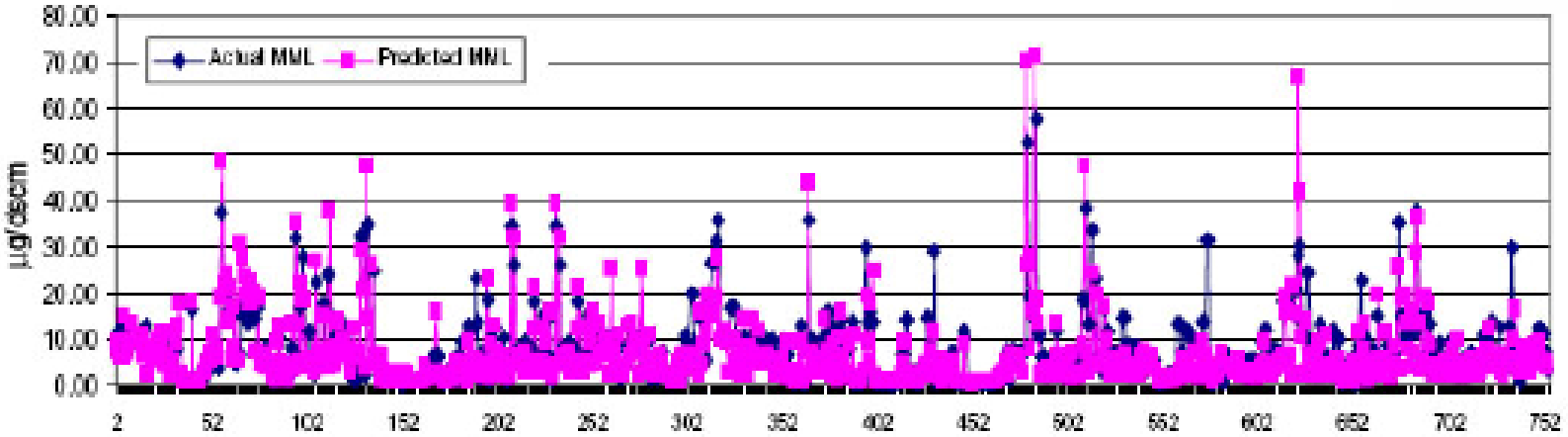
EG&G A Division of URS



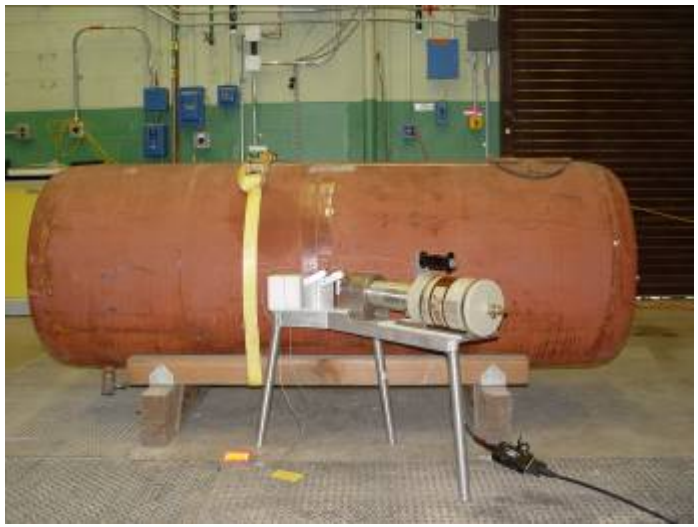
Excellent correlation between MPM and compliance monitor

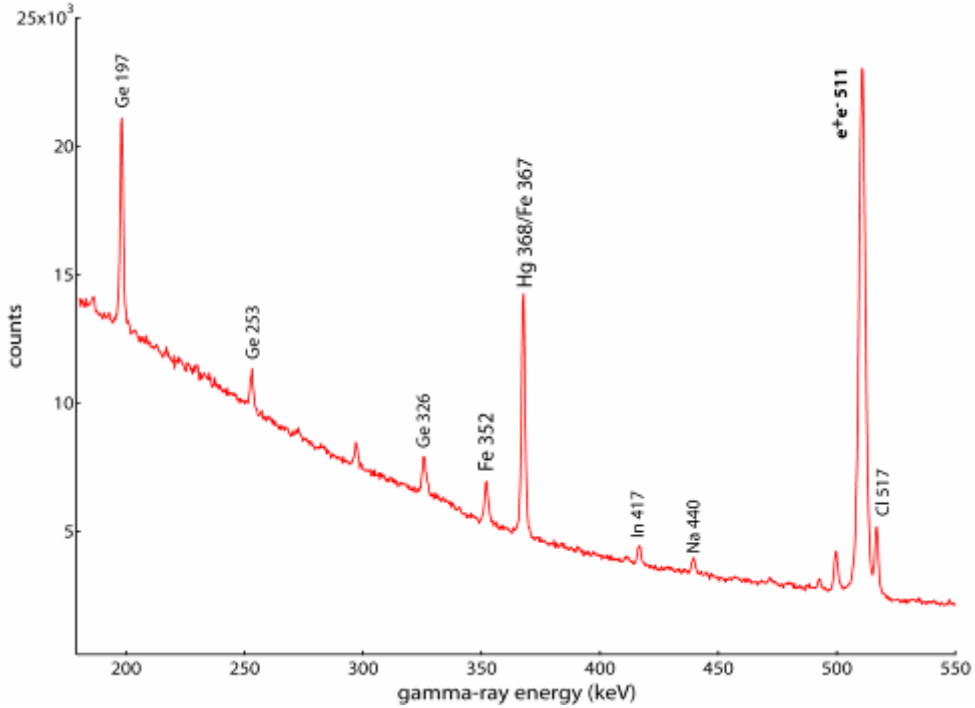
Typical values from 0-10 micrograms Hg/dscm

Compliance limit: 130 micrograms Hg/dscm

- Assessing Neutron Activation Analysis (NAA) for non-invasive quantification of Hg in mustard TCs
- Detection and quantification of gamma rays emitted from elements upon neutron capture
  - Element-specific gamma rays proportional to relative concentration
- Commercial neutron generators and detectors
- Objectives
  - Phase 1: Quantification of mercury dissolved in liquid mustard agent in a TC at a detection limit of < 1 ppm (mg/L)
  - Phase 2: Quantification of total amount of mercury in a TC that contains both liquid mustard and heel
  - Phase 3: Demonstration of system, if appropriate

- Completed Phase 1
  - Determined minimum detection limit (MDL) too high for identifying low Hg TCs (< 1 ppm Hg)
- Phase 2 nearing completion
  - Identified several improvements in MDL
  - MDL < 100 ppm Hg (single region)
  - Using modeling to determine total detection limit for entire TC
- Phase 3 decision pending





- Strategy calls for mercury abatement from flue gas using fixed beds of sulfur-impregnated carbon in addition to existing pollution abatement system
- Initiated a testing program at Energy and Environmental Research Center (EERC, Grand Forks, North Dakota) to establish understanding of carbon performance and identify high performing carbons
- Two phase approach
  - Phase 1: Thin-film tests based on established screening methodology
    - » Approx. 40 short duration (16-22 hours) tests
    - » Criteria for down-selection developed
      - » Mercury adsorption capacity
      - » Stability of adsorption
      - » Effects of acid gases (e.g., SOX, NOX, HCl)
  - Phase 2: Screening based on kinetic performance
    - » Long-term column test with multiple monitoring points to determine kinetics and mass-transfer zone

Carbon Sorbent Screening Results: Phase 1

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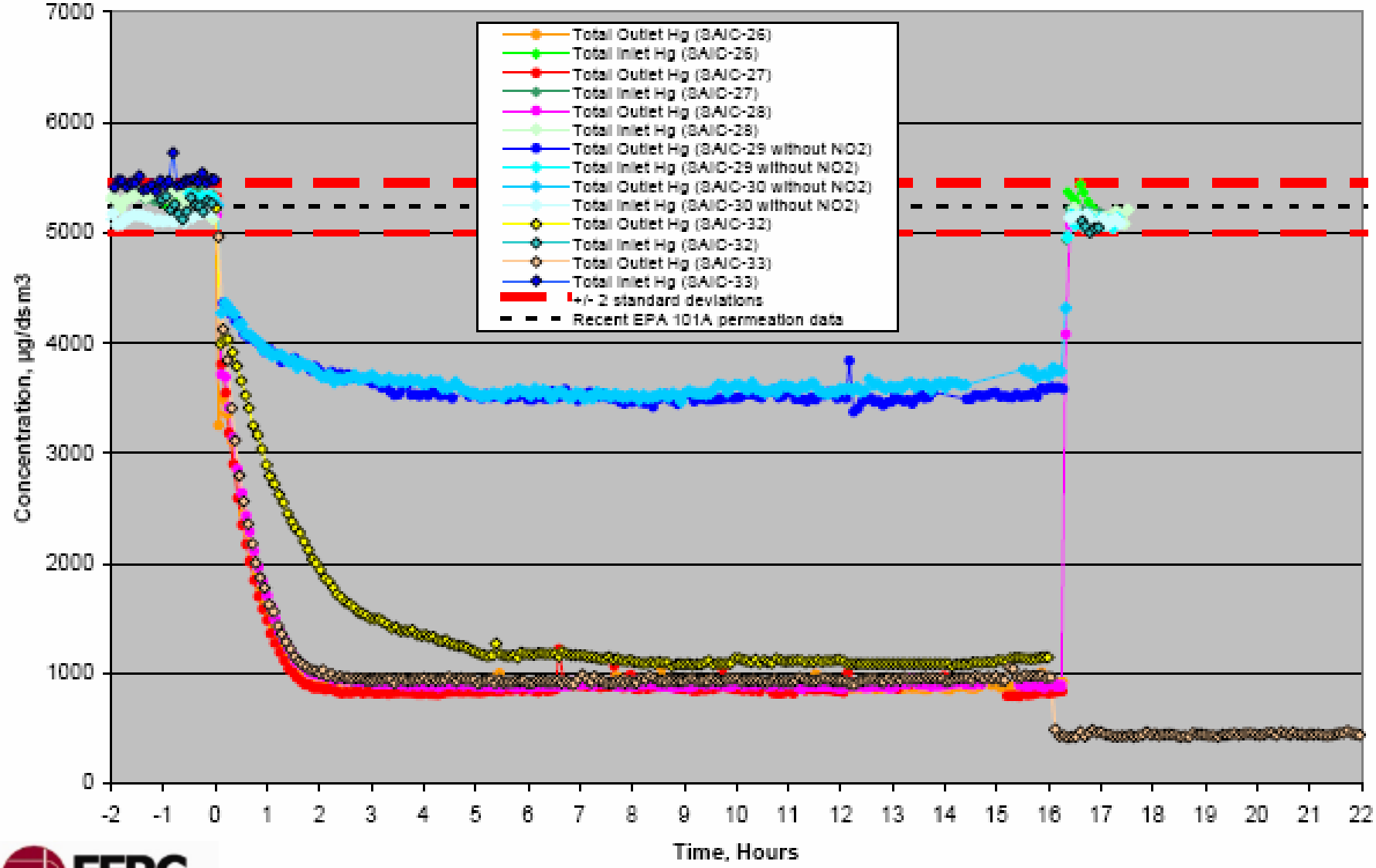

- Greatest challenge to complete mustard stockpile elimination
  - Regulatory restrictions on quantity of mustard solids in drained TCs that can be fed to the MPF
  - Operational limits due to problems processing large amounts of mustard solids in drained TCs
- Need a mechanism to reduce amounts of mustard solids in drained TCs. Four possibilities identified:
  - Partial washout/removal of solids with high temperature, high pressure water (190°F, 3000 psi)
  - Dissolution/breakup of portion of heel with chemical solvent
  - Mechanical removal of heel
  - Externally heating to melt a portion of heel and remove the resultant liquid

- High temperature, pressurized water washout
  - Based on rinse and drain process implemented at Aberdeen system to neutralize over 1,600 mustard TCs
  - Investigating options and requirements for incineration of rinsate
- Solvent-based removal
  - Laboratory solubility studies to identify solvent or solvent mixture
  - Potential for direct feed of dissolved heel to primary liquid incinerator with minimal modifications

Summary

- Mustard challenges centered around
  - Mercury contamination (Hg)
  - Mustard solids (heels)
- Collaboration and coordination critical to overcome challenges for mustard incineration
  - Systems contractor
  - Technology providers and industry expertise
- Keys to completing mustard disposal remains
  - Reduction of solids in mustard TCs
  - Management of mercury in the flue gas stream

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