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U.S. Army Edgewood Chemical Biological Center

Decontamination of Personal Effects using Chemical Hot Air Decontamination (CHAD)

Joseph Myers, Jennifer Piesen, Jill Ruth, and Kevin Morrissey
Decontamination Sciences Branch
Edgewood Chemical Biological Center (ECBC)

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Personal Effects

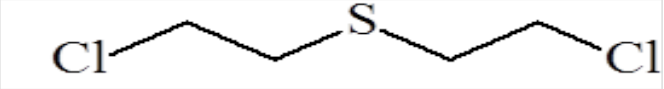
Personal effects refer to personal items that people carry with them on a day to day basis.

Personal items can be made from plastic and/or have complex material features that may make cleaning them difficult.

Project Objective

The primary objective of this effort was to evaluate the ability of humidified chemical hot air decontamination (CHAD) to remove the chemical warfare agent sulfur mustard (HD) from contaminated personal effects after pre-treatment with bleach.

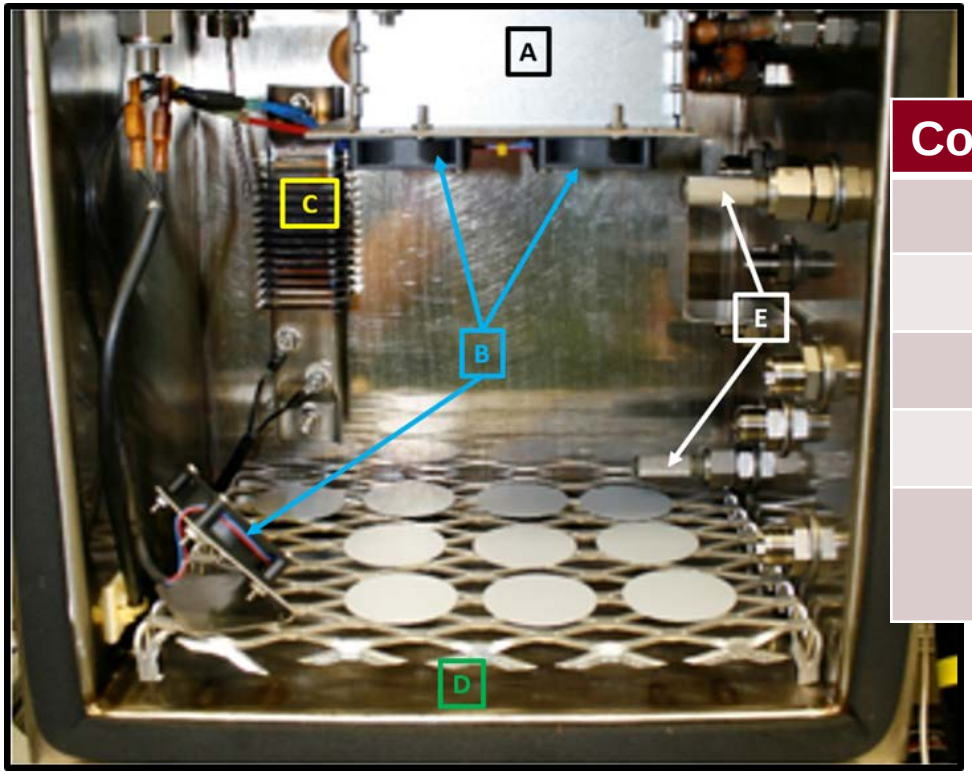
- Bleach pre-treatment mimics the cleaning procedure used by Mortuary Affairs for personal effects from chemical casualties.
- Using Humidified CHAD to further reduce the contamination.



Bis-(2-chloroethyl)sulfide	CAS No. 505-60-2
$C_4H_8Cl_2S$	MW: 159.08
Melting Point: 13–14 °C	VP: 0.11 mm Hg @ 25 °C
Volatility: 906 mg/m^3	Water Solubility: 920 mg/L

Chemical Hot Air Decontamination

Chemical Hot Air Decontamination (CHAD) is the process of heating contaminated materials in an enclosure to drive off the contamination. The air stream supplied to the chamber can be humidified to increase the heat transfer to items and/or promote hydrolysis of the CWA.



Small Item Vapor Chamber

Component	Details
A	Liquid-air Heat Exchanger
B	Mixing Fans
C	Resistive Heater
D	Sample Stage
E	Temperature/humidity probes

Materials

Coinage (circulated)

Military Patches

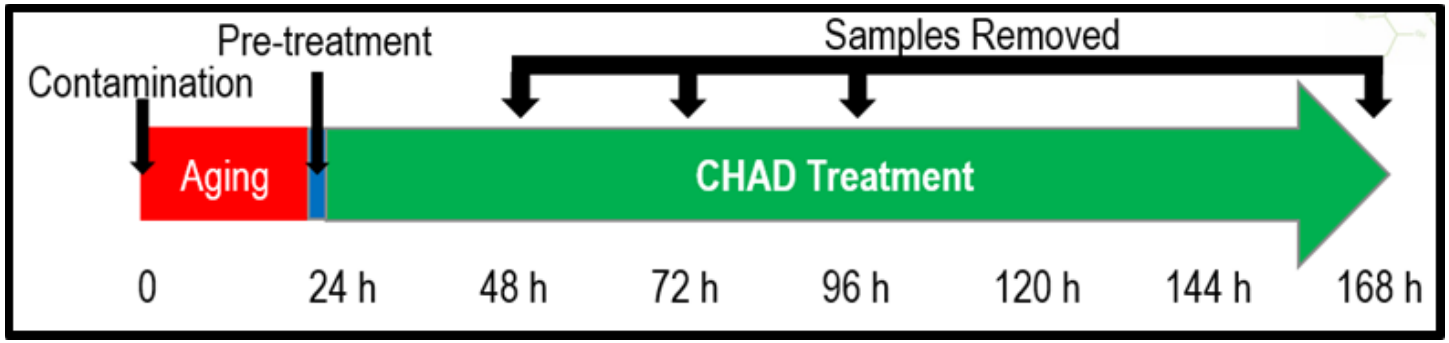
ID Cards (PVC)

Pocket Knives

Nylon Webbing

- The test materials for this effort are close surrogates for items people carry around from day to day.
- Items encompass fabrics, bare metals, absorptive polymers and complex features.
  - Fabrics, absorptive polymers and complex features are historically difficult to decontaminate.

Evaluation Procedure

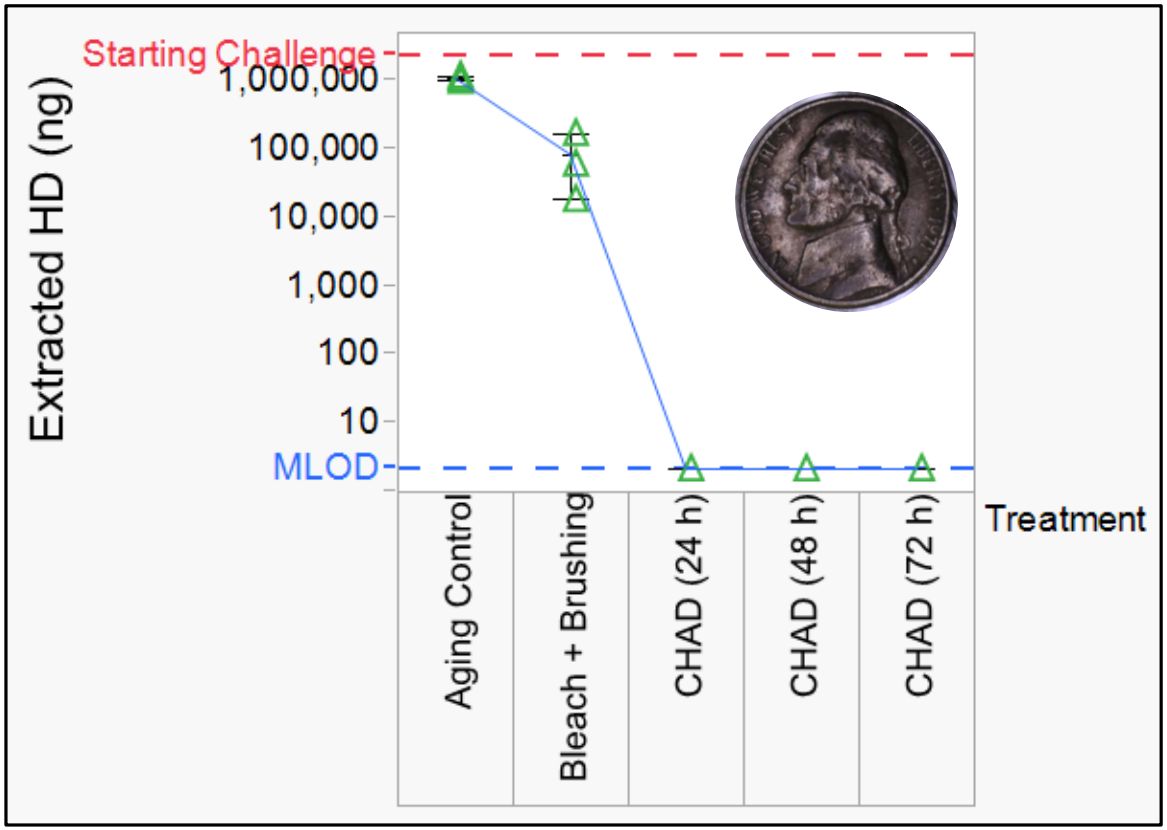


Parameter	Value	Justification
Contamination	Single 2 µL drop of HD (2,410,000 ng)	Approximates low level of contamination
Aging	24 h at 72°F, RH 30-50%, 2 turn-overs/h	Interaction time between agent and substrate before decontamination begins
Pre-treatment	5% bleach with brushing	Consistent with cleaning procedure established by Mortuary Affairs
CHAD	170°F, RH ~25%, 2 turn-overs/h	High level of heat to promote evaporation of the HD without causing material breakdown.

Samples were removed at indicated time increments to determine decontamination performance at different treatment times.

Results - Nickels

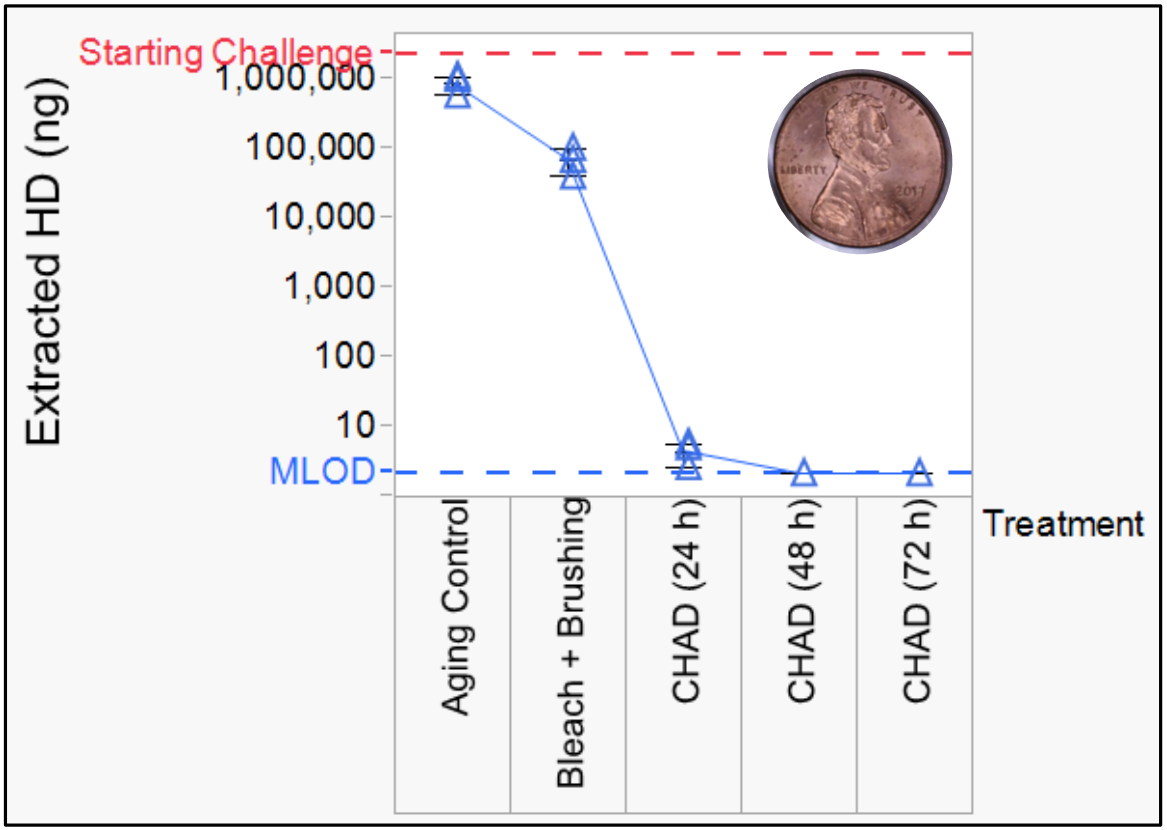
- On average, 58% of the applied HD was removed during the aging process, and another 39% of the applied HD was removed during the bleach pre-treatment.



- 24 h of humidified CHAD reduced the level of HD to the method limit of detection (2.4 ng).

Results- Pennies

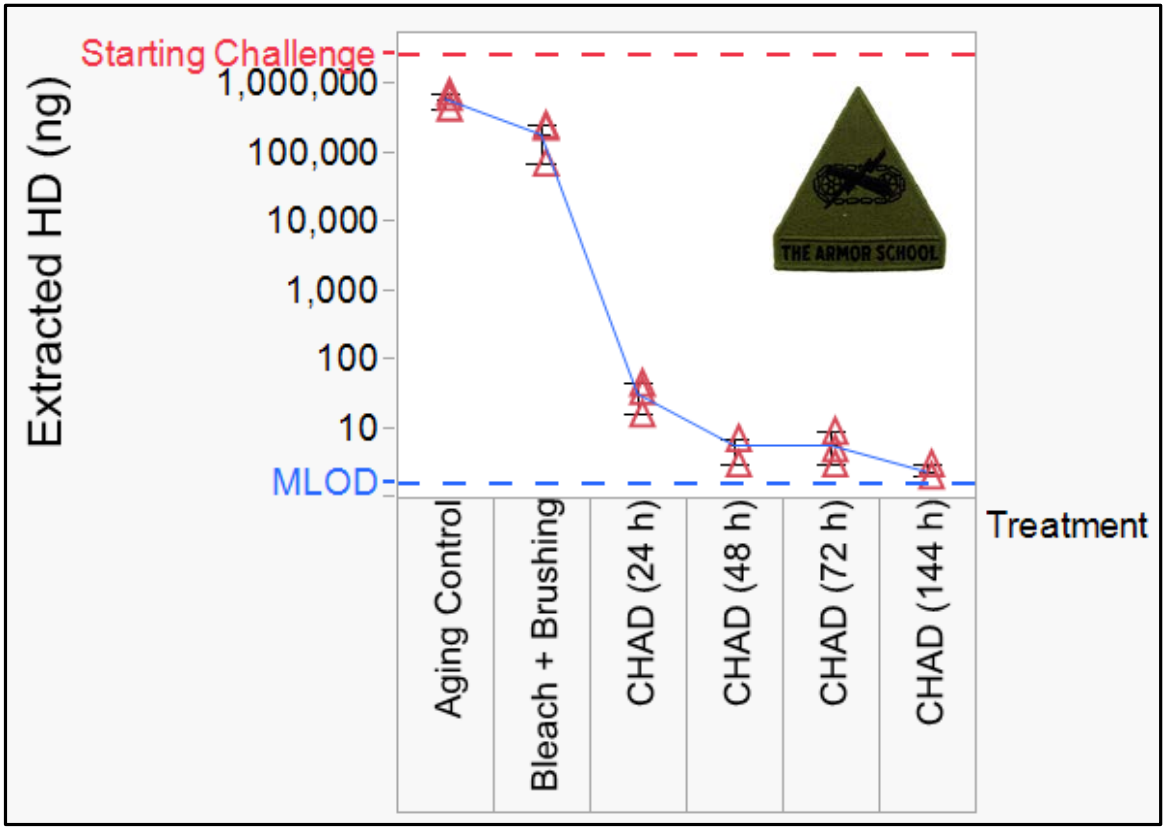
- On average, 58% of the applied HD was removed during the aging process, and another 39% of the applied HD was removed during the bleach pre-treatment.



- 24 h of humidified CHAD reduced the level of HD to nearly the method limit of detection (2.4 ng).

Results – Military Patches

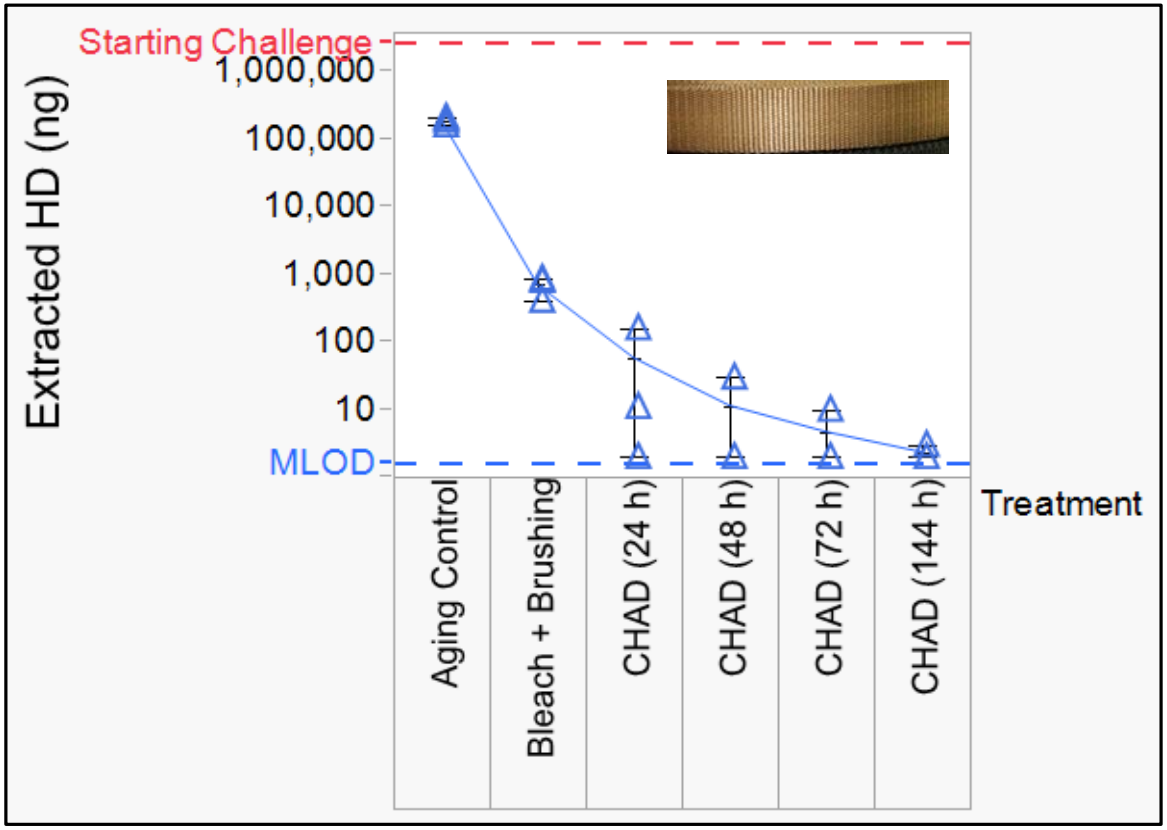
- On average, 74% of the applied HD was removed during the aging process, and another 18% of the applied HD was removed during the bleach pre-treatment.



- 24 h of humidified CHAD significantly reduced the amount of HD in the military patches.
- 144h of humidified CHAD reduced the contamination to nearly the method limit of detection (2.4 ng).

Results- Nylon Webbing

- On average, 92% of the applied HD was removed during the aging process, and another 7% of the applied HD was removed during the bleach pre-treatment.

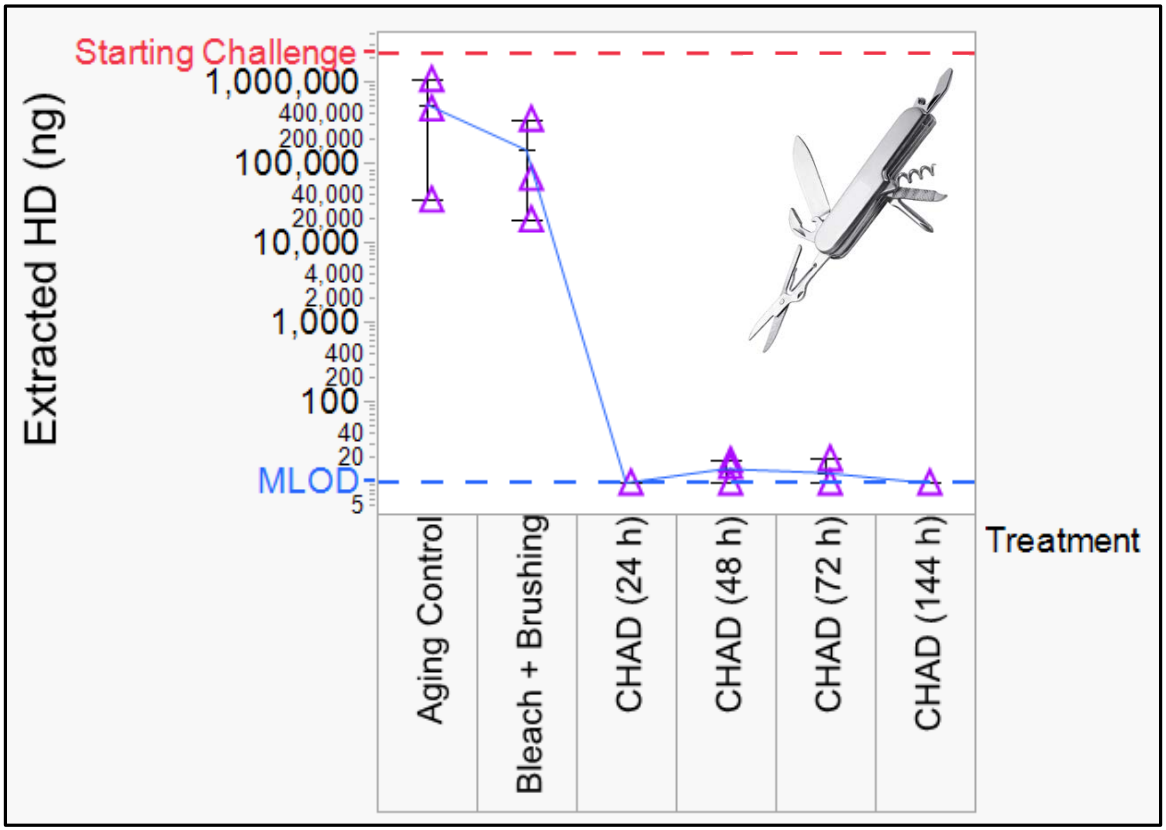


- 144h of humidified CHAD reduced the contamination to nearly the method limit of detection (2.4 ng).

Results – Pocket Knives

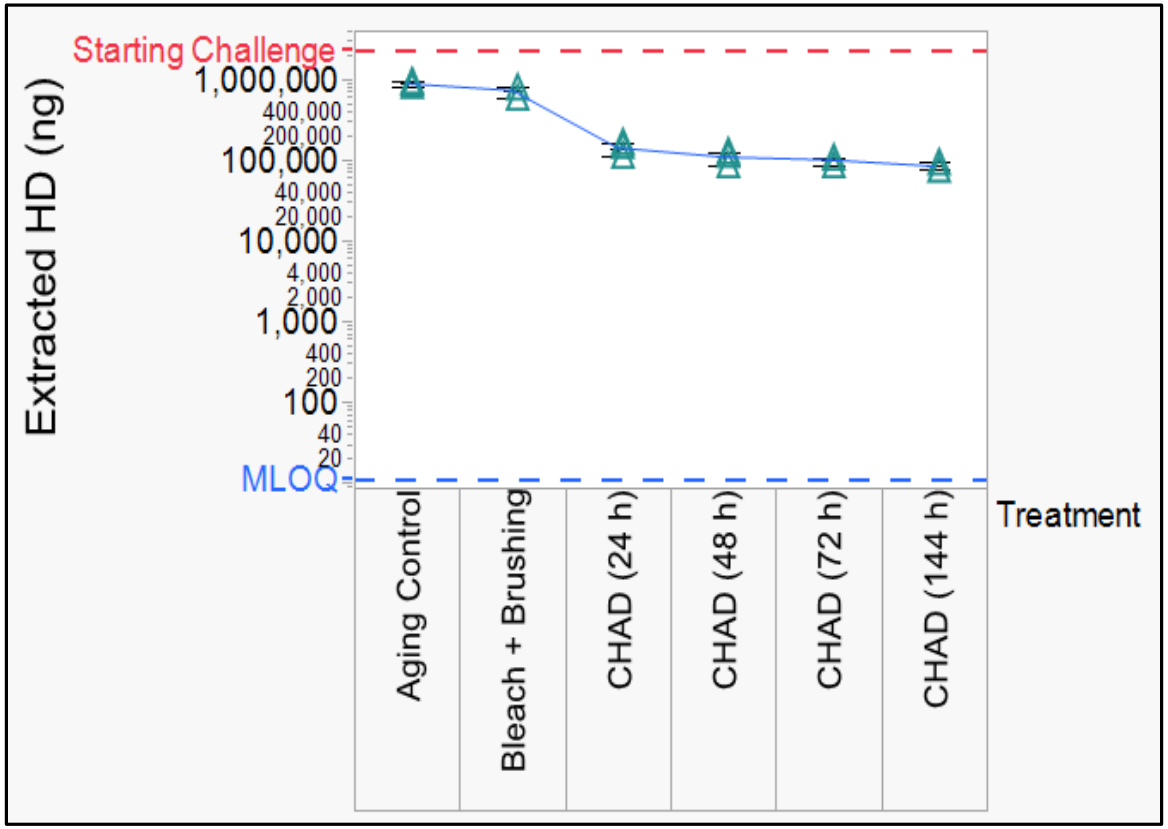
- On average, 77% of the applied HD was removed during the aging process, and another 16% of the applied HD was removed during the bleach pre-treatment.

- The pre-treatment procedure did not significantly reduce the contamination compared to the aging control.



24h of humidified CHAD reduced the contamination to nearly the method limit of detection (9.5 ng). More variability in results.

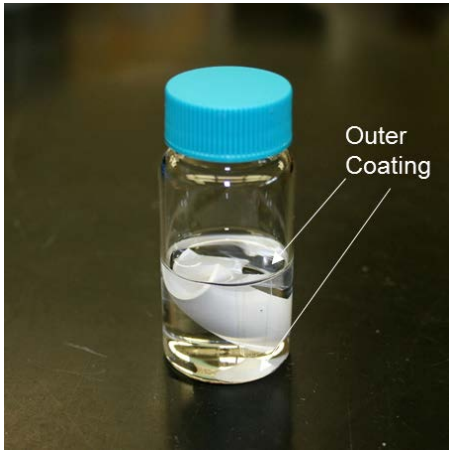
Results – ID Cards



- On average, 62% of the applied HD was removed during the aging process, and another 7% of the applied HD was removed during the bleach pre-treatment.

- Humidified CHAD reduced the contamination by an additional 90% after 24 h, but longer treatment times did not remove any additional contamination.

Results – ID Cards

Initial ID Card	Time Zero in Solvent
	
Time 60 min in Solvent	**Pieces Removed After 60 min**
	

- Extraction solvent swelled and de-laminated the ID card.
- Due to HD being a plasticizer, it is theorized that the contaminant strongly absorbed into the ID Card material and the heat of the CHAD treatment did not provide sufficient energy to remove the contaminant.
  - Solvent extraction in chloroform was able to recover the HD.

Conclusions

- ✓ The bleach pre-treatment for personal effects removed a significant amount of HD from bare metal and fabric materials.
- ✓ Humidified CHAD, when combined with the bleach process, removed significantly more HD, leaving MLOD amounts in the substrate after 24 h for coinage metals and pocket knifes.
  - ✓ Longer treatment times were required to reach MLOD values for fabric materials.
- ❖ CHAD treatment was not successful at reducing contamination when mustard strongly interacts with a polymeric material, such as ID cards.

On-Going Efforts

- ✓ Using a mixture-process experimental design approach to optimize temperature, humidity, and flow rate.
  - ✓ Examining multiple materials and chemical agents.
- ✓ Evaluating the efficacy of an aerosol pre-treatment.
  - ✓ Evaluating hydrogen peroxide, sulfolane, and water as reagents.
  - ✓ Examining multiple materials and chemical agents.

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Questions