Laboratory Decontamination Using Low-Concentration Hydrogen Peroxide

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R. Leroy Mickelsen, EPA

Chemical, Biological, Radiological, and Nuclear
Consequence Management Advisory Division (CBRN CMAD)

Contributors to Low-Concentration HP Study

EPA's CBRN Consequence Management Advisory Division /OLEM

- Shannon Serre

EPA's Center for Environmental Solutions & Emergency Response /ORD

- Joseph Wood
- M. Worth Calfee
- Shawn Ryan

Jacobs Technology, Inc.

- Abderrahmane Touati
- Rob Delafield
- Ahmed Abdel-Hady
- Denise Aslett

Problem Statement

- Limited resources available to respond to a large *Bacillus anthracis* release.

- Many efficacious decontamination options have issues:
  - Produce highly toxic environments,
  - Require specialized equipment and expertise,
  - Have material compatibility issues, and
  - They are costly

Overview

Background

EPA laboratory study found:

- Hydrogen peroxide (HP) vapor at 5 ppm for four to seven days was efficacious for both *Bacillus anthracis* and surrogate spores
- The "low-concentration" HP vapor could be achieved using commercially available vaporizers or humidifiers
- This approach was efficacious when deployed in a 1200 square foot home

Health Frame of Reference:

- HP Immediately Dangerous to Life and Health (IDLH) = 75 ppm
- HP Threshold Limit Value (TLV®) = 1 ppm

Overview (continued)

Objective

- To test this methodology in full-scale laboratory settings

Methodology

- **Location:** EPA wind tunnel & High-bay laboratory
- **Equipment:** Commercially-available off-the-shelf humidifiers
- **Decon Agent:** Commercially-available liquid HP
- **Efficacy Evaluation:** Surrogate spores on structures & coupons

Concept

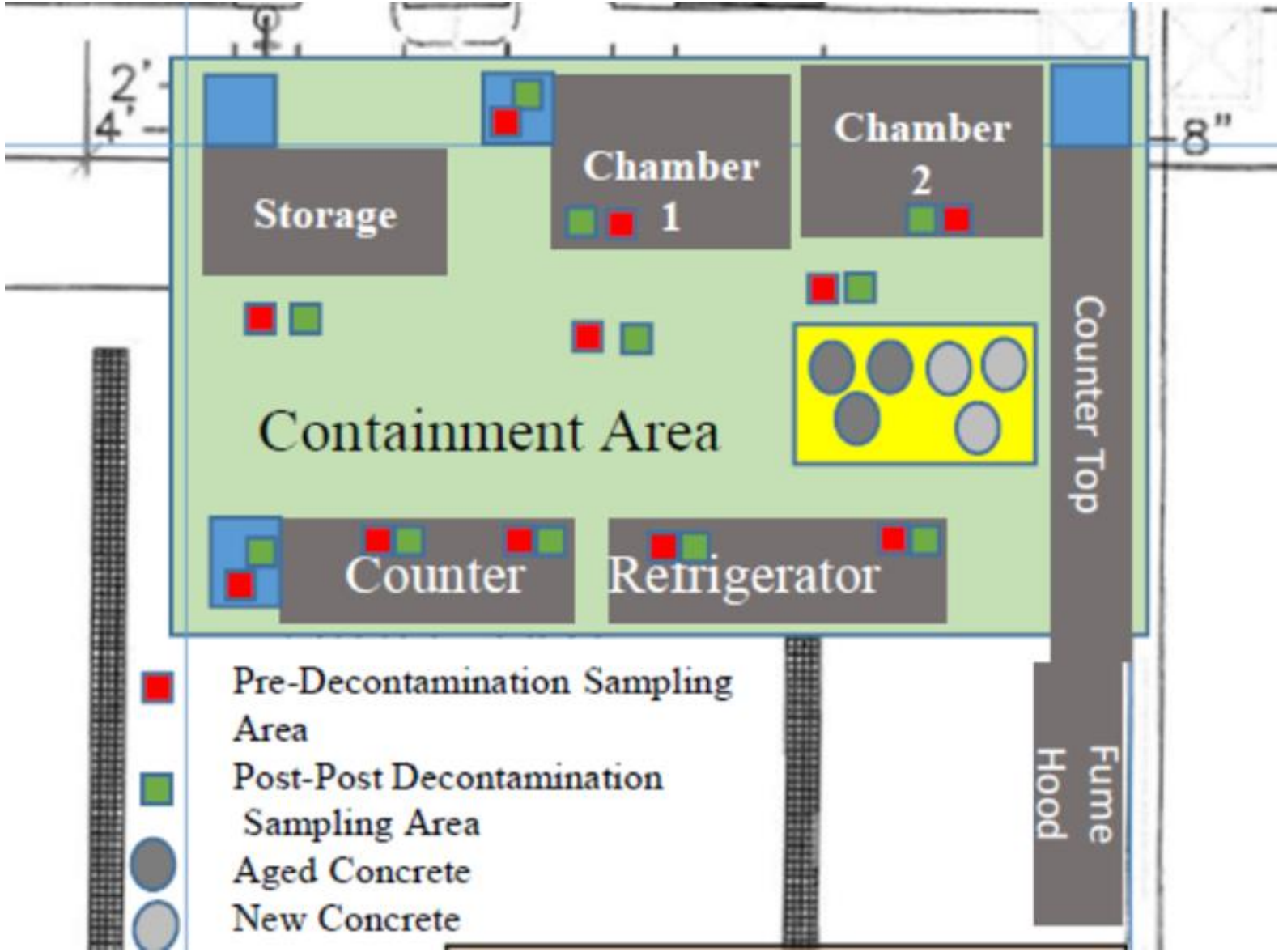
- Measure volume of contaminated space
- Purchase humidifiers & HP
- Fill humidifiers w/ HP liquid
- Turn on humidifiers
- Exit and secure space
- Return in several days

EPA Wind Tunnel

- Plastic sealed-off section
- 12’ x 30’ x 10’ +
- 6’ x 20’ x 5’ + Transition
- = 4,500 cubic ft
- No air flow
- Three humidifiers
- Total of 30 liters of 3% HP
- Surface samples (21)
- Measured HP vapor concentration, T, RH

Section of EPA High-Bay Laboratory

- Plastic tarps
- 15’ x 25’ x 12’
- One humidifier
- 12 liters of 6% HP liquid
- Surface samples (12)
- Concrete coupons
- Estimated 1-ACH exhaust



Efficacy Testing

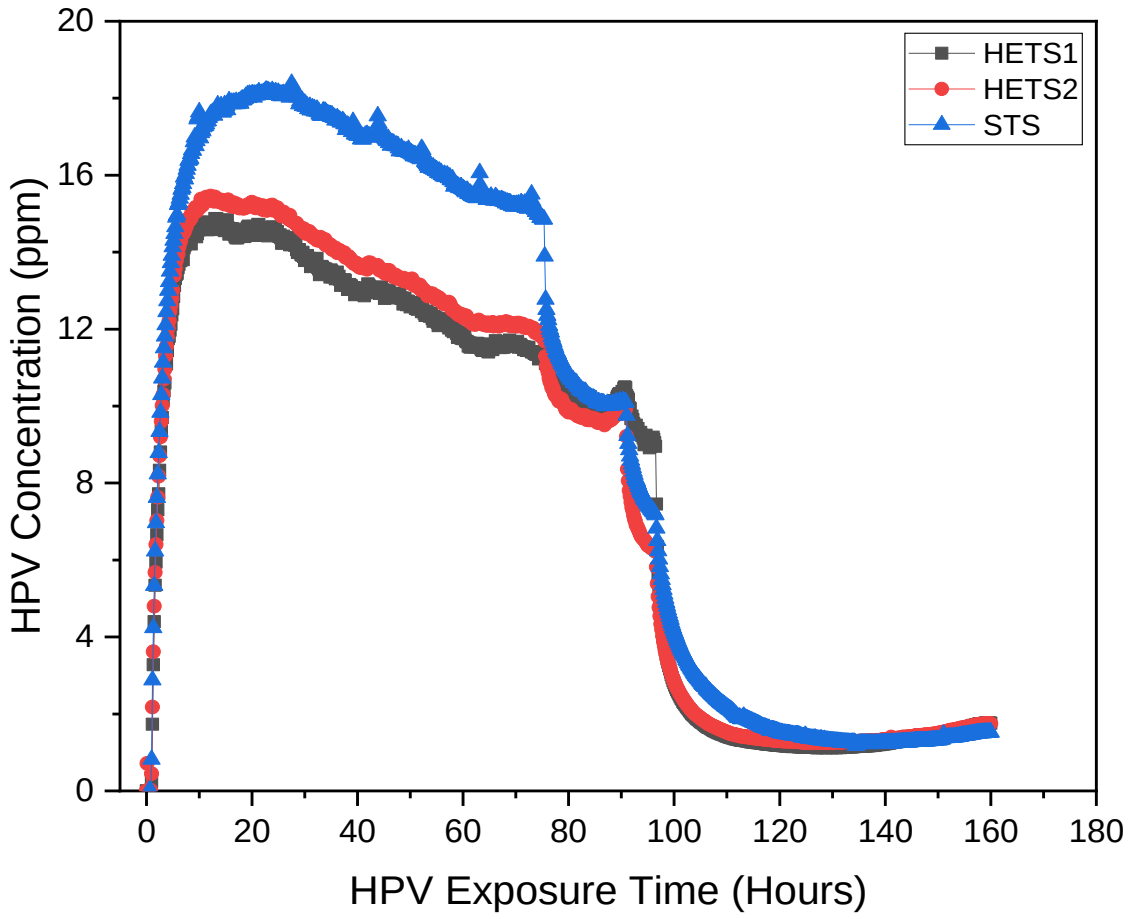
Wind Tunnel

- Surface sampling pre- & post-decon
  - Glass, Painted steel plate,
  - Painted Plywood, Polyethylene trap,
  - Aluminum plate, Polypropylene table,
  - Vinyl fabric covering table
- 21 biological indicators (BIs)
  - *Geobacillus stearothermophilus:*
  - 10^6 CFU/BI steel disk
- Temperature & humidity sensors (HOBO)

High-Bay Laboratory

- Surface sampling pre- & post-decon
- Concrete test coupons old and new
  - *Bacillus atrophaeus:*
  - 10^7 CFU/coupon
- Six biological indicators (BIs)
  - *Geobacillus stearothermophilus:*
  - 10^6 CFU/BI on steel disks
- Temperature & humidity sensors (HOBO)

EPA Wind Tunnel HPV Fumigation Concentrations



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EPA
CBRN CMAD
CONSEQUENCE MANAGEMENT ADVISORY DIVISION

Wind Tunnel Surface Sample Results

Test Condition	Pre-Decontamination					Post-Decontamination
Spores Types	Btk			Bg		Btk/Bg
Material		CFU/ft^2	Log (CFU/ft^2)	CFU/ft^2	Log (CFU/ft^2)	CFU/ ft^2
Aluminum Plate	Average	9.6 10^4	4.9	3.1 10^2	2.4	No Detectable Spores
Polypropylene Folding Table	Average	6.4 10^7	7.4	1.9 10^2	2.3	
Painted plywood	Average	1.3 10^7	7.1	3.7 10^3	3.0	
Polyethylene Tarp	Average	3.0 10^5	5.2	3.1 10^2	2.4	
Painted Steel Plate	Average	7.3 10^5	5.5	9.9 10^2	2.7	
Vinyl Fabric	Average	4.6 10^5	5.7	1.9 10^2	2.3	
Glass	Average	2.0 10^4	4.0	1.9 10^2	2.3	

* BI Results: 19 of 21 no growth

High Bay Laboratory Surface Sample Results

Location	Material	Pre-decon	Pre-decon	Post -decon
		CFU/ft^2	Log	CFU/ft^2
Column base front	Painted concrete	2.65E+03	3.4	No Detectable Spores
Column base back	Painted concrete	3.30E+03	3.5	
Floor (front)	Painted concrete	3.44E+03	3.5	
Floor (mid)	Painted concrete	2.79E+03	3.4	
Floor (back)	Painted concrete	8.73E+04	4.9	
Table	Plastic	1.49E+03	3.2	
Counter top	Soapstone	9.41E+02	3.0	
Computer monitor	Video screen	9.78E+01	2.0	
Small chamber front	Plexiglass	1.16E+01	1.1	
Small chamber back	Plexiglass	5.88E+01	1.8	
Refrigerator top	metal	9.50E+01	2.0	
Refrigerator kick plate	metal	1.25E+04	4.1	

High Bay Laboratory Concrete Coupon Surface Sample Results

Material	Pre-decon		Post -decon		Efficacy
	CFU/ft^2	Log	CFU/ft^2	Log	LR
Fresh concrete 1	5.36E+04	4.7	4.87E+03	3.7	1.0
Fresh concrete 2	1.52E+05	5.2	3.01E+03	3.5	1.7
Fresh concrete 3	5.26E+04	4.7	9.79E+03	4.0	0.7
Aged concrete 1	9.61E+05	6.0	3.81E+05	5.6	0.4
Aged concrete 2	6.91E+06	6.8	5.16E+04	4.7	2.1
Aged concrete 3	2.73E+06	6.4	1.45E+04	4.2	2.3

Summary: Improved EPA Response Capabilities

- ✓ Scale up lab test to field study
- ✓ Affordable off-the-shelf equipment
  - $180 vs. $80,000
- ✓ Easy to use
- ✓ Low vapor concentrations
  - Below IDLH
- ✓ Longer exposure times
  - Days vs. 4 hours
- ✓ Green tech: By-products, water & oxygen
- ✓ 1.5-gal 3% HP liquid/1000 cubic feet, @ 70°F
- Conclusion: Effective &

  Increases Response Readiness

What Next?

- **Follow-on research:** Desorption: When is it safe to put your head to a pillow after an LCHP decontamination effort is conducted?
- **Legal:** How to provide self-help guidance for emergency responders and general public? Guidance vs. Standard Operating Procedures?
- Any other testing ideas? Let me know what you think.

Questions?