



# *JUDGING THE EFFICACY OF ANTHRAX FUMIGATIONS*

Joint Services Scientific Conference  
Towson, MD  
November 20, 2003

Dorothy A. Canter, PhD.  
US EPA



# Report Documentation Page

Form Approved  
OMB No. 0704-0188

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1. REPORT DATE <b>19 NOV 2003</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>Judging The Efficacy Of Anthrax Fumigations</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>US Environmental Protecion Agency</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>See also ADM001851, Proceedings of the 2003 Joint Service Scientific Conference on Chemical &amp; Biological Defense Research, 17-20 November 2003. , The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			



# *ANTHRAX REMEDIATION PROCESSES*

- Site assessment/environmental sampling
  - Isolation of contaminated areas
  - Artifact/critical item removal
  - Source reduction/waste removal
  - Decontamination of contaminated areas (e.g., fumigation)
  - Post-remediation environmental sampling
  - Further remediation/sampling (if needed)
  - Disposal of PPE, waste water, debris
- 



# *ANTHRAX-CONTAMINATED SITES WITH FUMIGATION REMEDIES*

Sites	Nature of Contamination	Fumigant	Volume Fumigated	Fumigation Approach
Hart Bldg	Aerosolized	Chlorine dioxide (ClO <sub>2</sub> )	90,000 ft <sup>3</sup> 2 floors	All at once
DOJ mail facility	Secondary	Formaldehyde	4,000 ft <sup>3</sup>	Machines tented
GSA Bldg 410	Secondary	Vaporized hydrogen peroxide (VHP)	1.6 x 10 <sup>6</sup> ft <sup>3</sup>	9 zones
Brentwood	Aerosolized	ClO <sub>2</sub>	14.5 x 10 <sup>6</sup> ft <sup>3</sup> 2 floors	All at once
SA-32	Aerosolized	VHP	1.4 x 10 <sup>6</sup> ft <sup>3</sup>	10 zones
Trenton	Aerosolized	ClO <sub>2</sub>	6.1 x 10 <sup>6</sup> ft <sup>3</sup>	All at once





# *FUMIGATION*

- Definition: the process of applying smoke, vapor or a gas to a facility or room for the purpose of disinfecting or destroying pests\*

\* Webster's Dictionary





# *HISTORICAL ANTHRAX FUMIGATIONS WITH FORMALDEHYDE*

- Biosafety hoods and laboratories in research and clinical settings
    - NIH recommendations
    - NSF/ANSI standard for Class II biosafety cabinets
  - Containment areas (animal rooms and office areas), equipment/materials, and buildings at US Army Medical Research Institute of Infectious Diseases (USAMRIID)
    - Regulations for conducting fumigations
- 



# *FUMIGATIONS IN RESPONSE TO 2001 ANTHRAX ATTACKS*

- Most fumigations modeled after biomedical sterilization processes, with established ranges for process variables for all four process phases and use of biological indicators as measures of efficacy of process
    - Phases:  
humidification (dehumidification);  
conditioning; decontamination; aeration
- 



# PROCESS VARIABLE GOALS/REQUIREMENTS

Fumigant/ Facility	Process Variables			
	Temperature	Relative Humidity	Concentration	Duration of Treatment
<b>ClO<sub>2</sub></b>				
Hart Bldg	70-80° F	65-75%	750 ppm	≥12 hrs.
Brentwood	≥75° F	≥75%	750 ppm	≥12 hrs.
Trenton	≥75° F	≥75%	750 ppm	≥12 hrs.
<b>VHP</b>				
Bldg 410	not specified	≤40%	108 ppm	3 hrs
SA-32	70° F	≤40%	≥216 ppm	≥4 hrs.





# BIOLOGICAL INDICATOR GOALS/REQUIREMENTS

Fumigant/ Facility	Biological Indicator Parameters			
	Surrogate species	Number used	Placement Strategy	Consequences of Positive Results
<b>ClO<sub>2</sub></b>				
Hart Bldg	Multiple species	>>1/100 ft <sup>2</sup>	Random	None
Brentwood	<i>B. subtilis var. niger</i>	≥1/100 ft <sup>2</sup>	Random, biased, focused locations	None
Trenton	<i>B. subtilis var niger</i>	≥1/100 ft <sup>2</sup>	Random stratified + hard to reach/ contaminated locations	Additional environmental sampling





# BIOLOGICAL INDICATOR GOALS/REQUIREMENTS

## Biological Indicator (BI) Parameters

**Fumigant/  
Facility**

**Surrogate  
species**

**Number  
used**

**Placement  
Strategy**

**Consequences of  
Positive Results**

**VHP**

Bldg 410

*B. subtilis var.  
niger*

>1/100 ft<sup>2</sup>

Hard to reach/  
contaminated  
locations

Re-fumigation if  
≥1 +BI

SA-32

*B. stearo-  
thermophilus*

>1/100 ft<sup>2</sup>

Hard to reach/  
contaminated  
locations

Re-fumigation if  
≥1 +BI



# *SA-32: SITE WITH MOST STRINGENT REQUIREMENTS*

- All process conditions achieved throughout all four phases of fumigation cycle at all real-time monitoring points
  - All chemical indicators (CIs) exhibit color change following exposure to VHP
  - All BIs recovered aseptically negative for growth of *B. stearothermophilus*
  - Positive control BIs (5% of BIs) demonstrate growth
  - Negative control BIs (5%) exhibit no growth
- 



## *SA-32: SITE WITH MOST STRINGENT REQUIREMENTS*

- If any of above requirements not met, zone had to be refumigated
  - One of 10 zones was re-fumigated; second fumigation met all requirements





# *HISTORICAL CRITERIA FOR SUCCESSFUL TREATMENT*

- Biomedical sterilizations
  - FDA regulation: Subsequent growth or failure of BI microorganism to grow under suitable conditions indicates adequacy of sterilization
- USAMRIID fumigations
  - All BIs negative for growth of indicator spores, or fumigation repeated





# *CRITERIA FOR SUCCESSFUL FUMIGATIONS*

- All process variables within prescribed ranges for all four phases of fumigation at all monitoring points
- All aseptically removed BIs negative for growth of indicator organism

If criteria not met, further treatment or additional environmental sampling, depending upon site-specific results





# *BUT*

Extensive post-remediation  
environmental sampling  
required even if fumigation(s)  
successful





# *ULTIMATE CRITERION FOR EFFECTIVE REMEDIATION*

- No growth of *Bacillus anthracis* spores from all post-remediation environmental samples

