Electrostatic Sprayer Efficacy for Personnel PPE Decontamination

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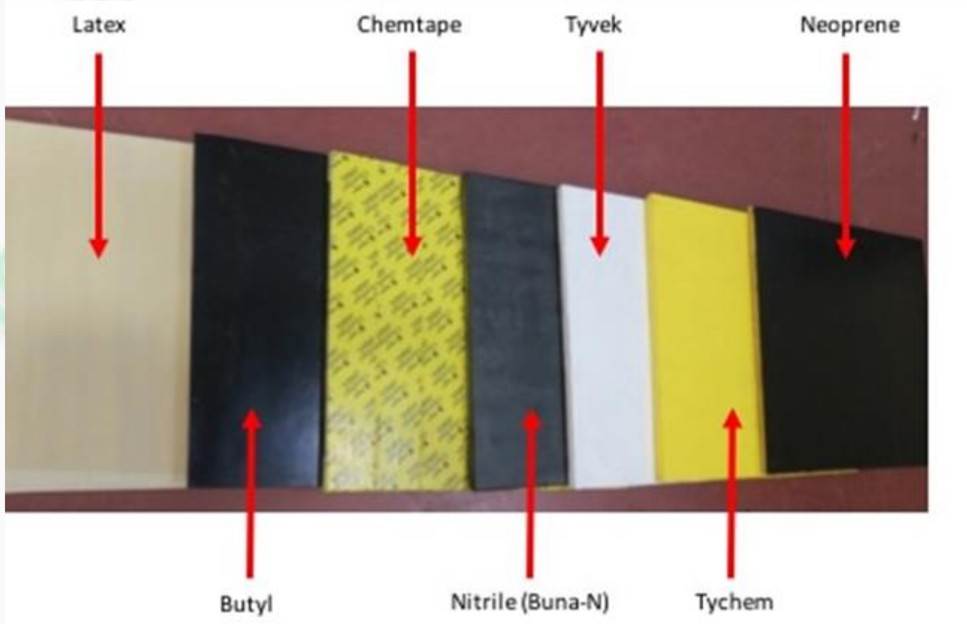

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- Jacobs Technology: Madhura Karnik, Abderrahmane Touati, Denise Aslett, Ahmed Abdel-Hady

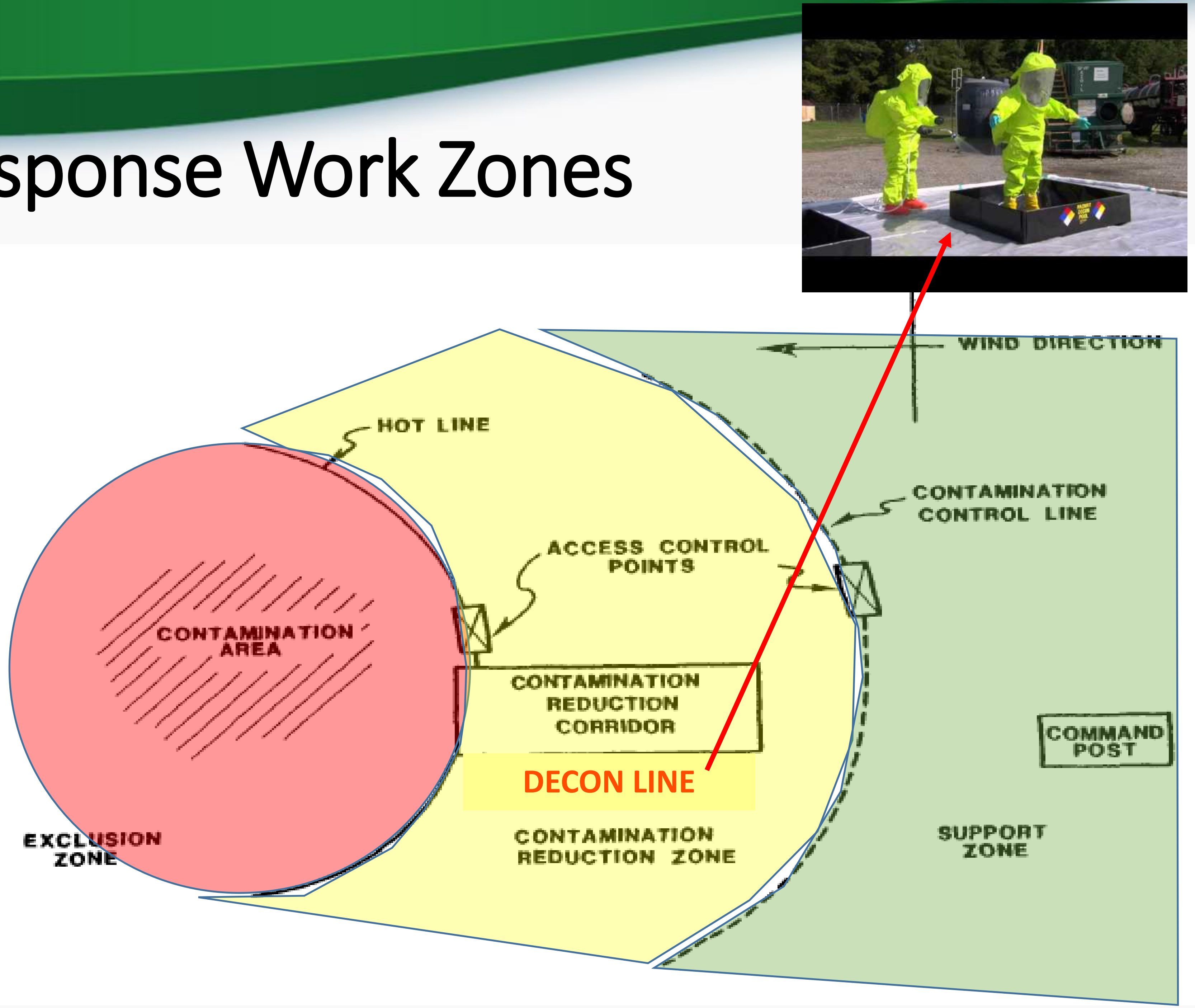
Objectives

- Evaluate EPA's internal personnel bio decontamination protocol
- Evaluate decontamination efficacy of an electrostatic sprayer (ES) on personal protective equipment (PPE) and compare to traditional backpack sprayer (TS)
  - Bench-scale study (initial phase)
  - Pilot-scale study (ongoing)
  - Field study to evaluate real-world application
- Assessed operational factors and fate and transport compared to current traditional sprayer use
- **Goal** is to improve personnel decon procedure, minimize liquid waste, and reduce cross contamination

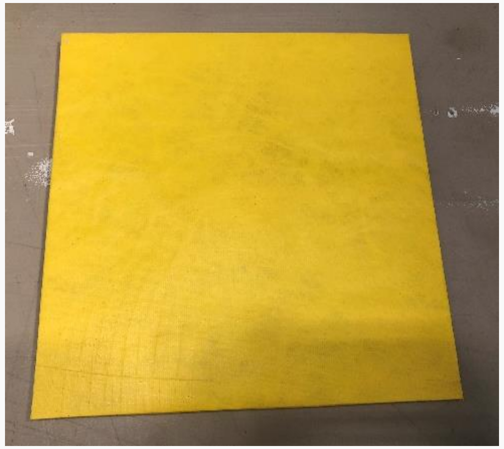
Emergency Response Work Zones

Factors for Consideration

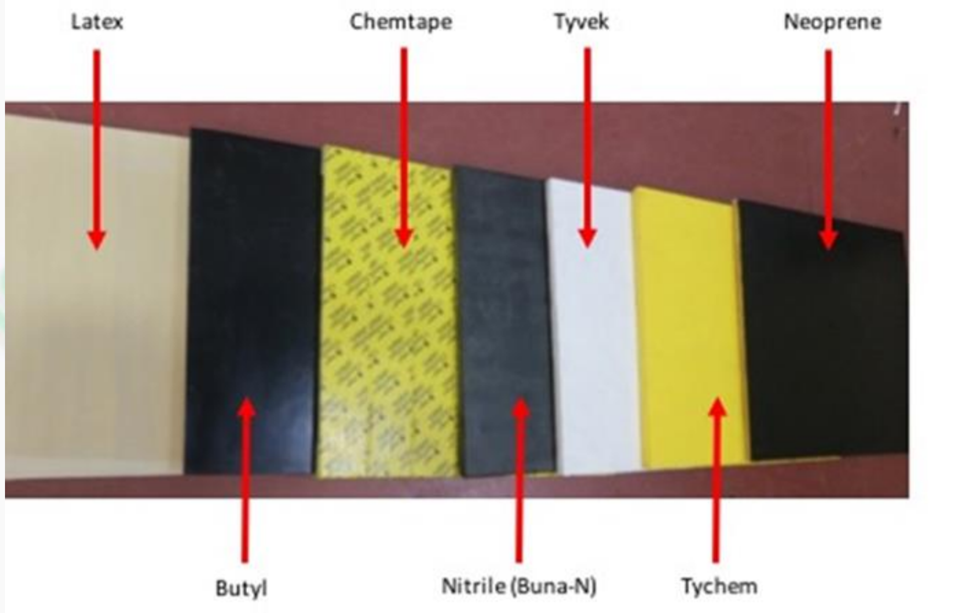
- Cost, time, and manpower
- Fate and Transport/Cross contamination
- Hazards to decon line personnel or others via reaerosolization
- Liquid waste produced



Experimental Approach

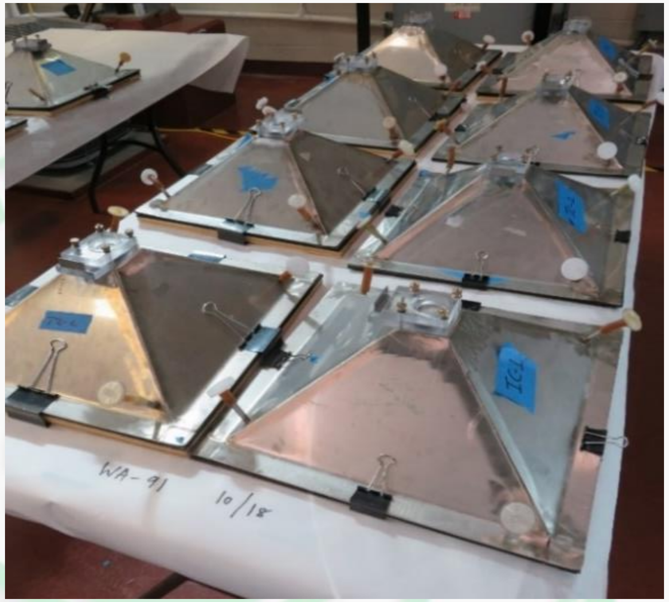


- Test chamber sterilization
- Preparation of coupons
  - 14”X 14” vertical coupons covered with PPE materials:
    - nitrile, butyl, latex, Tyvek®, Tychem®, neoprene, and ChemTape®
- Contamination/inoculation of coupons
  - MDI deposition (1 X 10^7)
  - *Bacillus atrophaeus var. globigii (Bg)*
- Application of decon procedure on coupons
- Sampling, collection of runoff, and analysis
- Determination of decon efficacy



Test Setup

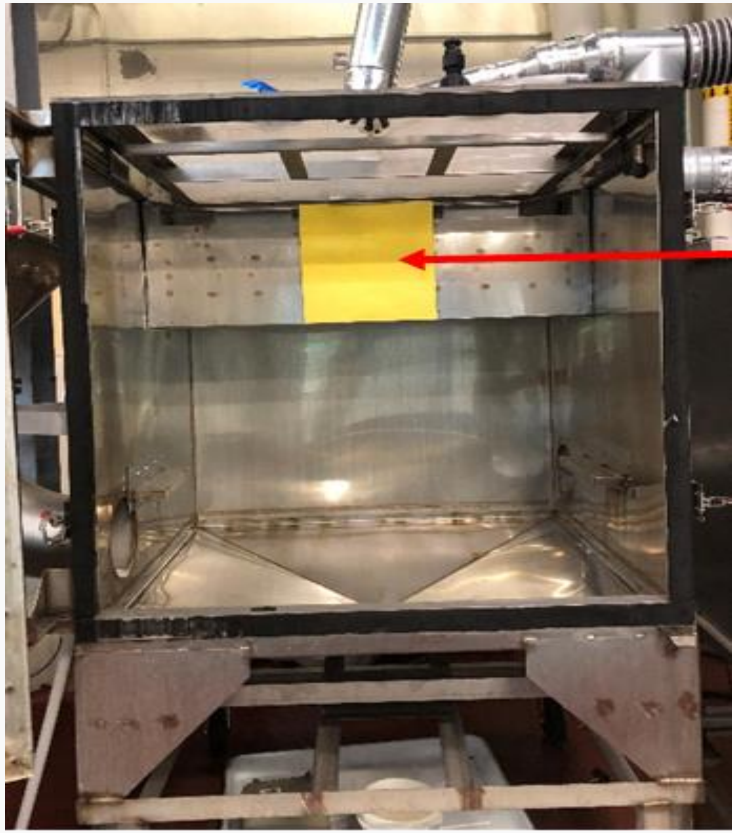
- All materials sterilized prior to testing
- Inoculation:
  - *Bacillus atropheus var. globigii*
  - Metered dose inhaler (MDI) with deposition chamber



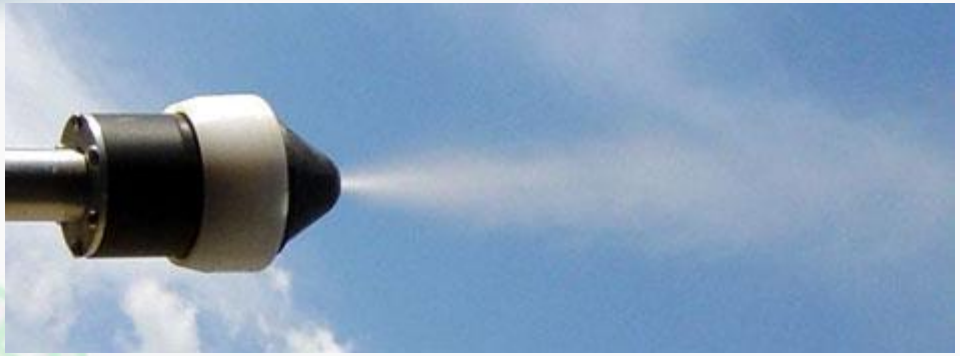
- Test Chamber
  - 4’X4’ stainless steel chamber
  - Acrylic front panel
  - Used vertical coupon orientation
  - Negative pressure
  - Drain for runoff collection

<u>Decontaminant</u>

1:10 diluted bleach



Electrostatic Sprayers



Pic from www.electrostaticspraying.com

- Commonly used in agricultural and healthcare industries
- Droplets are atomized and produce electrically-charged spray
- Can cover all surfaces through “wrap around” effect
- Increased deposition efficiency
  - Demonstrated more uniform distribution of liquid decontaminants on flat building materials (US EPA, 2015)
- Intended for light-duty, quick disinfection and sanitization applications

Personnel Decon Sprayers "Tale of the Tape"

Traditional Backpack Sprayer (TS)

- SHURFlo 4 ProPack Rechargeable Electric Back Pack Sprayer SRS-600 (Pentair-SHURFlo, Costa Mesa, CA)
- 996 mL/min
- Larger particle size
- Traditional spray nozzle – spray pattern can be adjusted
- 4 gal capacity
- 10 sec spray time
- 5 min contact
- Normal lab gloves

Electrostatic Sprayer (ES)

- SC-ET HD electrostatic sprayer (Electrostatic Spraying Systems ESS, Watkinsville, GA)
- 62 mL/min
- Smaller particle size (40 um VMD)
- Electrostatic nozzle
- 1 gal capacity
- 30 sec spray time
- 5 min contact
- Anti-static gloves

Testing Approach

*Each individual test material experiment included negative control, procedural blank, positive control, inoculation control, and triplicate test coupons

Test ID	Test Material	Category for wipe sampling	Decontamination Technology	Total # of Material Coupons
1	Nitrile (Buna-N)	Rubber	Traditional Backpack Sprayer	12
2			Electrostatic Sprayer	12
3	Butyl	Rubber	Traditional Backpack Sprayer	12
4			Electrostatic Sprayer	12
5	Latex	Rubber	Traditional Backpack Sprayer	12
6			Electrostatic Sprayer	12
7	Tyvek®	Plastic	Traditional Backpack Sprayer	12
8			Electrostatic Sprayer	12
9	Tychem®	Plastic	Traditional Backpack Sprayer	12
10			Electrostatic Sprayer	12
11	Neoprene (chemical-resistant rubber)	Rubber	Traditional Backpack Sprayer	12
12			Electrostatic Sprayer	12
13	ChemTape®	Plastic	Traditional Backpack Sprayer	12
14			Electrostatic Sprayer	12

Sampling

1) Wipe Sampling

- Wipe sampling conducted following inoculation and decontaminant application (including 5-min contact time)
- Polyester-rayon blend wipes used to wipe coupon surfaces
  - Until visibly dry
  - 2 wipes for rubber-type materials (nitrile, butyl, latex, and neoprene)
  - 3 wipes for plastic-type materials (Tyvek®, Tychem®, and ChemTape®)

2) Liquid Runoff Sampling

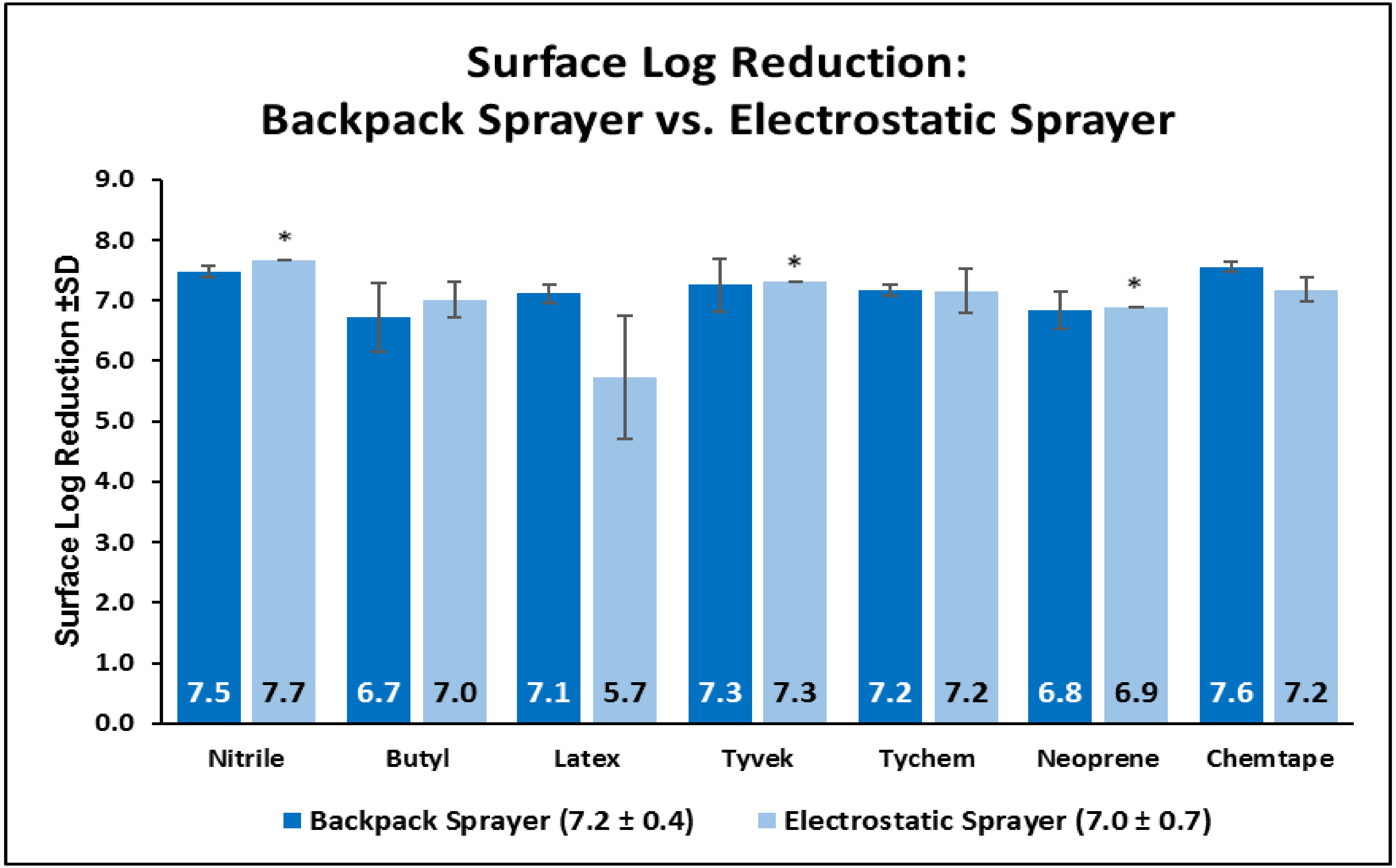
- Neutralized immediately with STS

3) Air samples for reaerosolization

- Inside chamber and exhaust duct

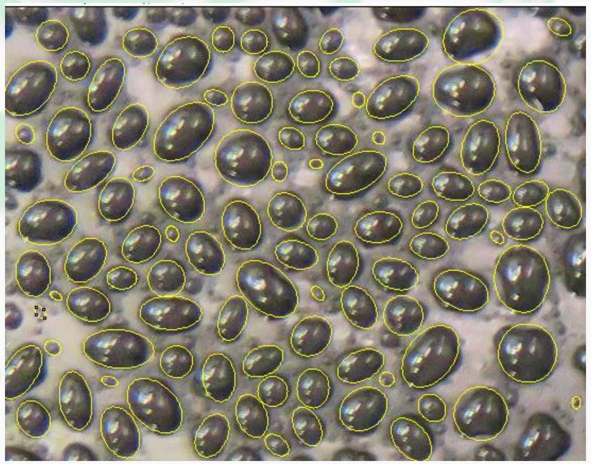
Results – Decon Efficacy for PPE Materials

*Denotes no CFUs above detection limit



Results – Decon Efficacy for PPE Materials

- Both types of sprayers used achieved LR > 6 for all material types
- No statistically significant difference in efficacy between sprayers ($p = 0.49$)
- Non-detects post-decon for 3 of 7 test materials for electrostatic sprayer
- 5.7 LR for latex (electrostatic sprayer)
  - Hydrophilicity, droplet contact angle
  - Immediate runoff



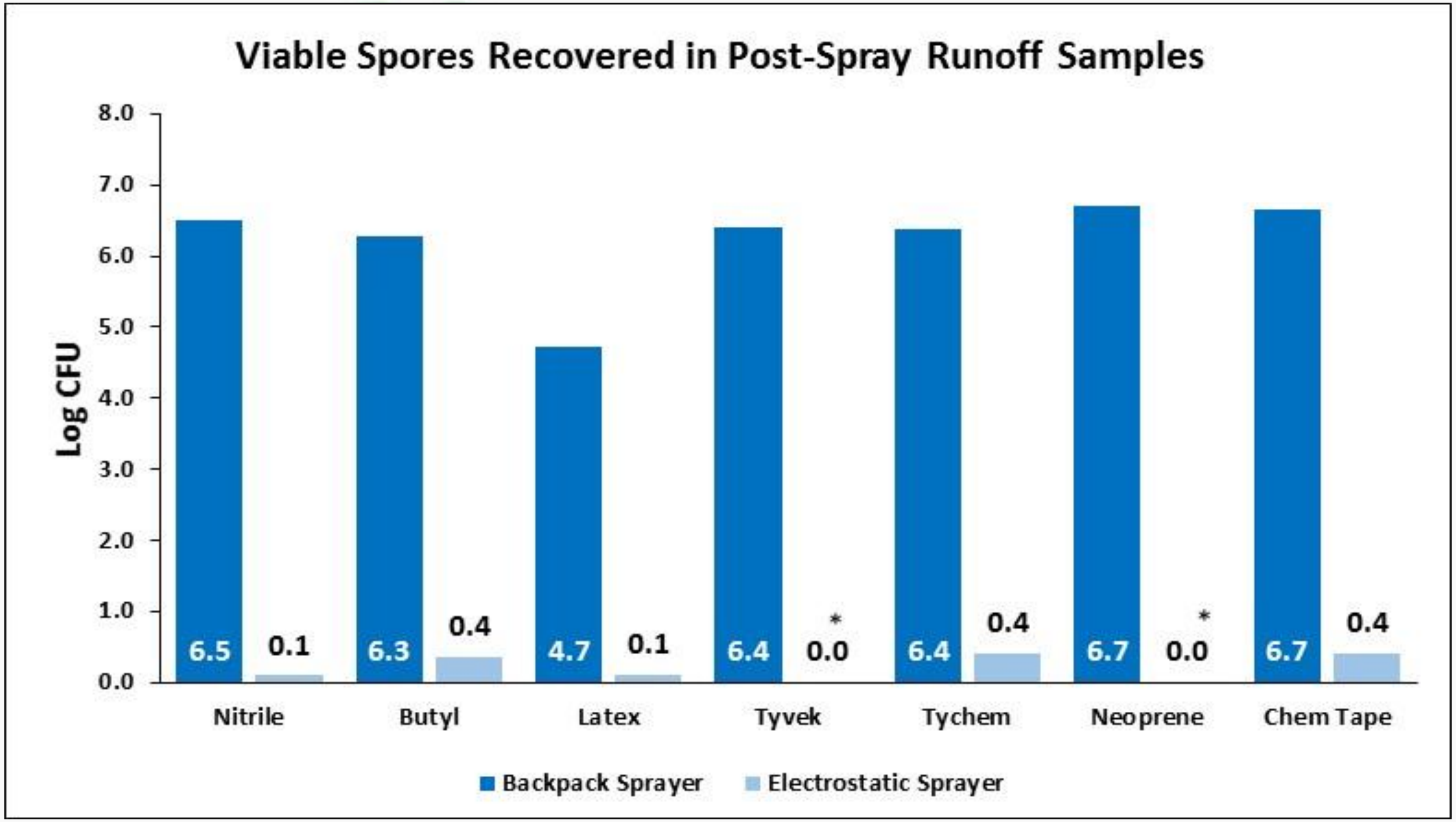
Beading observed on other test materials

Lack of beading (coalescence) on Latex

Results – Fate and Transport

Runoff

- Runoff sample collected during each test
- Neutralized
- Analyzed for CFUs
- Traditional Backpack (many spores in runoff)
- Electrostatic (very few spores in runoff)



*Denotes no CFUs above detection limit

Results – Fate and Transport

- Backpack (many spores in runoff for all test materials)
  - Spores were washed off PPE surfaces prior to inactivation
- Electrostatic (very few spores in runoff)
  - Forms liquid "encapsulation" on PPE
  - Electrostatic nature and droplet size helps it adhere to PPE
- Higher potential for cross contamination for traditional backpack sprayer
- Avg liquid runoff volume collected for Backpack was 450 mL
- Avg liquid runoff volume collected for Electrostatic was 6 mL

Results – Fate and Transport

Reaerosolization

- Minimal reaerosolization observed for both sprayer types
- Limited samples collected
- Will be evaluated further in PPE ensemble testing

Material type	Traditional Backpack Sprayer (TS)		Electrostatic Sprayer (ES)	
	Inside Chamber	Chamber Duct	Inside Chamber	Chamber Duct
	(CFUs)			
Nitrile	ND	ND	ND	3.28E+01
Butyl	ND	ND	ND	ND
Latex	ND	ND	ND	ND
Tyvek®	4.24E+01	3.08E+00	8.67E+01	ND
Tychem®	ND	ND	ND	ND
Neoprene	9.38E+00	ND	ND	ND
ChemTape®	1.54E+00	ND	ND	3.08E+00

Notes: CFU = Colony-forming unit   ND = None detected

Summary

- Current bio decontamination line protocol (10% bleach, 5-min contact time) tested on 7 different PPE materials
- Compared traditional backpack sprayer (TS) with Electrostatic sprayer (ES)
- Electrostatic sprayer performed well overall
  - Similar efficacy between ES and TS (both > 6 Log reduction)
  - 5-minute contact time was effective for inactivation – can it be reduced further?
  - Less decontaminant used with ES
  - Much less runoff/washoff with ES, so less waste
  - Spores were transported off vertical coupons with TS, but formed a liquid film with ES
- ES demonstrated advantages which warrant further investigation

Next Steps

- Test electrostatic sprayer efficacy with full PPE ensemble (ongoing)
- Calculate time and cost considerations of electrostatic sprayer vs traditional wet sprayer methods
- Reaerosolization during decon procedure and PPE doffing
- Scale up to automated field deployable unit for bio decon
    - Eliminate manual spraying
- Determine if electrostatic sprayer is operationally feasible
    - Field study – test efficacy and cross contamination

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