

Evaluation of Dry Fogging System for Microbial Inactivation

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Objectives

- Dry fog: An Overview
- Preliminary Studies
- Dry fog in a Containment Level 4 laboratory
- Dry fog vs computer
- Conclusions

Dry Fogging System

- Fog particle size: $\sim 7.5\mu$
- 1/10 Minncare™ (Peracetic acid solution, MarCor, USA)
 - 22% Hydrogen peroxide, 4.5% Peracetic acid

Mechanism

- PAA is a strong oxidizer
- Oxidation of microbial cell proteins and enzyme systems
- Not deactivated by peroxidase, catalases that break down H_2O_2

Dry Fogging System

Advantages of PAA/Dry Fog System

- No residue/toxic byproducts (H_2O , O_2 , CO_2)
- Effective at low temperature ($10^{\circ}C$)
- Portable (Dry Fog System)
- Rapid Decontamination
- Rapid Aeration
- **High soil load tolerance**

Dry Fogging System

Disadvantages of PAA

- Material compatibility
- Compatibility to electronics?

HCOH, GCD, DFS & VHP

	HCOH	GCD	DFS	VHP
Health Risk	Carcinogen	Non-carcinogen	Non-carcinogen	Non-carcinogen
Humidity Requirement	65 - 80%	65 - 80%	65 - 80%	10 - 60%
Microbicidal Activity	Broad	Broad	Broad	Broad
Neutralization	Yes	No, scrubbed or vented out	No, aerated out	No, catalytically destroyed
Real time con. Monitoring	None	Yes	None	Yes
By-products	Hexamine (powder)	Chlorites and chlorates	H ₂ O, O ₂ , CO ₂	H ₂ O, O ₂
EPA registration	No	Yes	Yes	Yes
Compatible to electronics	No	?	?	Yes
Aeration time	Long	Shortest	Short	Long
Cost	\$	\$\$\$	\$\$	\$\$\$\$

Dry Fogging System (Portable)

Ikeuchi, USA

- AKIMist “D”
- 1-4 Nozzles
- 2.5 - 12 L/hr
- \$5000 USD
- 19L reservoir



Dry Fogging System (Mini)

MarCor, USA

- MiniDry Fog System
- 1 Nozzle
- 500 mL/hr
- \$5000 USD
- 500 mL reservoir



DFS Decontamination Process

3 Step Process

1. Dry Fogging

- Up to 75-80% RH.

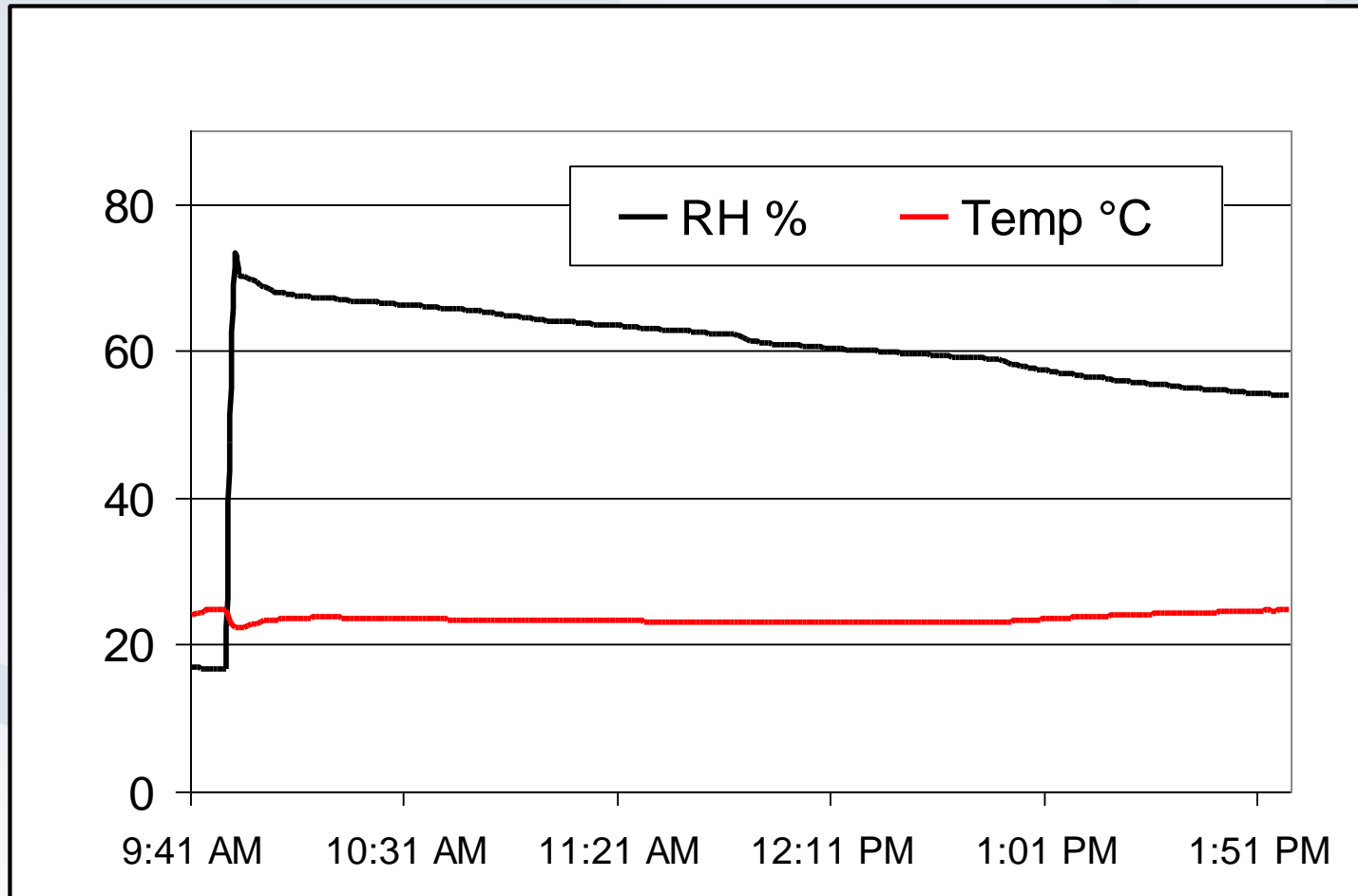
2. Decontamination

- Overnight (~18 hours) for laboratory decons.

3. Aeration

- Down to <1ppm Hydrogen Peroxide.

DFS: Decontamination Cycle



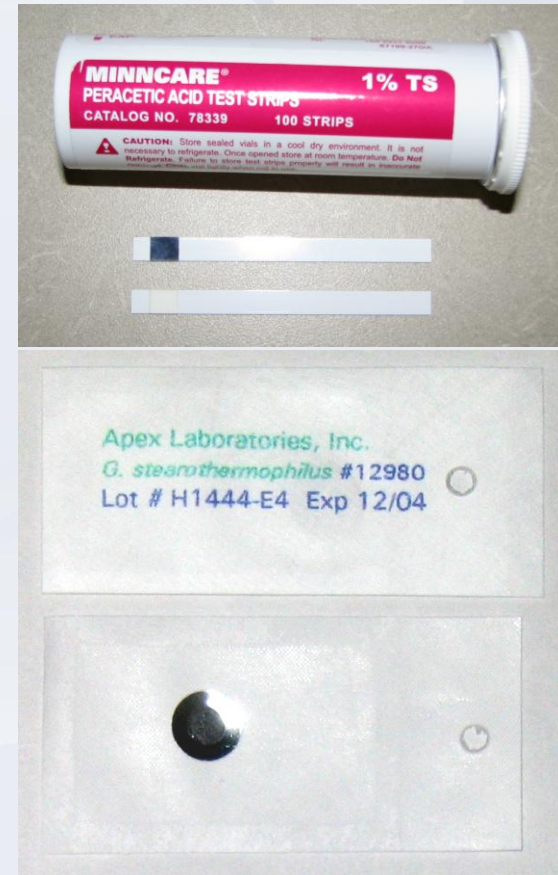
DFS: Process Validation

- **Chemical Indicators (CI)**

- Changes from white to grey or black
- Indicates a concentration greater than 1%

- **Biological Indicators (BI)**

- Spores of *Geobacillus stearothermophilus* ($\geq 10^6$)



Detection

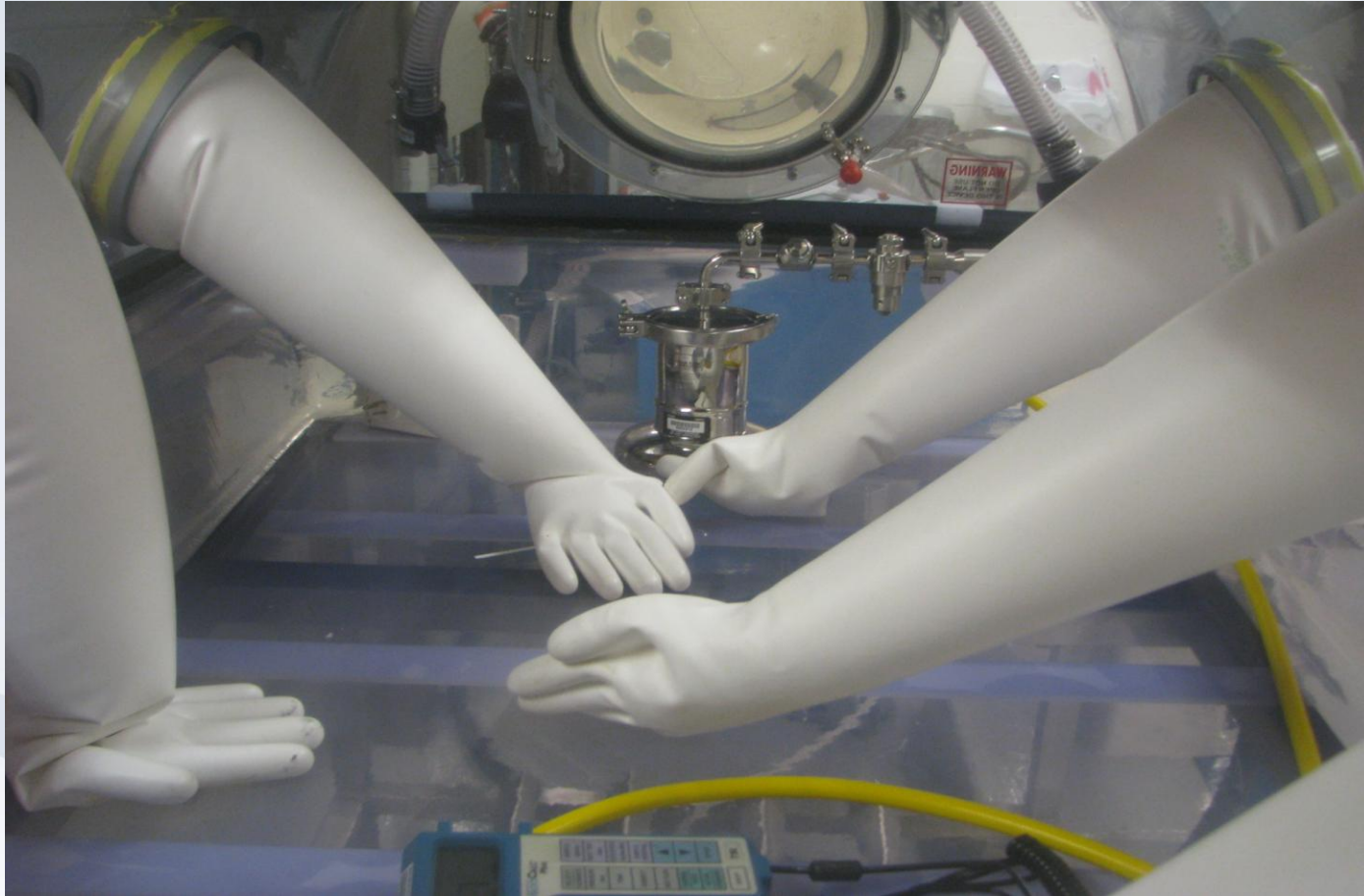
- Dräger Polytron 2 w/H₂O₂ Sensor
- Dräger Pac III w/H₂O₂ Sensor
- Dräger H₂O₂ Detection Tubes
- Safe concentration: <1ppm



Small Scale Experiments: Setup



Small Scale Experiments: Setup



Disinfectant Testing: QCT

- **Quantitative Carrier Test**

- Soil load (BSA, Mucin, Tryptone)
- Brushed stainless steel
- Dried test inoculum



DFS: Effect of Soil Load

Microbial agents	Initial titre**	Exposure	Result
<i>Vesicular stomatitis virus</i>	5.9	2 hours	NG
<i>Escherichia coli</i>	6.9	1 hour	NG
<i>Staphylococcus aureus</i>	6.2	1 hour	NG
<i>Bacillus atrophaeus</i> spores	5.8	Overnight	NG
<i>Geobacillus stearothermophilus</i> spores*	6.0	30 min	NG

* Biological Indicator spore strips, contain no protein soil load

** titres are in LOG₁₀

NG: No Growth

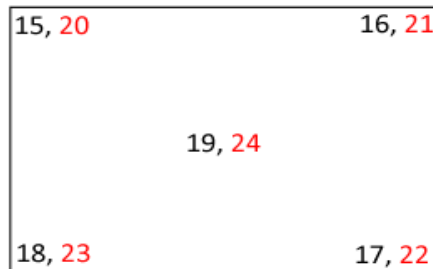
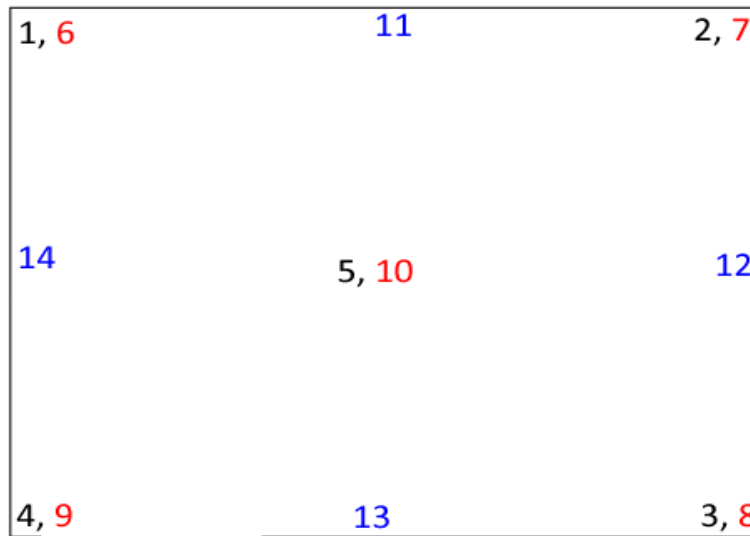
Dry Fogging Experiments: Setup



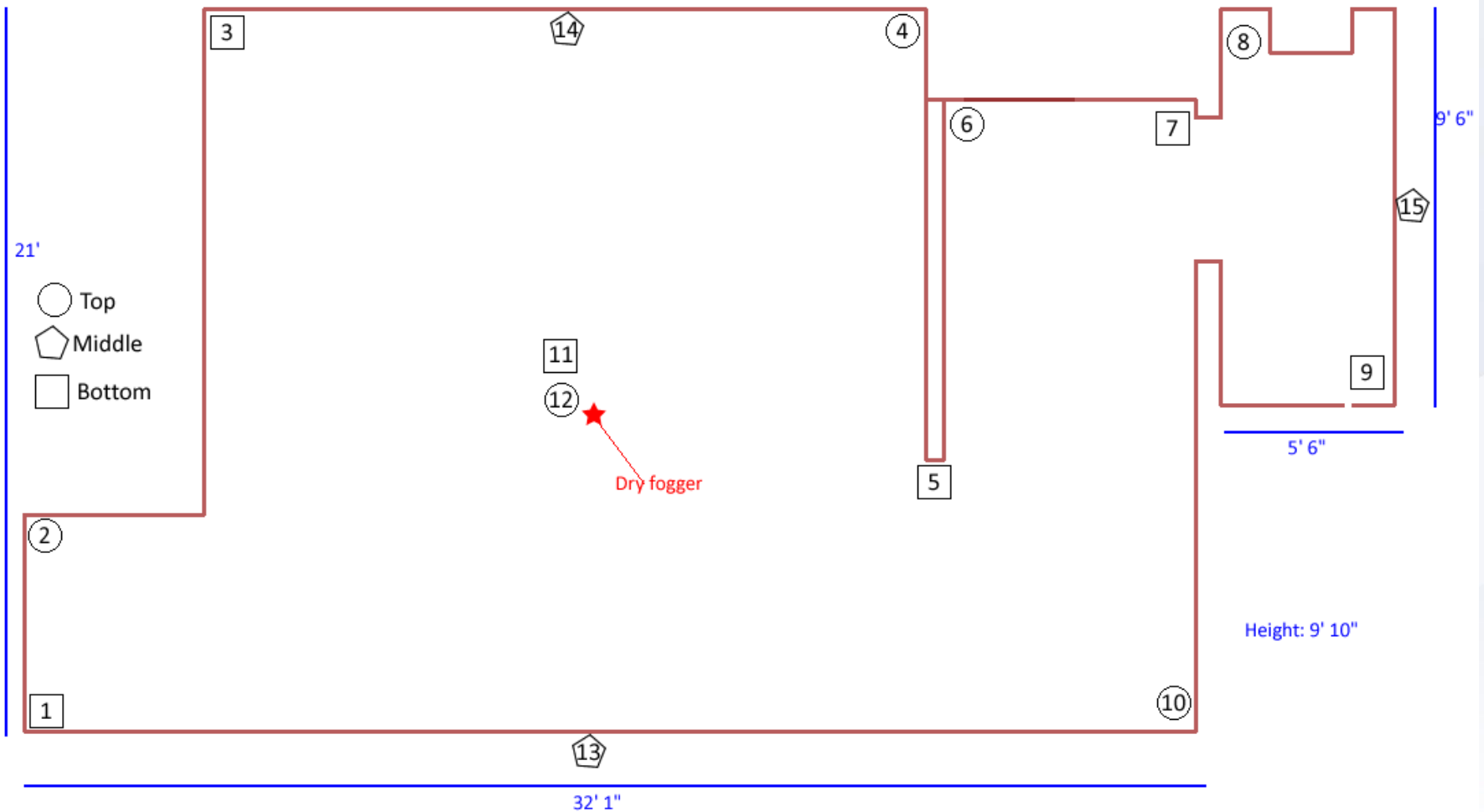
- Simulated lab space
- Metal framing,
polypropylene sheets
- ~700 ft³

Dry Fogging Experiments: Setup

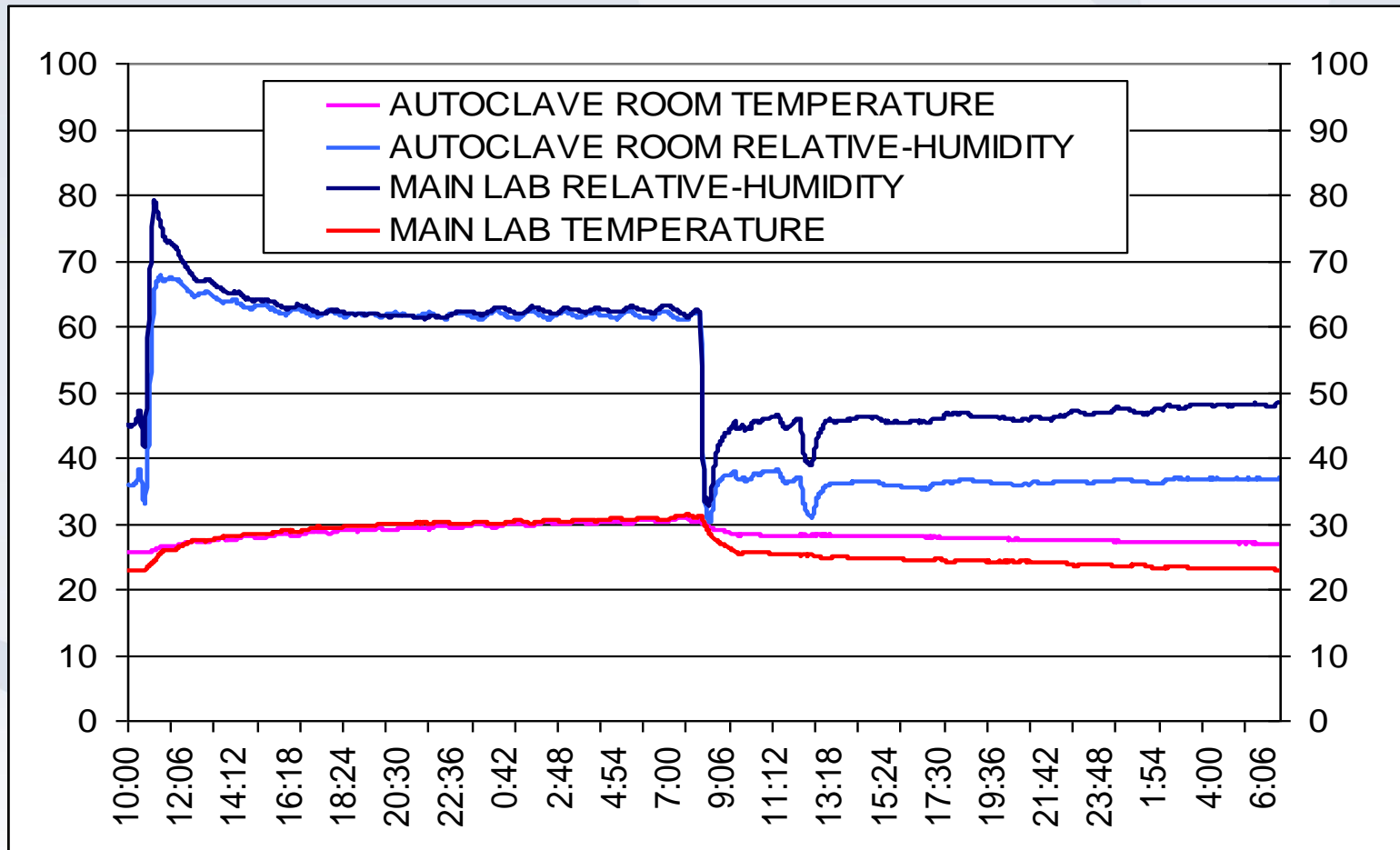
Location of Bls: Floor (bottom), Ceiling (top), Wall (middle)



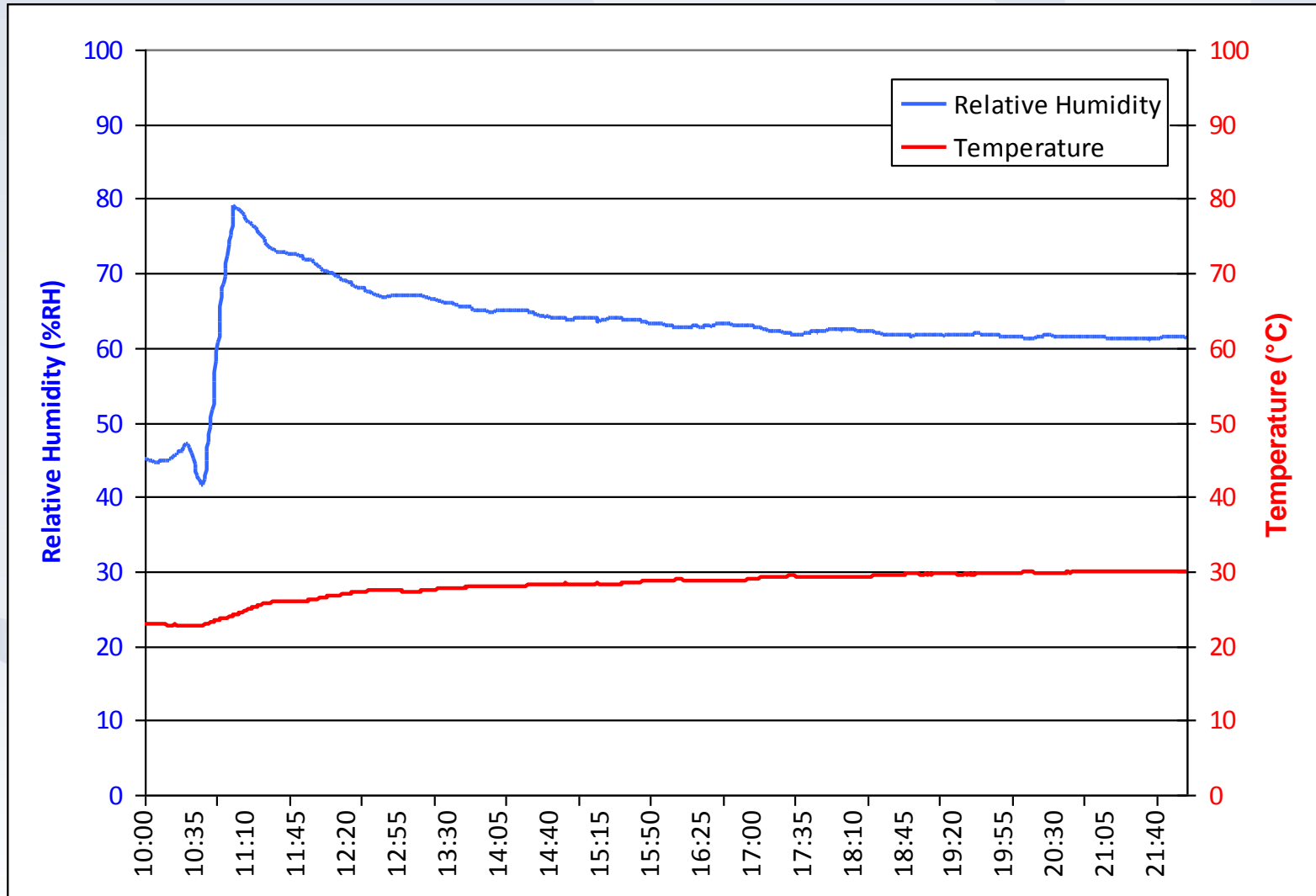
BI Locations



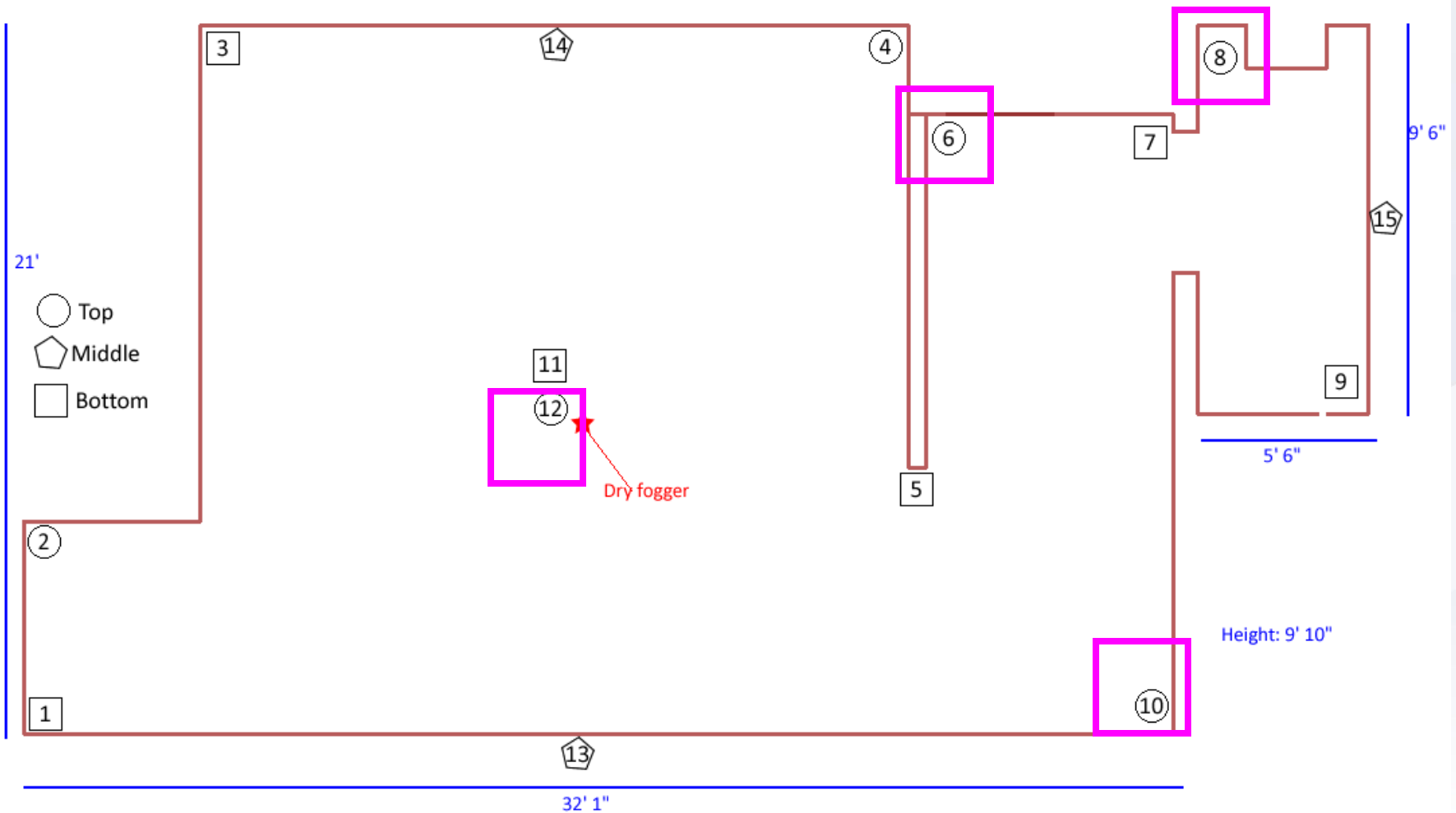
DFS: Main Lab vs. Autoclave Room



DFS: RH & Temp



Results: Failed BIs

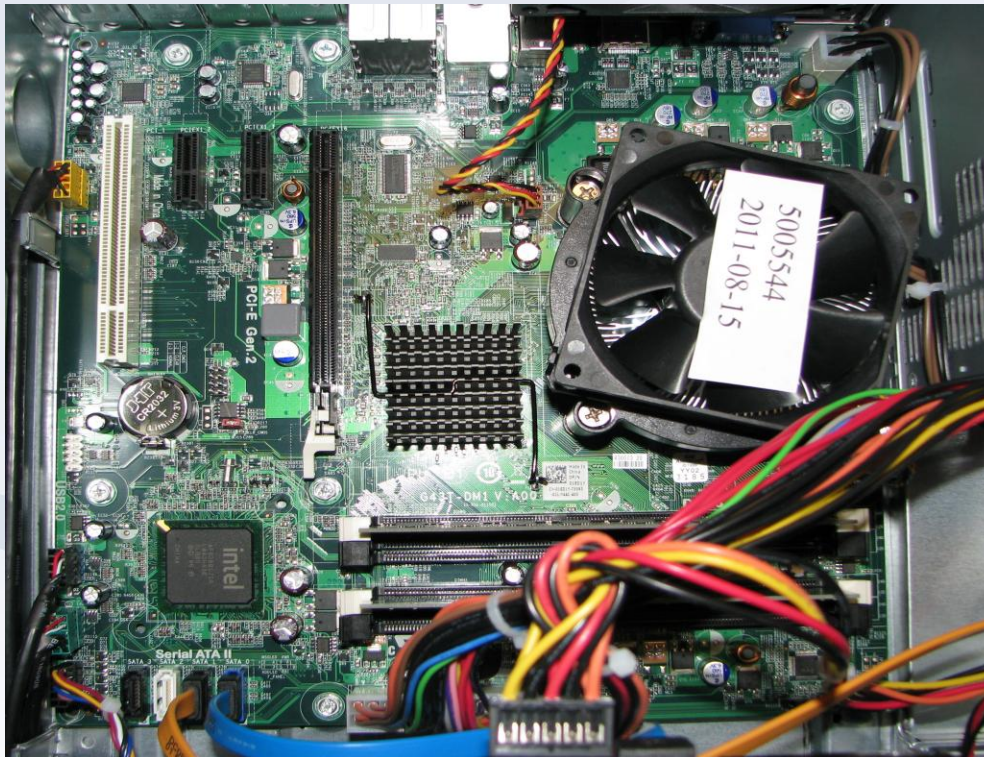


What happened?

- The fog failed to rise to ceiling
 - Raise fogger arm higher, articulating head fogger
- Heat from lab equipment caused stratification of T
 - Higher temp will \downarrow H, prevent dry fog from contactng surface
 - Add fans to circulate air, \downarrow heat load
- May not have achieved desired RH at ceiling
 - Add fans to circulate air

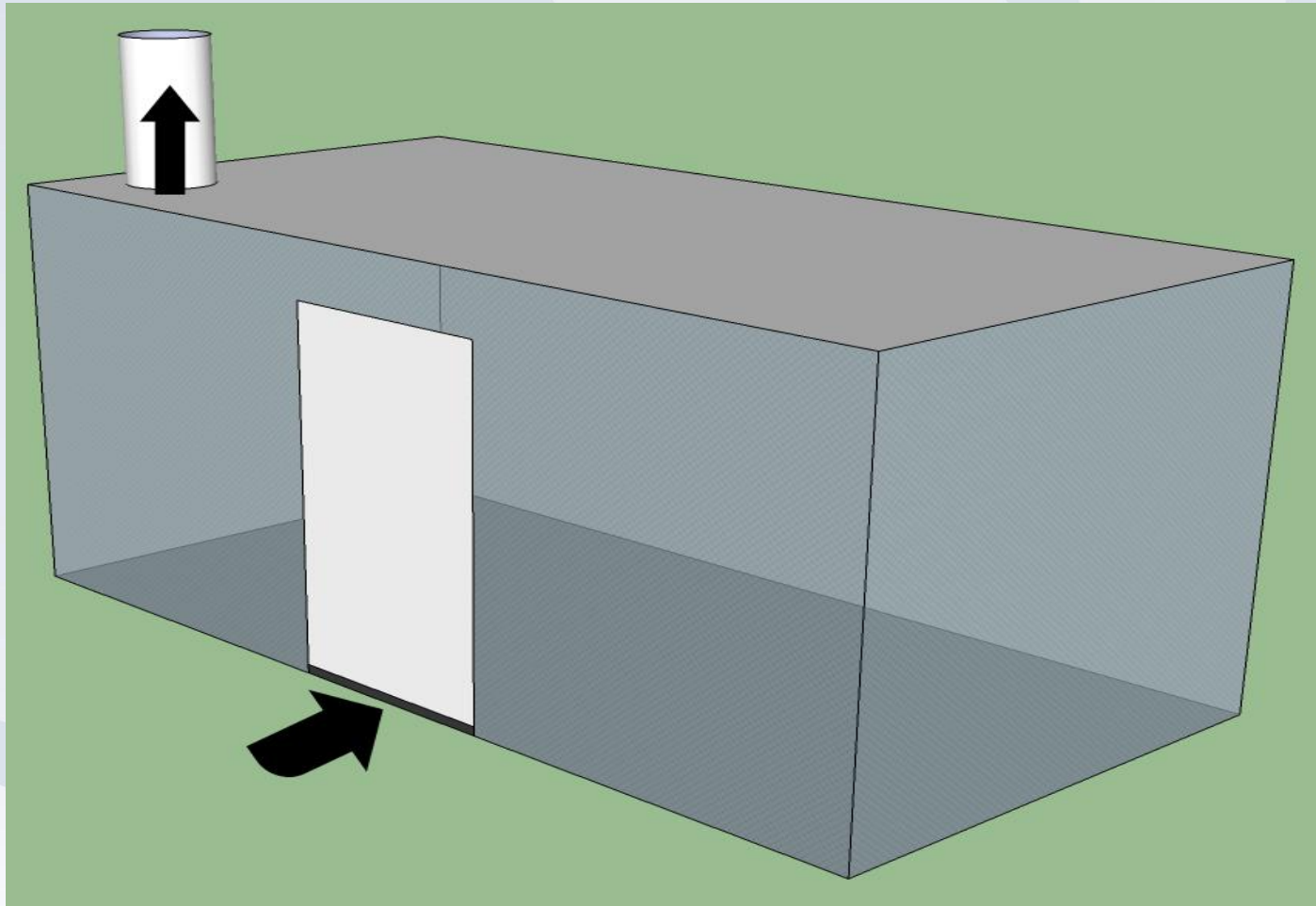
Is Dry Fogging System Compatible to Electronics?

- Test Vehicle: Dell Inspiron 560

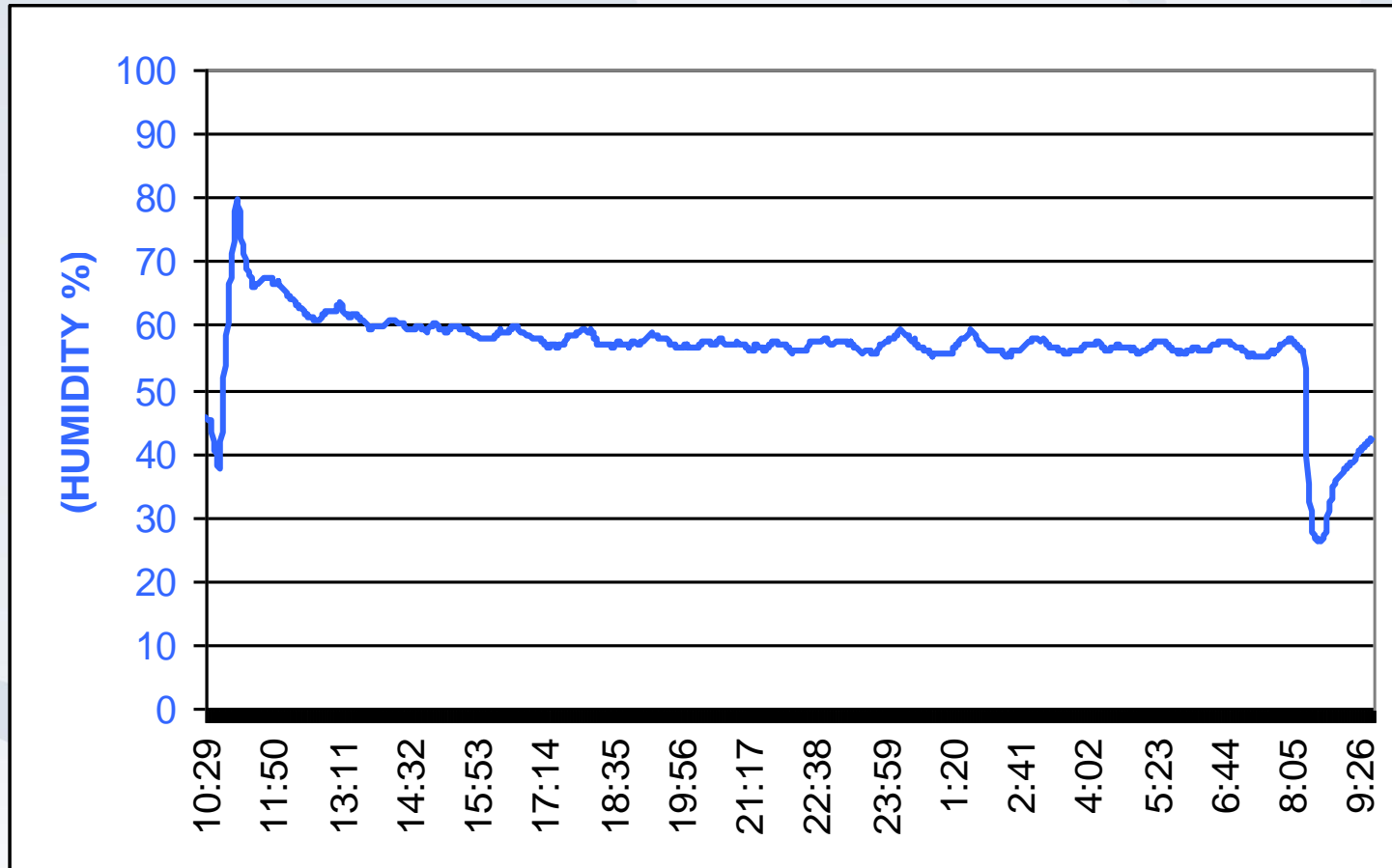


Sheet metal
Plastic
Aluminum
Copper

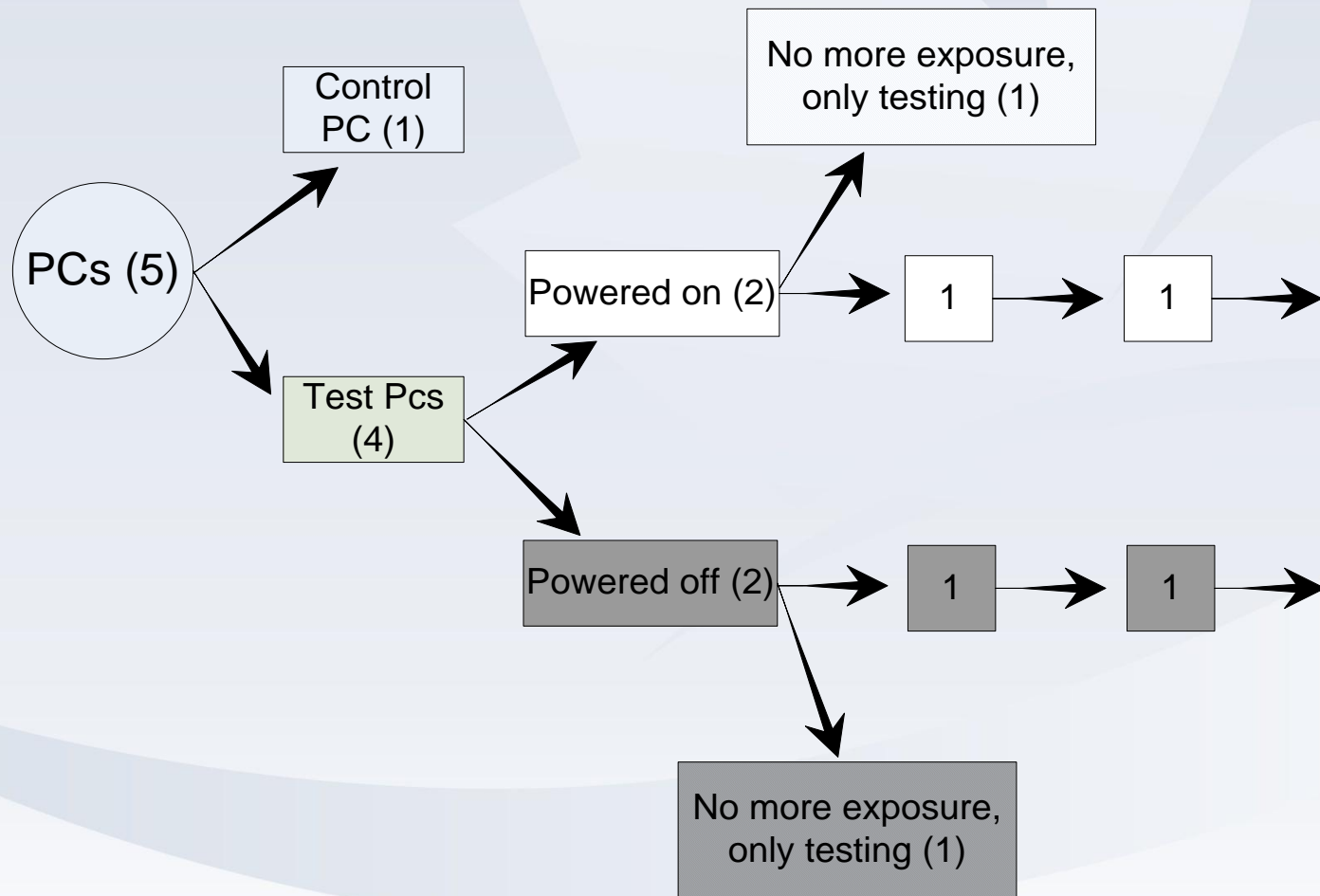
Decon Chamber



Validation Conditions (RH)



Validation Plan



Results

- **BIs**

- **PC, power on---> BI pass (3/3)**
- **PC, power off---> BI pass (2/3)**

- **Physical**

- **No visual evidence of corrosion, discoloration**

- **Functional**

- **No evidence of functional impairment by PC-Doctor**

Conclusions:

- Potential use for Dry fog/PAA in decontamination of high containment laboratories and sensitive electronics
- PAA able to penetrate soil load
- More validation studies required

Acknowledgements

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