Evaluation of Dry Fogging System for Microbial Inactivation

Carol Stansfield
Senior Biosafety Officer
Safety & Environmental Services
Canadian Science Centre for Human and Animal Health,
Winnipeg, Manitoba

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: ~7.5µ
- 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°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_2O, O_2, CO_2	H_2O, 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

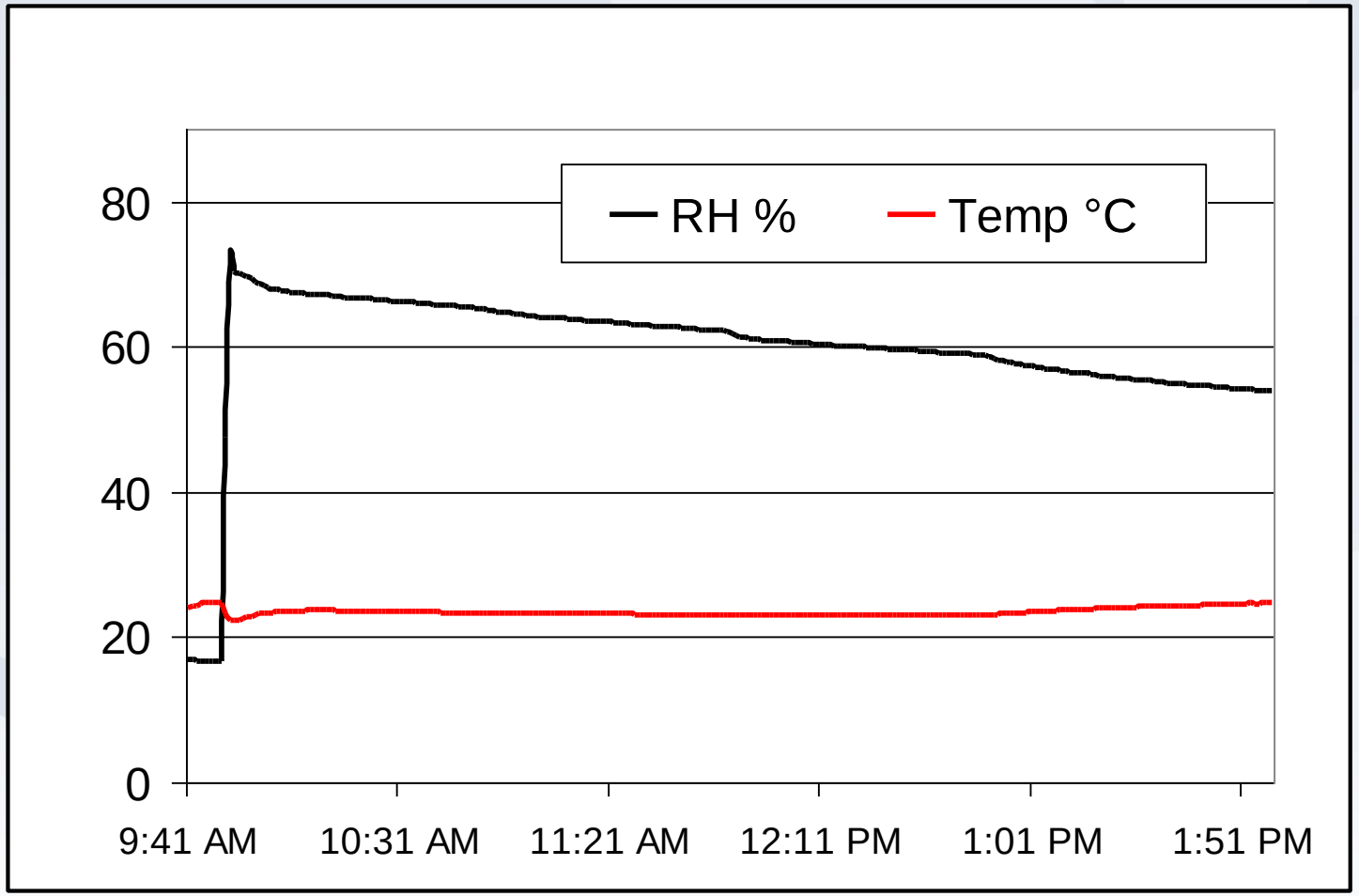
- MiniDry Fog System
- 1 Nozzle
- 500 mL/hr
- $5000 USD
- 500 mL reservoir

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.

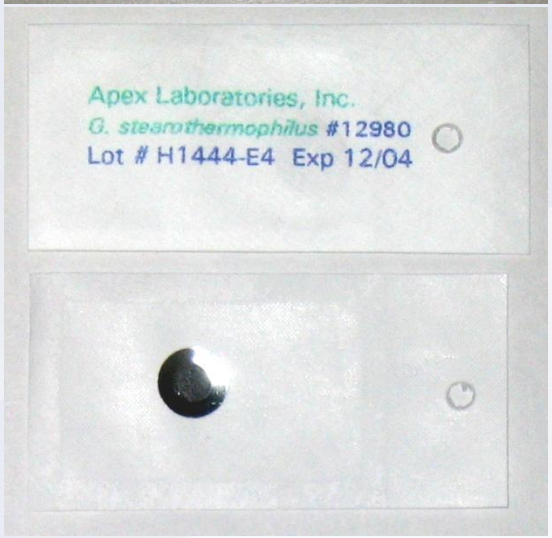
DFS: Decontamination Cycle



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* ($\geq 10^6$)

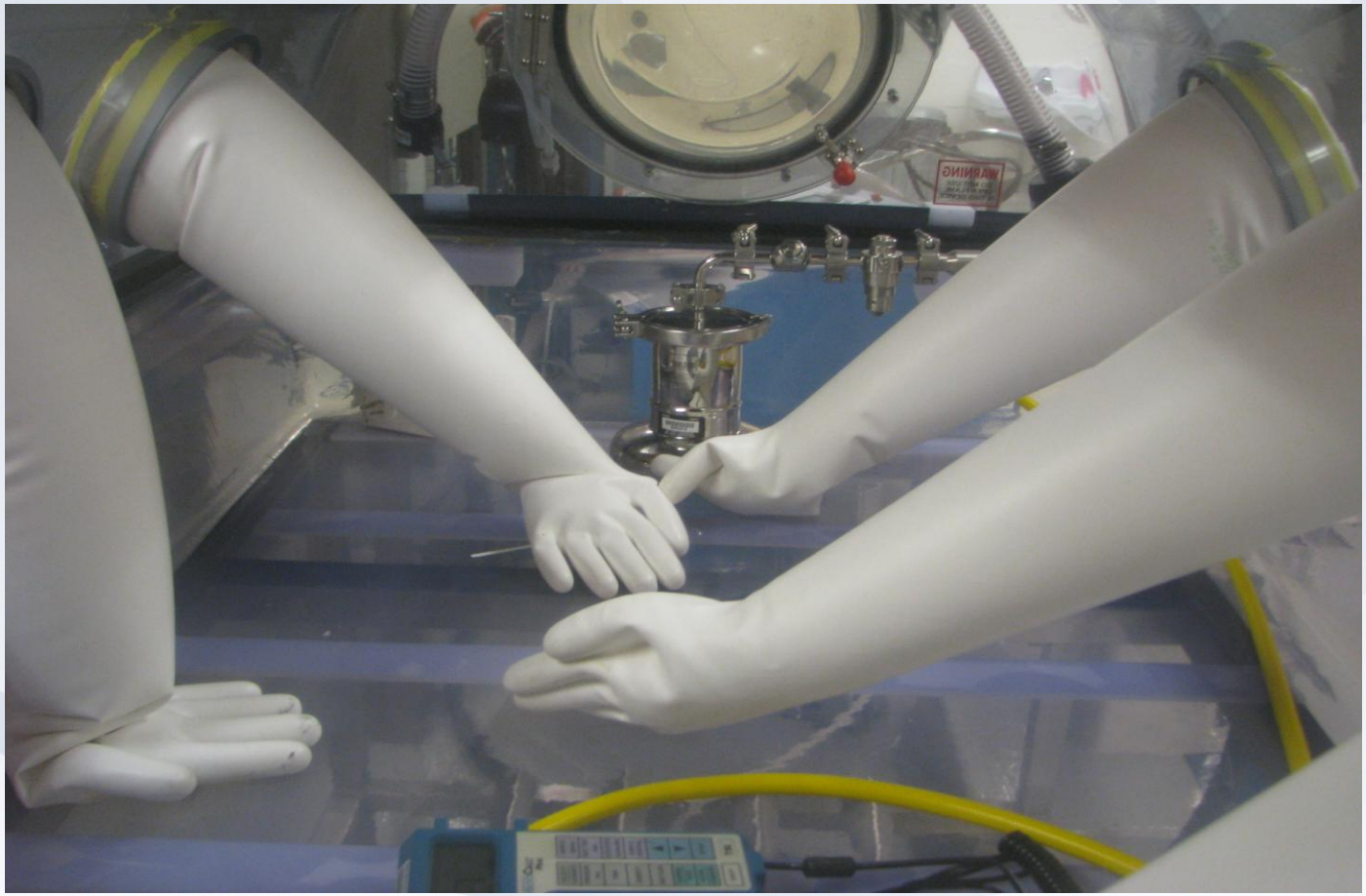


Detection

- Dräger Polytron 2 w/H_2O_2 Sensor
- Dräger Pac III w/H_2O_2 Sensor
- Dräger H_2O_2 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
Vesicular stomatitis virus	5.9	2 hours	NG
Escherichia coli	6.9	1 hour	NG
Staphylococcus aureus	6.2	1 hour	NG
Bacillus atrophaeus spores	5.8	Overnight	NG
Geobacillus stearothermophilus spores*	6.0	30 min	NG

* Biological Indicator spore strips, contain no protein soil load

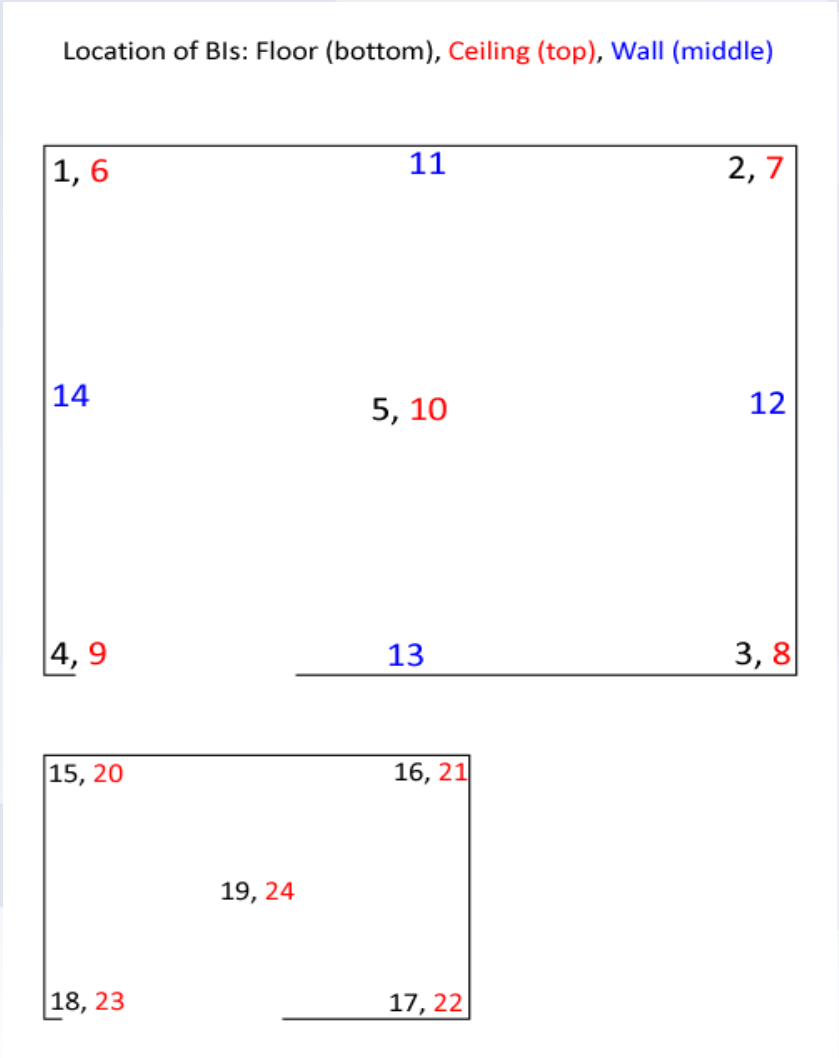
** titres are in LOG_{10}

NG: No Growth

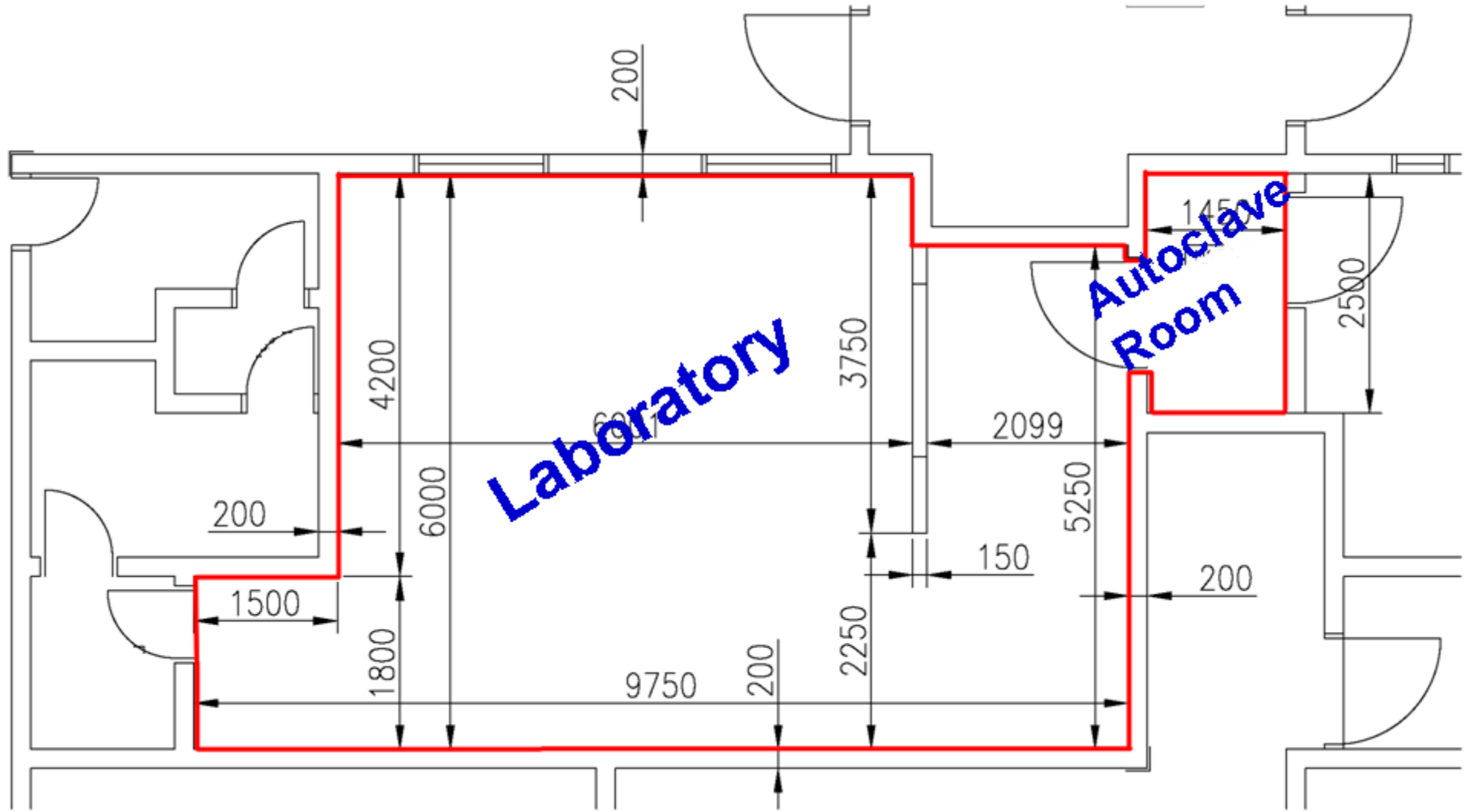
Dry Fogging Experiments: Setup

- Simulated lab space
- Metal framing, polypropylene sheets
- ~700 ft^3

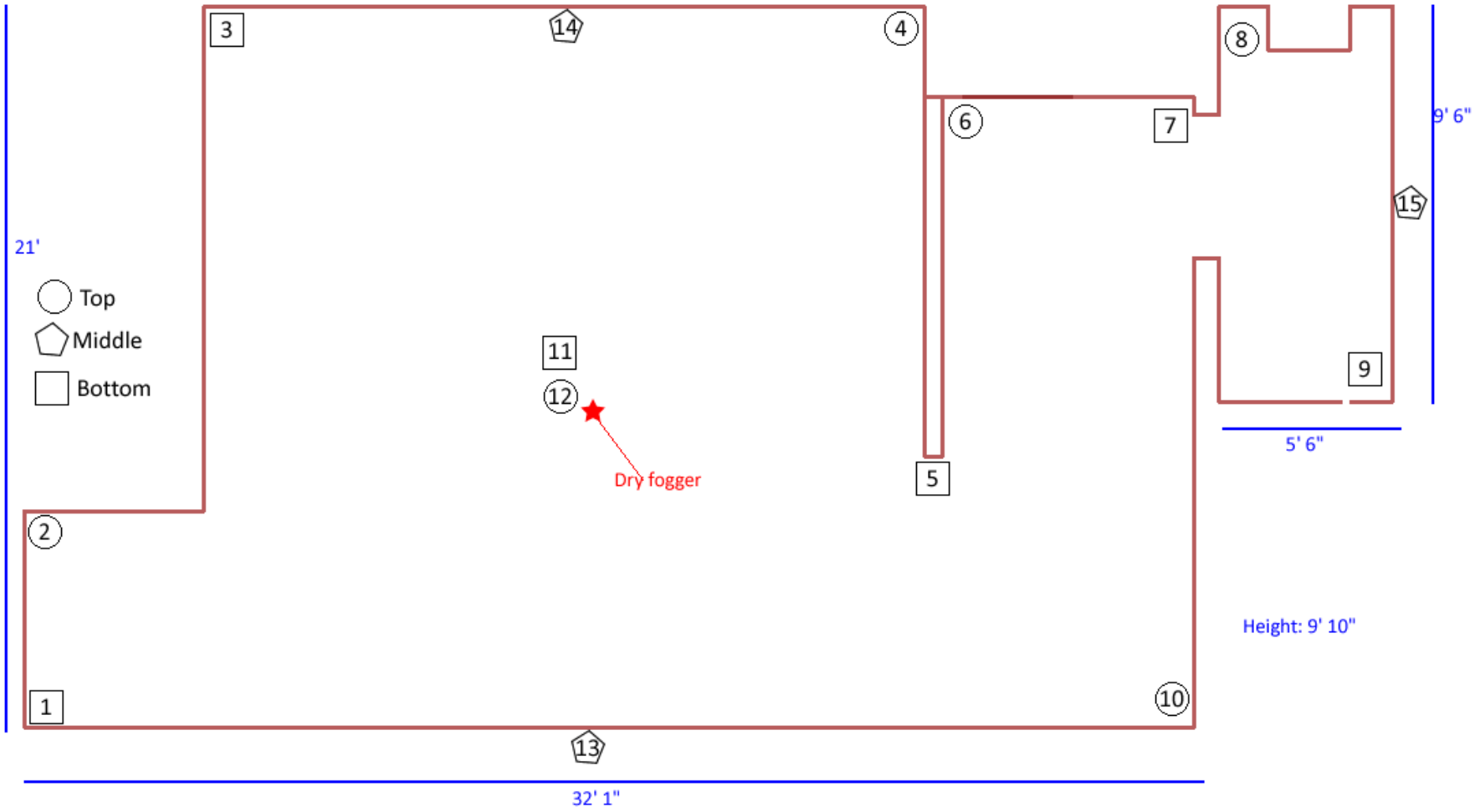
Dry Fogging Experiments: Setup



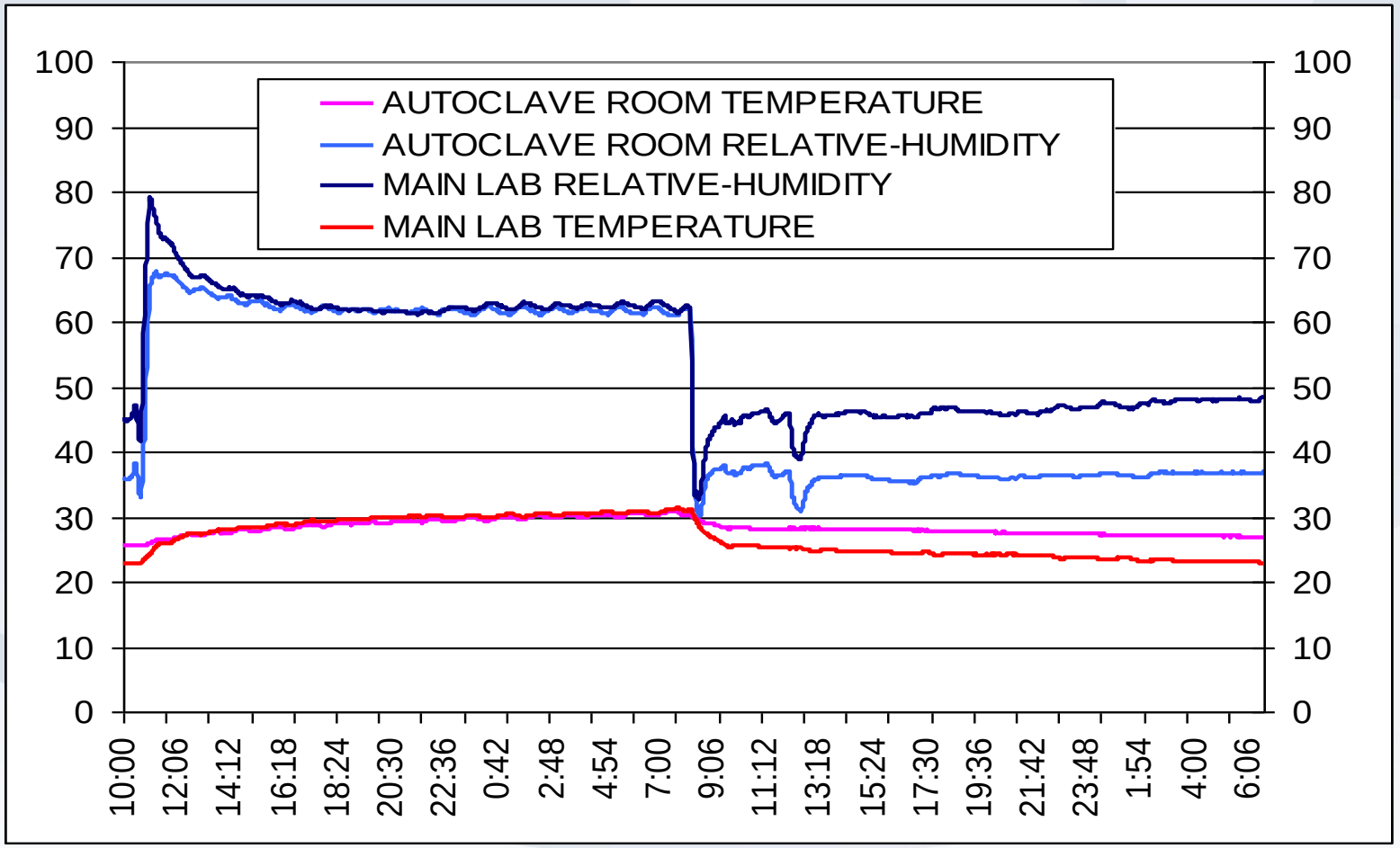
CFIA CL4 Lab Decon using DFS



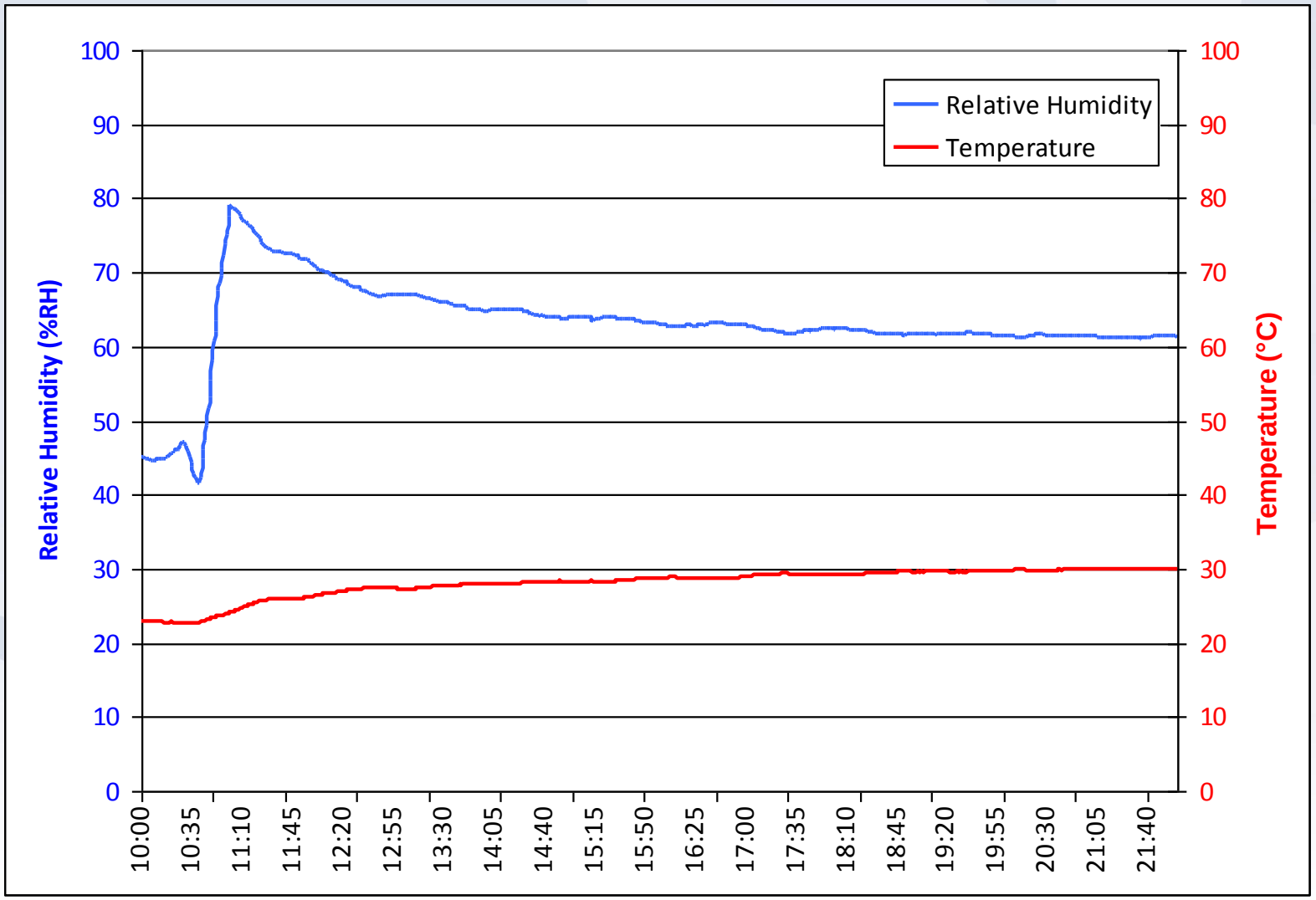
BI Locations



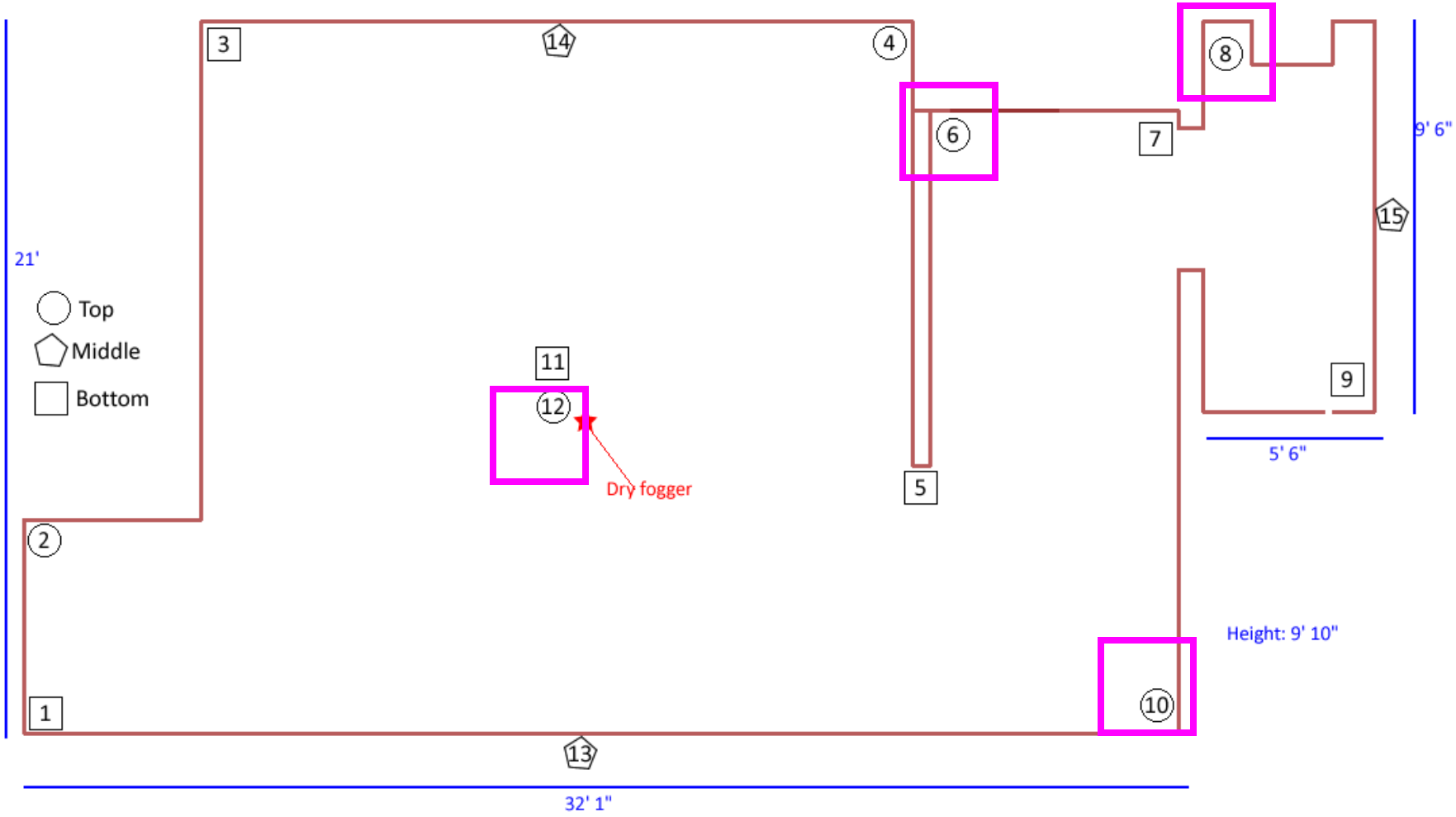
DFS: Main Lab vs. Autoclave Room



DFS: RH & Temp


Relative Humidity
Temperature
Relative Humidity (%RH)
Temperature (°C)
100
90
80
70
60
50
40
30
20
10
0
10:00
10:35
11:10
11:45
12:20
12:55
13:30
14:05
14:40
15:15
15:50
16:25
17:00
17:35
18:10
18:45
19:20
19:55
20:30
21:05
21:40

Results: Failed BIs

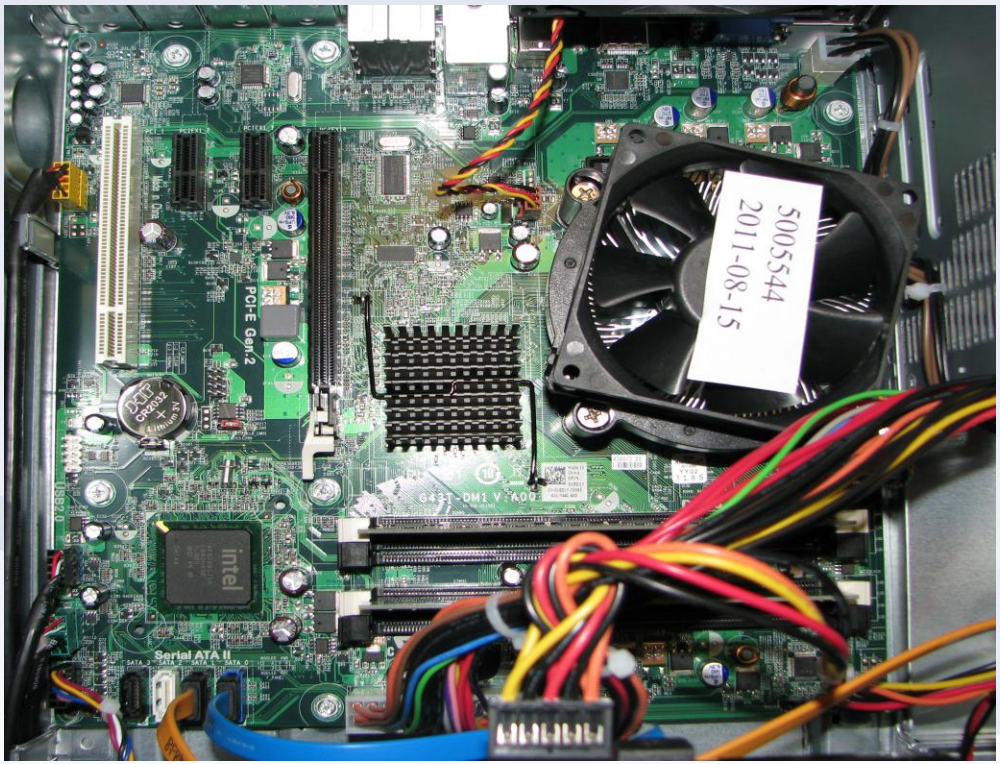


What happened?

- 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 ↓H, prevent dry fog from contactng surface
  - Add fans to circulate air, ↓heat load
- May not have achieved desired RH at ceiling
  - Add fans to circulate air

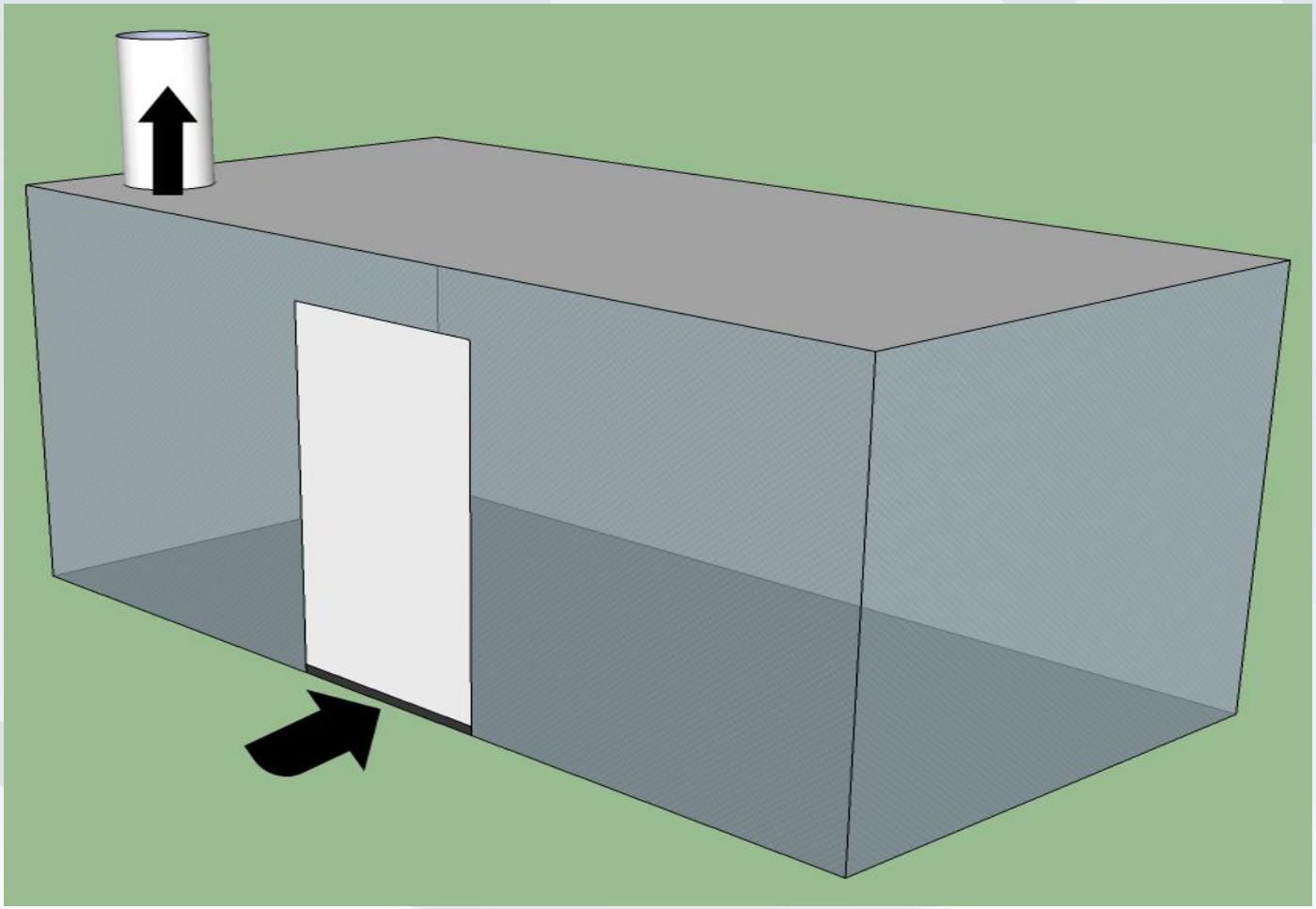
Is Dry Fogging System Compatible to Electronics?

- Test Vehicle: Dell Inspiron 560

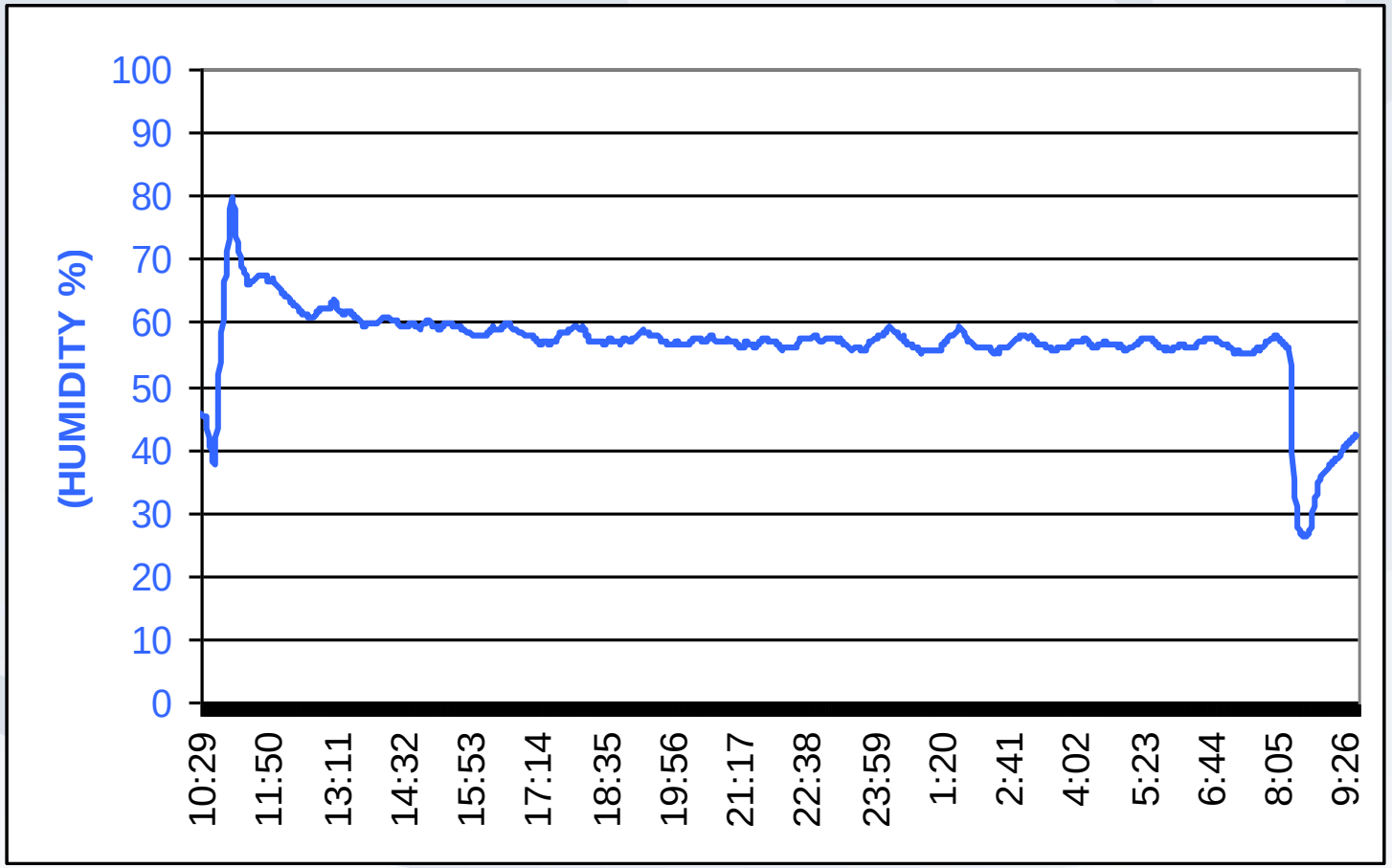


Sheet metal
Plastic
Aluminum
Copper

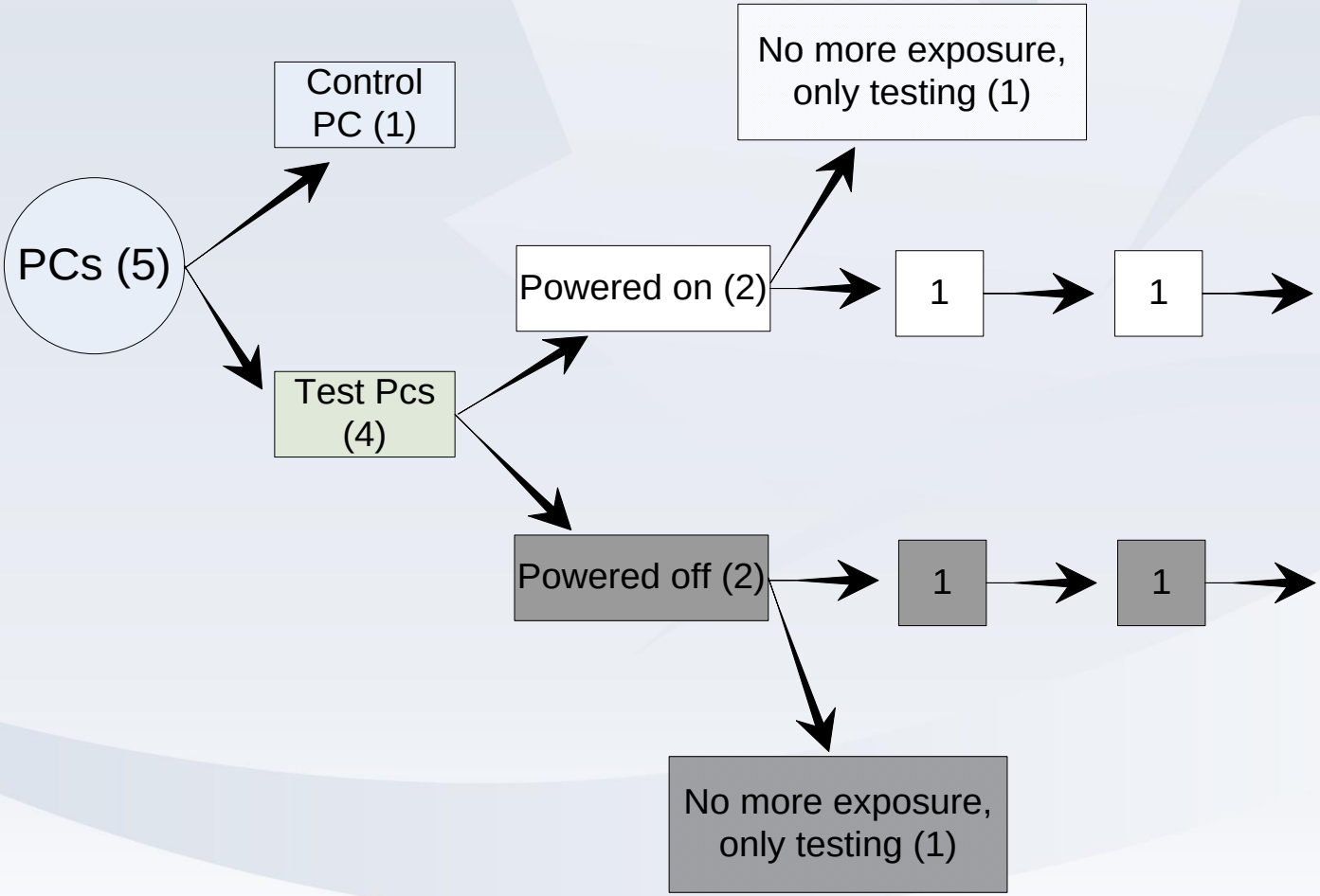
Decon Chamber



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

- Jay Krishnan, Senior Biosafety Officer NML
- Laura Landry, Biosafety Officer NML
- Greg Fey, Containment Services PHAC