Effectiveness of Decontamination of Laboratory Room Surfaces with Low Concentrations of Hydrogen Peroxide and Isopropyl Alcohol using Atmospheric Cold Plasma Activation

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Conflict of Interest

As of August 1, 2015 - Consultant for *TOMI Environmental Solutions* to provide guidance and advice on the performance testing of TOMI's decontamination technology in scientific research laboratories.

Our Decontamination Experience

- Formaldehyde gas decontamination – the “Gold Standard”.
- Decontamination tests with other technologies:
  - Vaporized Hydrogen Peroxide (Bioquell).
  - Chlorine Dioxide (ClorDiSys Solutions & DRS Laboratories).
- Goal – Looking for a suitable replacement for formaldehyde gas.

Units Tested

Photo Courtesy of TOMI Environmental Solutions

SteraMist Environment System

Photo Courtesy of TOMI Environmental Solutions

SteraMist Surface Unit

Biological Indicators Used During the Tests

MESA Labs:

- HMV-091 – Tyvek/Tyvek packaged BI - G. stearothermophilus (#12980) >10E6

- SBC-327 – Bare metal BI - G. stearothermophilus (#12980) >10E6

- GRS-090 – Tyvek/Tyvek packaged BI - B. atrophaeus (#9372) >10E6

What is Plasma

- Plasma – The 4th state of matter. Comprises 99% of the visible Universe.
- Consists of free moving electrons and ions that can be formed when energy is applied to molecules.

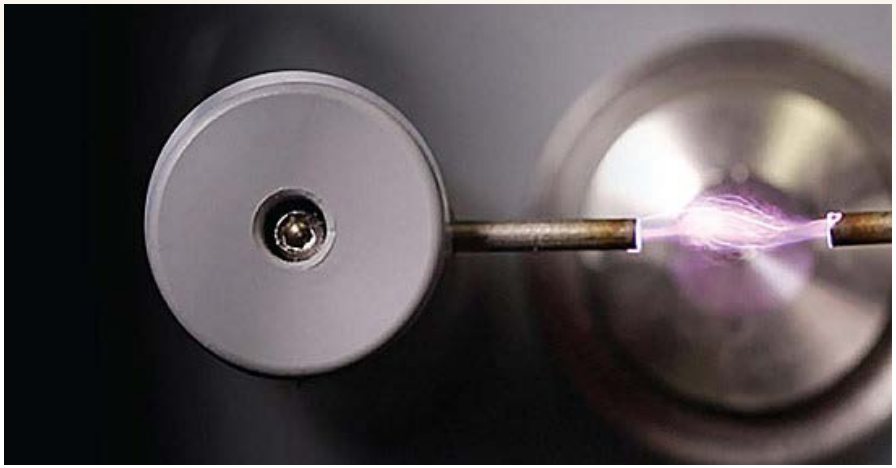
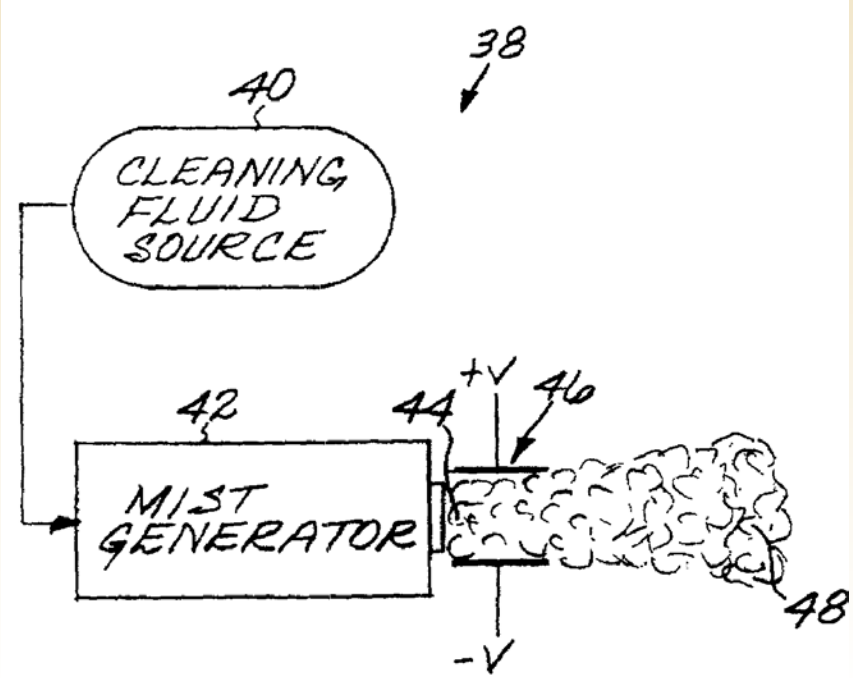


Photo Courtesy of TOMI Environmental Solutions

H2O2 – Atmospheric Cold Plasma Activation

How does it works:

Hydrogen Peroxide (H2O2) solution is mixed with air and sprayed in front of a cold plasma arc at atmospheric pressure which generates Hydroxyl Ions and Hydroxyl Free Radicals. Some of the Reactive Oxygen Species (ROS).

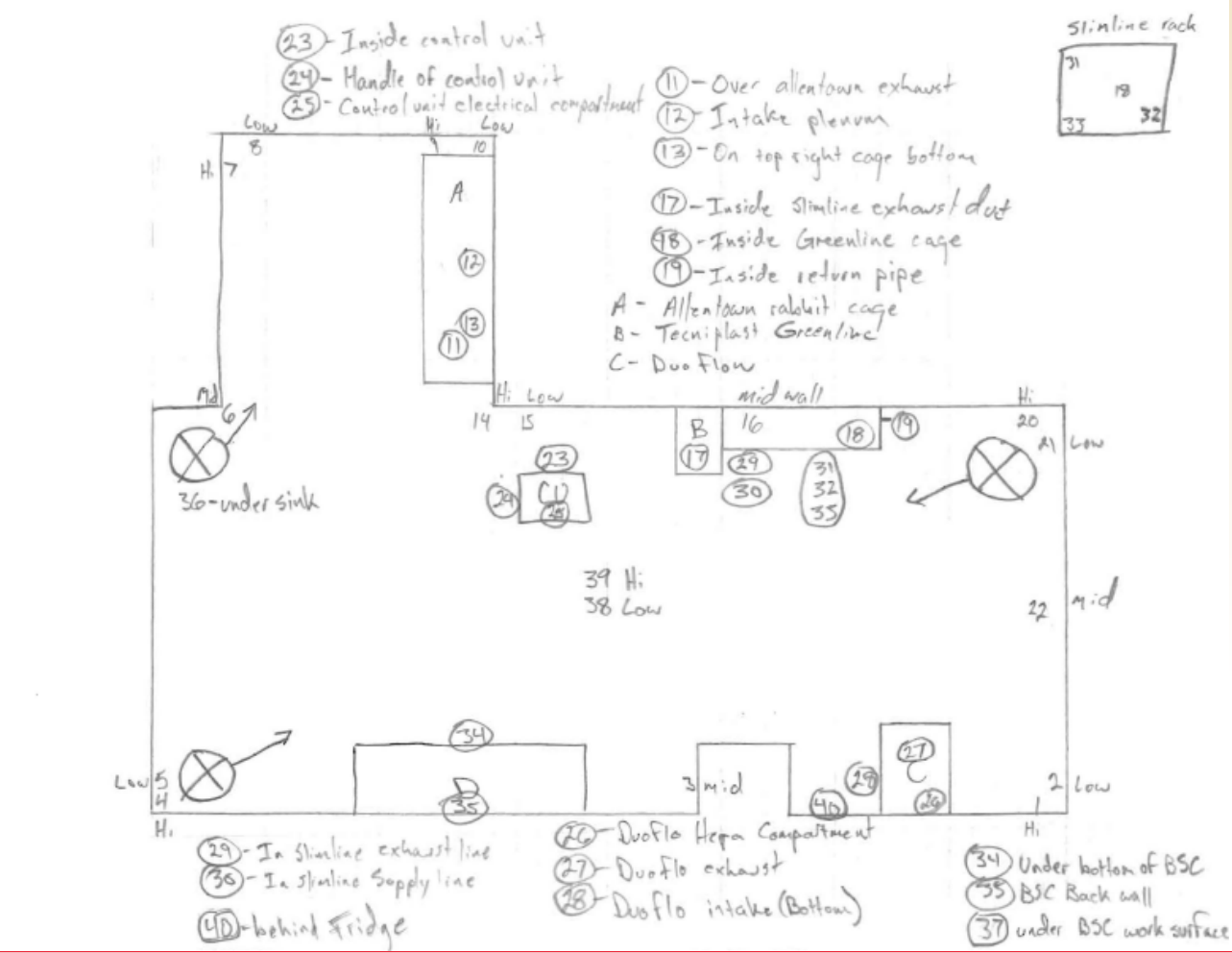


Source: Patent No. US 7,008,592 B2, of March 7, 2006.

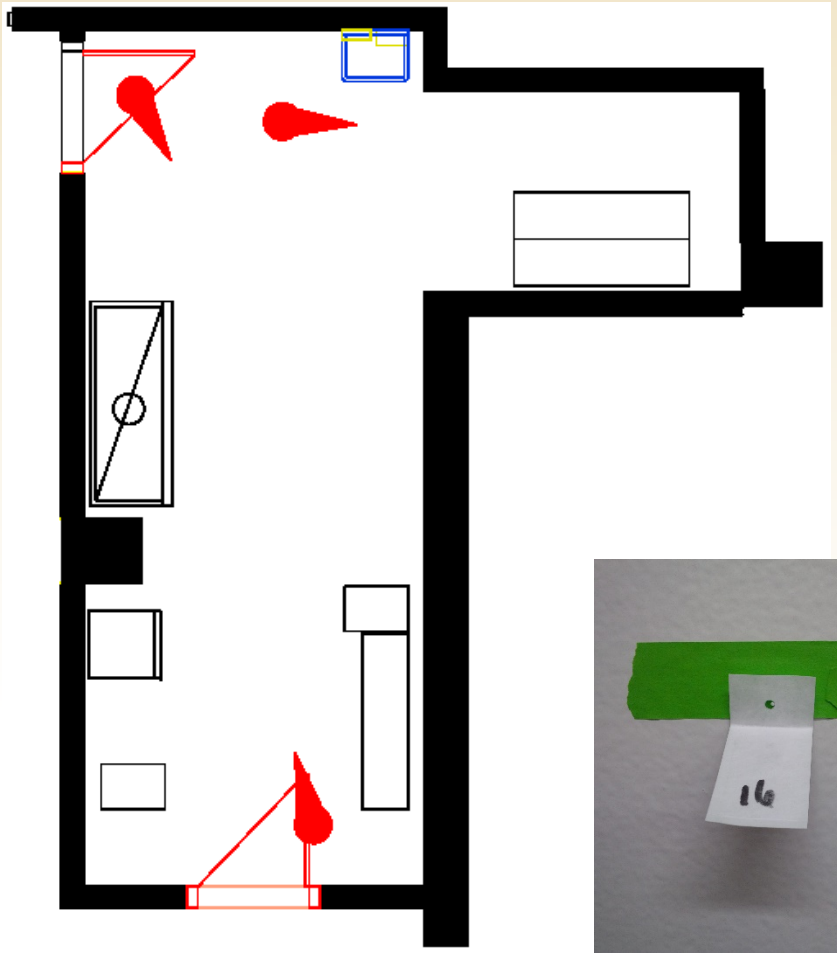
H2O2 – Atmospheric Cold Plasma Activation

Photo Courtesy of TOMI Environmental Solutions

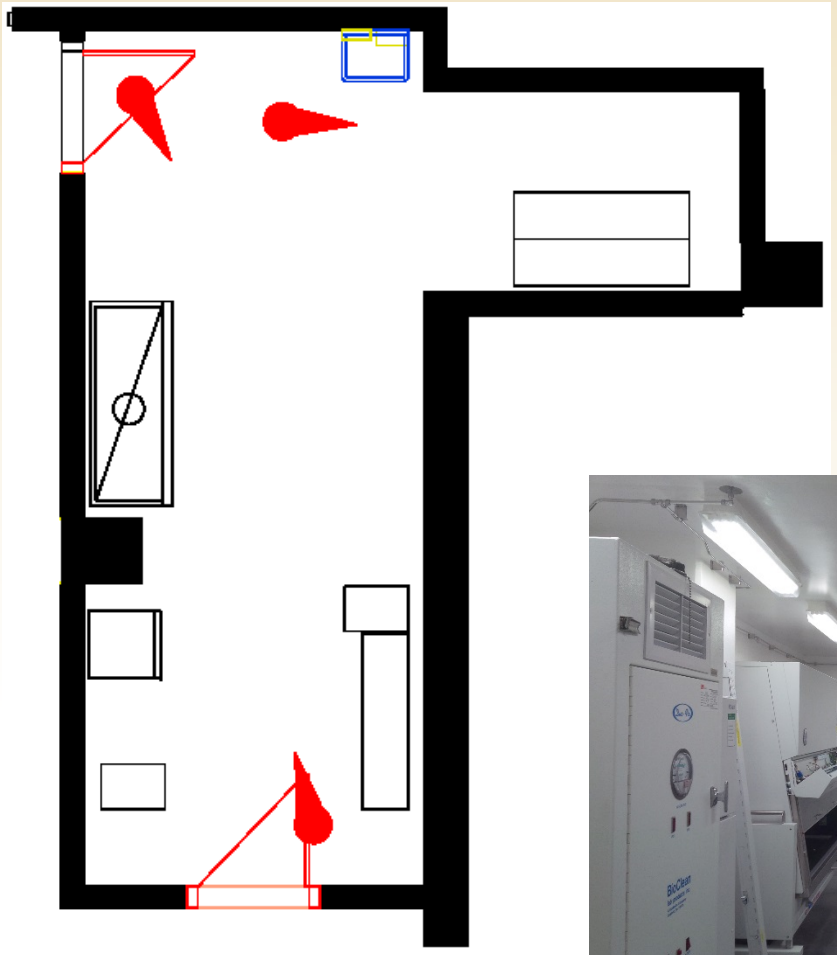
L-Shape Room – Test 1 - Spore Locations



L-Shape Room Setup – Test 1



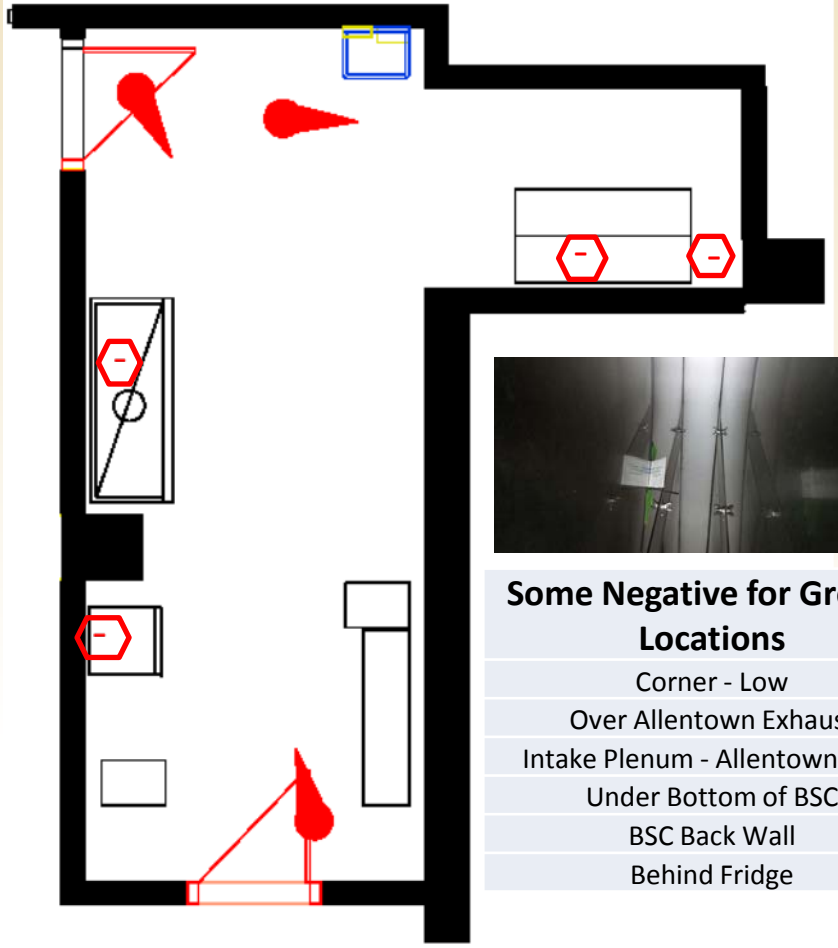
L-Shape Room Setup – Test 1



Decontamination Process

Results – 1st Test - G. stearothermophilus

	3 Nozzles
	Tyvek-Tyvek Package
	G. stearothermophilus
Positive	25
Negative	15
Total	40



Some Negative for Growth Locations
Corner - Low
Over Allentown Exhaust
Intake Plenum - Allentown Cage
Under Bottom of BSC
BSC Back Wall
Behind Fridge

Questions:

1. Does it behave like a gas??
2. Does the Tyvek packaging affect the penetration of the disinfectant?
3. Does the number of nozzles have an impact on the results (spray time)?

1st Test - Handheld Unit

Surface Decon - Animal Cage	
Tyvek-Tyvek Package	
G. stearothermophilus	
Sample No./Date	3/3/2015
1	+
2	-
3	-
4	+
5	-
6	+
7	+
8	-
9	+
10	-
11	-
12	+

Questions:

1. Does the Tyvek packaging affect the penetration of the disinfectant?
2. Are we over-wetting the Tyvek package, blocking the penetration of the ROS.

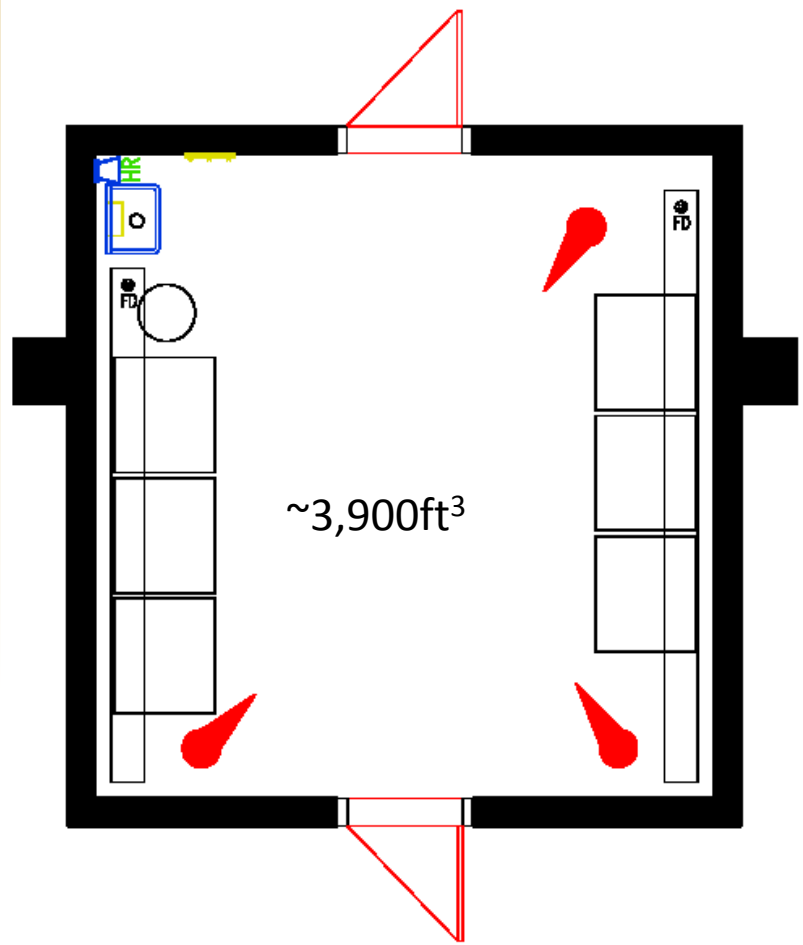
2nd Test - Handheld Unit

BIs Used on the Test:

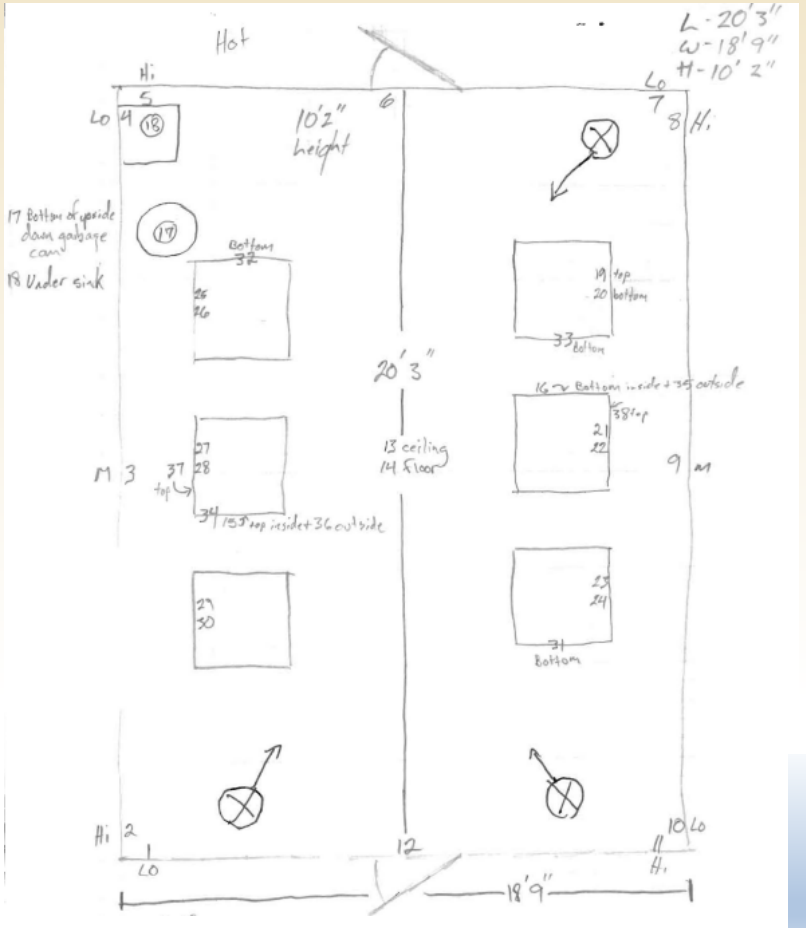
SBC-327 – Bare metal BI - G. stearothermophilus (#12980) >10E6

Surface Decon - Animal Cage	
Bare SS	
G. stearothermophilus	
Sample No./Date	3/12/2015
1	-
2	-
3	-
4	-
5	-
6	-
7	-
8	-
9	-
10	-

Large Animal Room Setup



Large Animal Room - Spore Locations



BIs Used on the Test:

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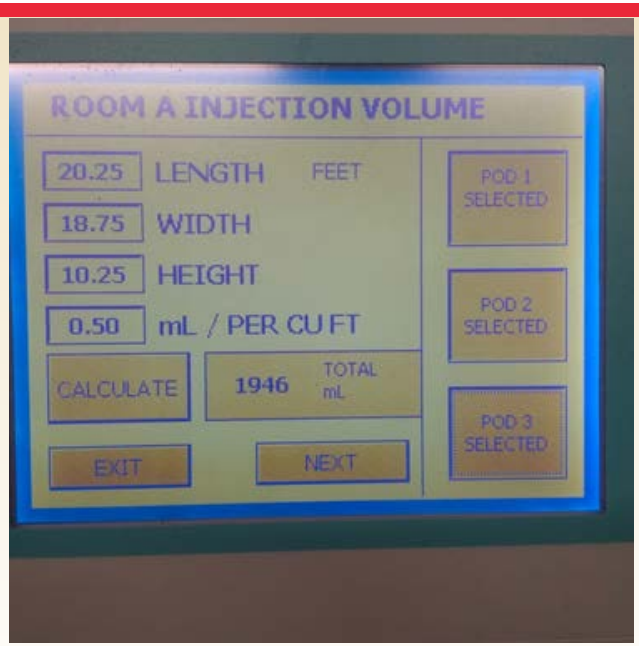
Large Animal Room Decontamination Process



Room Volume	**3891.8**	**ft3**
Solution Used	**1946**	**ml**
Injection Time	**25.07**	**min**
Dwell Time (manual)	**15.00**	**min**

Large Animal Room Results

	3 Nozzles - Old Solution Bare SS GS
Sample No./Date	3/16/2015
1	-
2	-
3	-
4	-
5	-
6	-
7	-
8	-
9	-
10	-
11	-
12	-
13	-
14	-
15	-
16	-
17	-
18	-
19	-
20	-
21	-
22	-
23	-
24	-
25	-
26	-
27	-
28	-
29	-
30	-
31	-
32	-
33	-
34	-
35	-
36	-
37	-
38	-

3 Nozzles	
Bare SS	
G. stearothermophilus	
	3/16/2015
Positive	0
Negative	38
Total	38

HPV vs AIHP

Clarus C Cycle Calculator — BIOQUELL

Enter room dimensions in feet using decimals

Room dimensions and volume		
Length	20.25	ft
Width	18.75	ft
Height	10.25	ft
Total room volume is	3891.8	cuft

Required Peroxide		
Total Peroxide volume @ 0.3g/cuft	1361	g
Required peroxide for injection phase	952	g
Required peroxide for dwell phase	408	g

Injection Rates and Periods	Rate	Period
Injection phase input data	8 g/min	119 min.
Dwell phase input data	8 g/min	51 min.

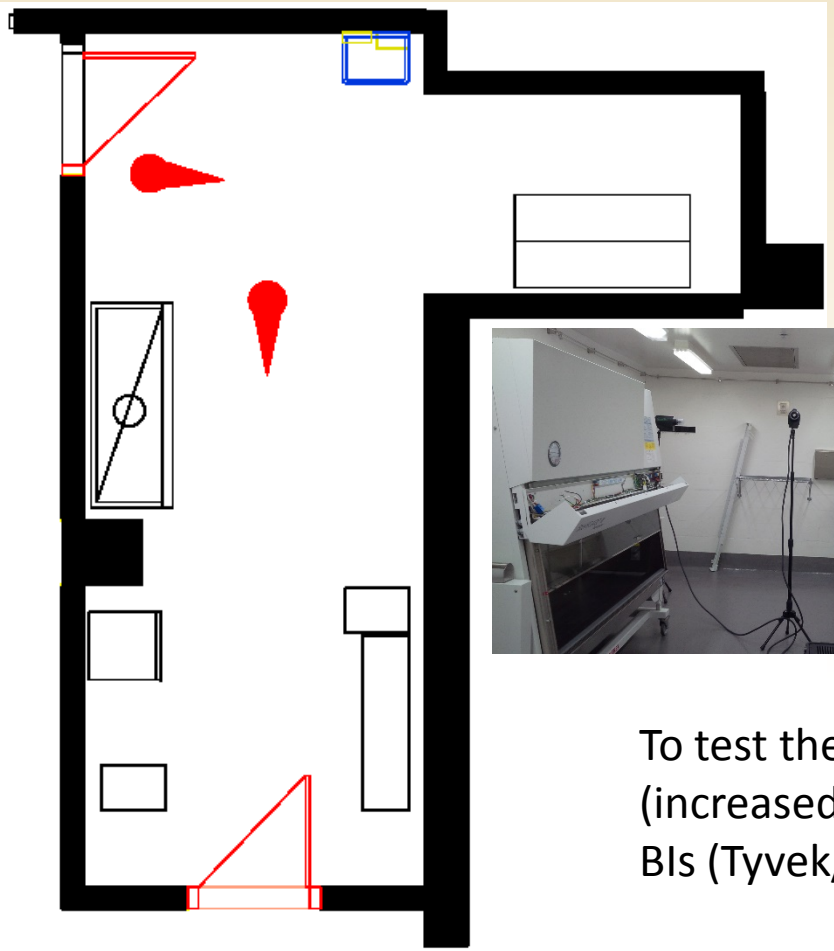
Decontamination Duration

Bioquell – 170 minutes + Aeration
Steramist – 40 minutes + Aeration

Solution Concentration:

Bioquell – 30% H_2O_2
Steramist – 7.5% H_2O_2

L-Shape Room - Results - 2nd Test
G. stearothermophilus

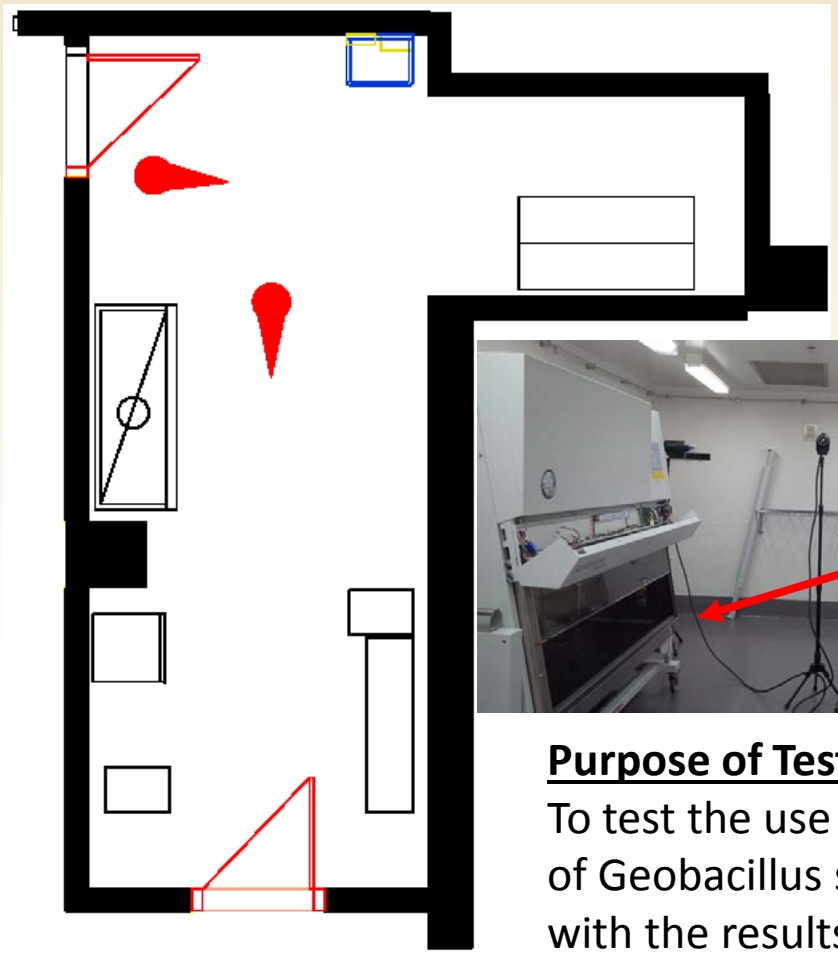


	2 Nozzles
	Tyvek-Tyvek
	G. stearothermophilus
	9/18/2015
Positive	5
Negative	26
Total	31

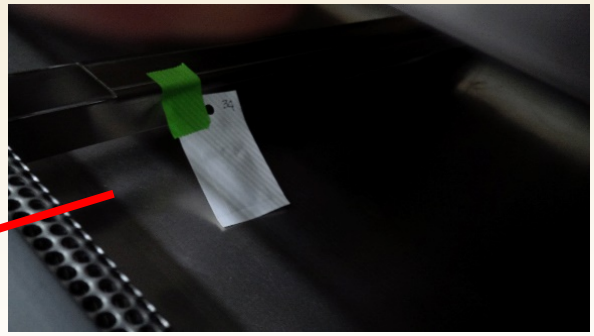
Location of Positive for Growth	
4	Corner - Hi
18	Inside Greenline Cage
24	Handle on Control Unit
26	Duoflow HEPA Comparment
37	Under BSC work Surface

To test the effect of nozzle reduction (increased spray time) with the same previous BIs (Tyvek/Tyvek – G. Stearothermophilus)

L-Shape Room - Results - 3rd Test B. atropheaus



	2 Nozzles
	Tyvek-Tyvek
	BA
	9/18/2015
Positive	1
Negative	30
Total	31



Location for Positive for Growth

Under BSC work Surface

Purpose of Test:

To test the use of Bacillus atropheaus indicators instead of Geobacillus stearothermophilus and compare them with the results of formaldehyde gas decontamination.

What have we learned so far?

Overall:

- The decontamination behaves more like a gas than a vapor.
- Reactive Oxygen Species (ROS) have a greater oxidation power that H2O2 on its own.
- The use of bare metal BIs of G. stearothermophilus proves to be a better indicator than the use of BIs packaged in Tyvek/Tyvek. Some samples did not achieve a 100% kill.
- The use of B. atrophaeus BIs provided better indication of results than the use of G. stearothermophilus in the same packaging (Tyvek/Tyvek). Samples achieved a 100% kill.

Surface Unit:

- Resulted to be 100% effective in the decontamination of surfaces achieving a >10E6 kill on bare metal BIs of G. stearothermophilus
- The methodology of application is important to achieve the results.

What have we learned so far?

Environment System:

- The setup of the room (number of active nozzles) provides different results. Longer activation times provided better decontamination results.
- Since the decontamination process does not use the concept of diffusion (like Formaldehyde gas or Chlorine Dioxide gas), area/surfaces to be decontaminated need to be exposed (i.e. bottom tray of non-operating BSC).
- Internal components of equipment that were operational (i.e. duo-flows) achieved decontamination.
- More tests are required to evaluate the decontamination of HEPA filter housings.

Acknowledgements

- Christopher Gibbs – UTMB
- Corrie Ntiforo - UTMB
- Alex Holloway – UTMB
- Terry Juelich – UTMB
- Dr. Alexander Freiberg - UTMB
- Dr. Halden Shane – TOMI
- Norris Gearhart – TOMI
- Dr. John Koerner – TOMI
- Rick Cantore - TOMI

Thank you…

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