

# *Decon 2.0: Emerging Decontamination Technologies*

*Vaporized Hydrogen Peroxide (VHP) and Chlorine Dioxide Gas Decontamination Field Studies:*

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# *Goals of Decontamination*

- Eliminate contamination through disinfection as validated w/biological indicators
- Reach all surfaces
- Contain chemical to target decontamination area
- Ventilate and/or neutralize chemical
- Do so safely and with minimal impact on materials in area

# *Concerns with Formaldehyde*

- Safety Issues: real and perceived
  - WHO carcinogen
  - low PEL (.75 ppm)
- OSHA regulated
- Residue
- Different applications may require different technologies

# *Decontamination Alternatives: The Options*

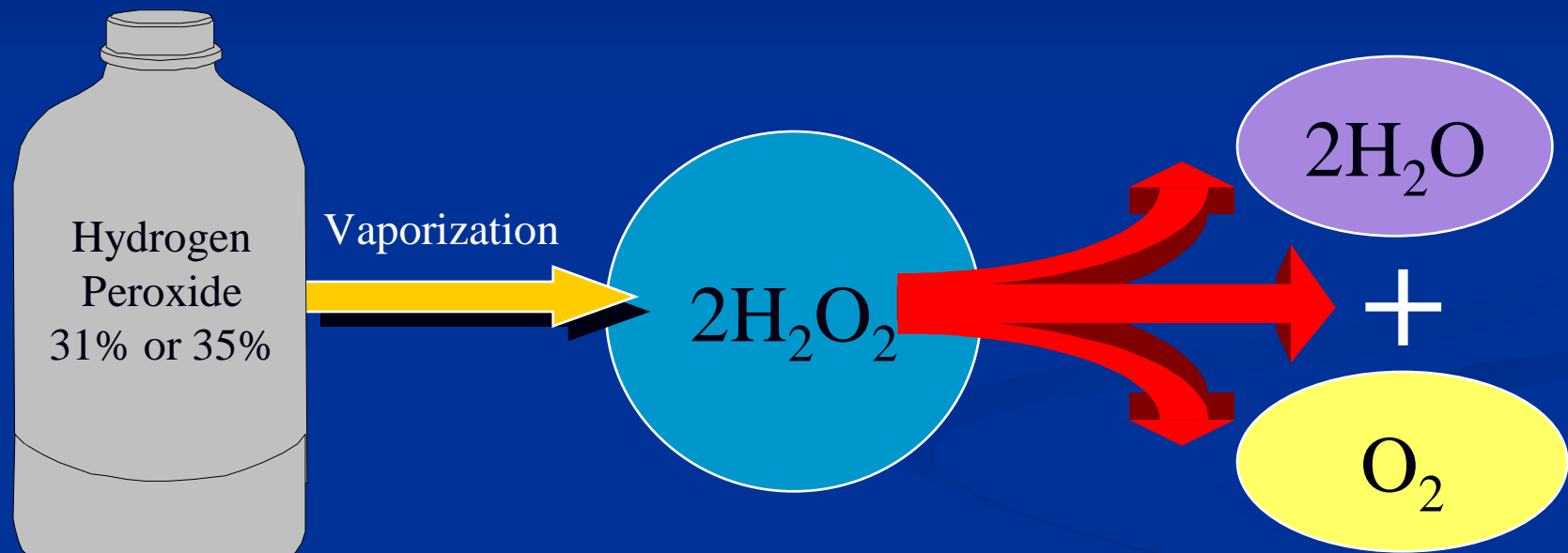
- Chlorine Dioxide Gas (ClorDiSys)



- Vaporized Hydrogen Peroxide (Steris 100P)



# Vaporized Hydrogen Peroxide (VHP)

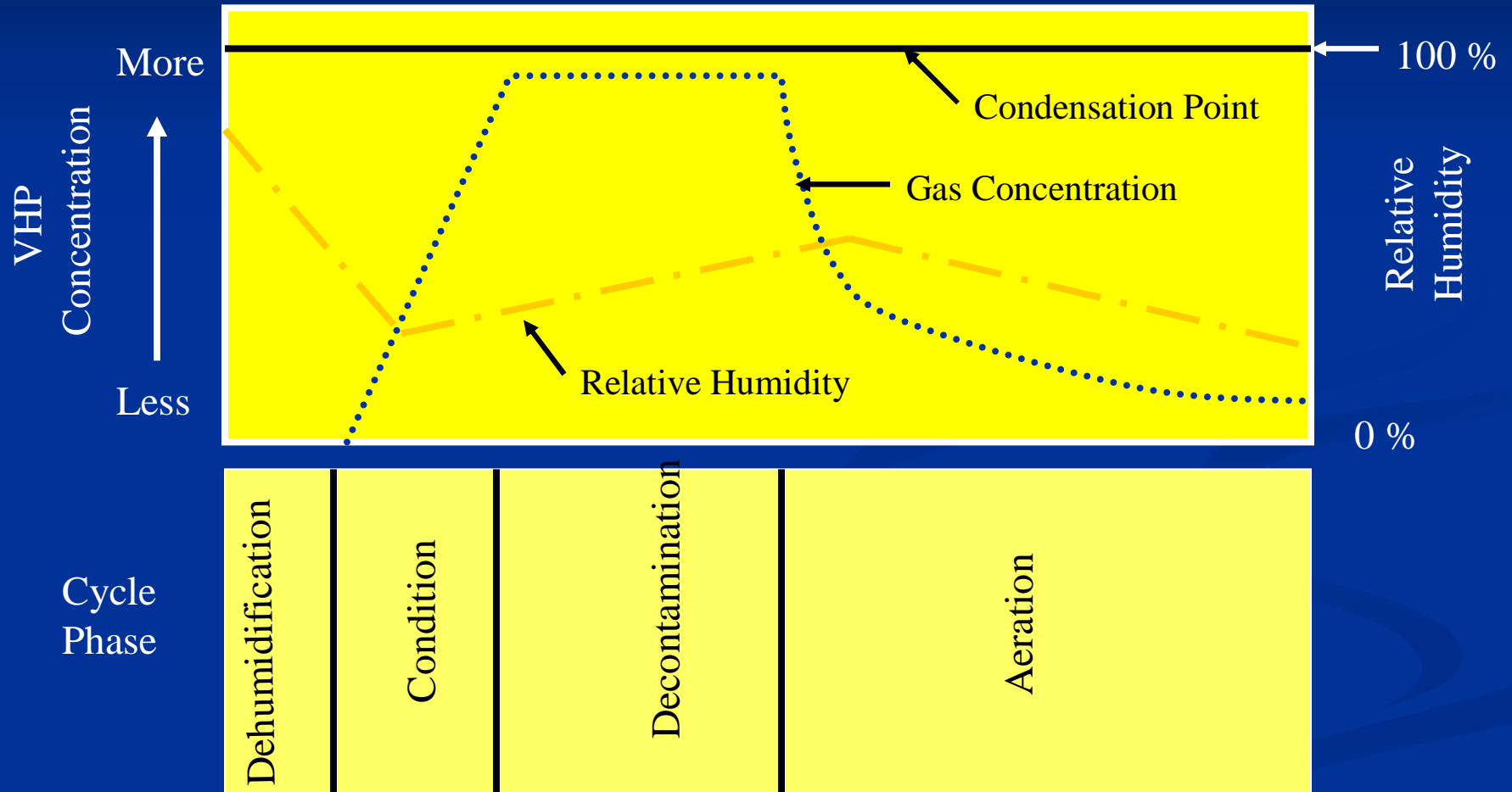


Sporicidal at Low  
Concentrations

By Courtesy of Steris Corporation



# Typical Vaporized Hydrogen Peroxide Bio-decontamination Cycle



By Courtesy of Steris Corporation



# *H<sub>2</sub>O<sub>2</sub> Vapor Concentration Versus D-Value*

Temp (°C)	Concentration (mg/L)	PPM	Typical D-Value
4	0.3 - 0.5	350	8 - 12 min.
25	1 - 2	700 - 1500	1 - 2 min.
37	3 - 4	2000 - 3000	0.5 - 1 min.
55	10 - 12	7000+	1 sec.

Note: Using *Geobacillus stearothermophilus*

By Courtesy of Steris Corporation



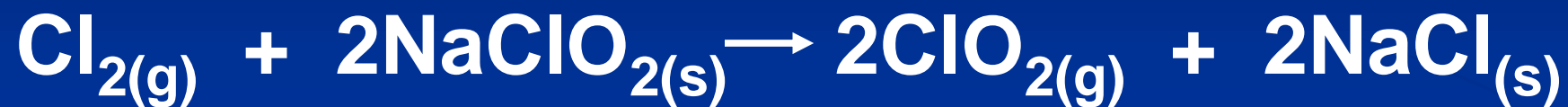
# *H<sub>2</sub>O<sub>2</sub> Vapor Exposure Limits*

- **Permissible Exposure Limit (PEL/8 hrs)**  
**1.0 ppm**
- **Immediately Dangerous to Life or Health (IDLH/30 minutes)** **75 ppm**
- **No STEL**





# *Chlorine Dioxide Gas*



# *Chlorine Dioxide Gas (ClO<sub>2</sub>) Cycle*

- **Humidification (65% + RH)**
- **Charge -- Raise ClO<sub>2</sub> concentration**
- **Exposure**
- **Aeration**
- **D-value .1-.8 min 10-30 mg/L**

# *ClO<sub>2</sub> Exposure Limits*

- **Permissible Exposure Limit (PEL/8 hrs)**  
**0.1 ppm**
- **Short-term Exposure Limit (STEL/15 minutes) 0.3 ppm**
- **Immediately Dangerous to Life or Health (IDLH/30 minutes)**  
**5.0 ppm**



# *Field Studies: VHP and ClO<sub>2</sub>*



# *Decontamination Procedure*

- Reach target temp/humidity; monitor
- Prepare area (BIs, fans, monitors, seal) for large scale, consider pre-test for seals
- Create safety perimeter/signage
- Introduce chemical and bring to target concentration for target exposure time; monitor
- Monitor surrounding areas for leakage
- Ventilate and/or neutralize to below PEL
- Incubate/analyze BIs

# *Class II biological safety cabinets (BSCs)*



- Class II A2s and B2s
- Multiple manufacturers
- 4-8 BIs per cabinet: work area, exhaust HEPA, supply plenum/HEPA

# *Space Decontaminations*



- Pharma aseptic production areas
- Laboratory Animal Research areas
- Pilot plant production areas
- Cold Rooms



# *Biological Indicators (BIs)*

- *Geobacillus stearothermophilus* ( $10^6$ )





# *Cycle Parameters for six log kill: VHP and ClO<sub>2</sub> gas*

- VHP
  - Humidity < 50% RH
  - stable temp 22 C
  - 400 - 1400 ppm-hrs
  - Aeration 1-4 hrs.
- ClO<sub>2</sub>
  - Humidity > 65% RH
  - stable temp 22 C
  - 900 - 1500 ppm-hrs
  - Aeration .5 hrs - 1.5 hrs



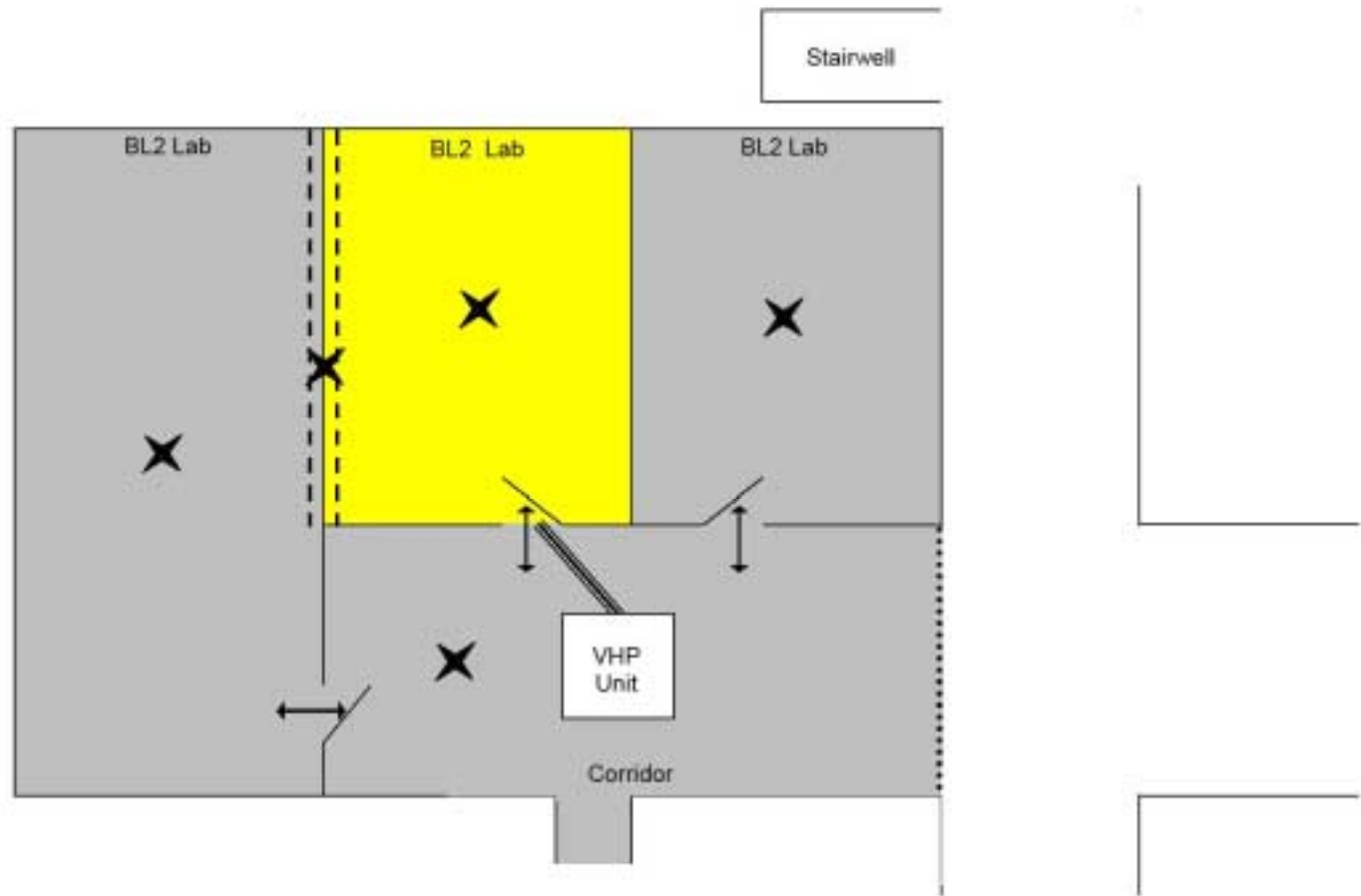
# *Case Study: Vaporized Hydrogen Peroxide*



**BSL2 TC Lab**  
**1,500 ft<sup>3</sup>**  
**Standard**  
**Drop Ceiling**



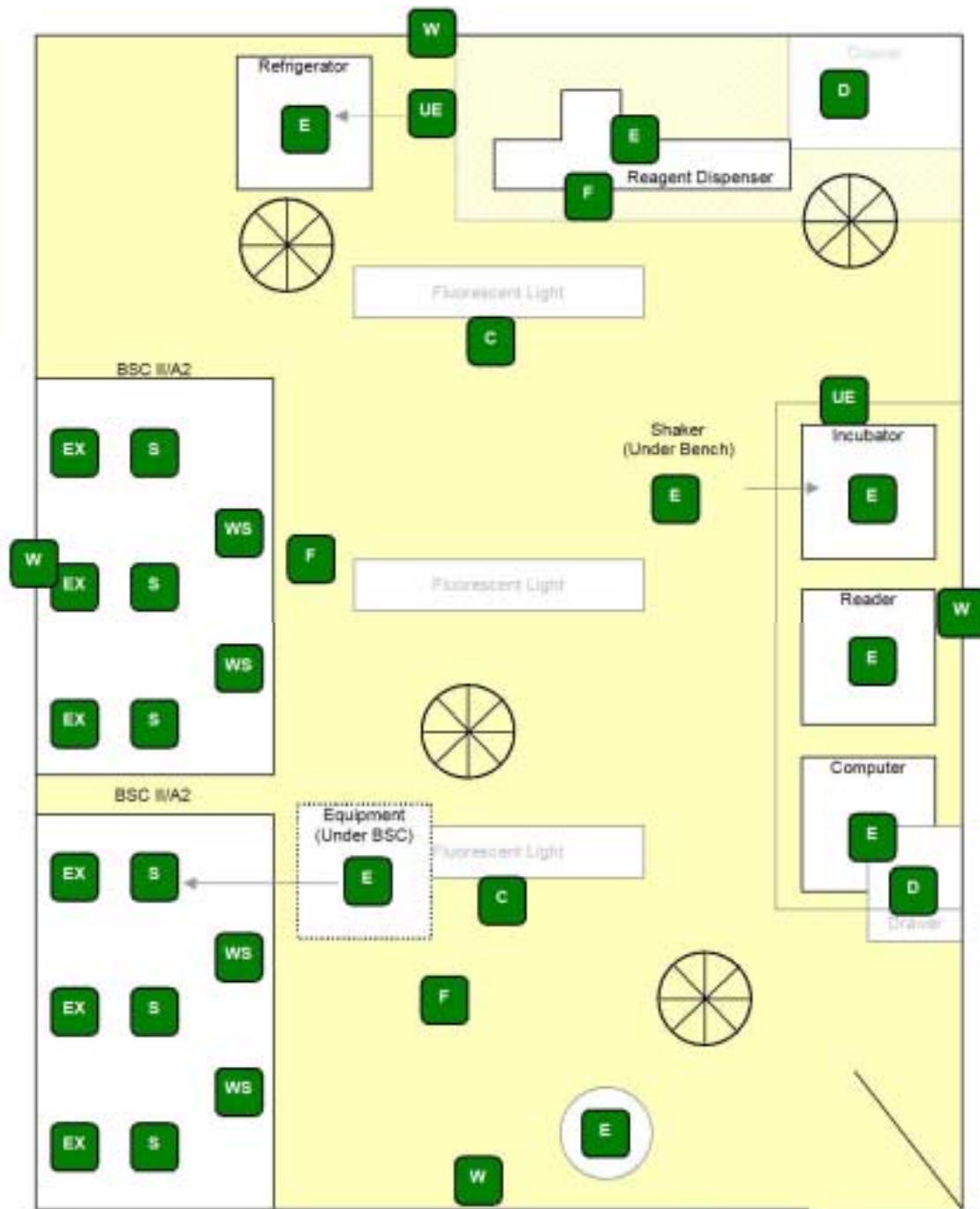
# *BL2 TC Lab Decon Schematic*



# *Unconventional Application: BSL2 TC Lab 1,500 ft<sup>3</sup>*

**Concerns: Unsealed ceiling, open ceiling plenum to adjacent lab, unsealed penetrations, volume of cellulose (ceiling tiles, supplies, etc.)**





# BI/Fan Location

## *Geobacillus*

## *Stearothermophilus*

### $10^6$

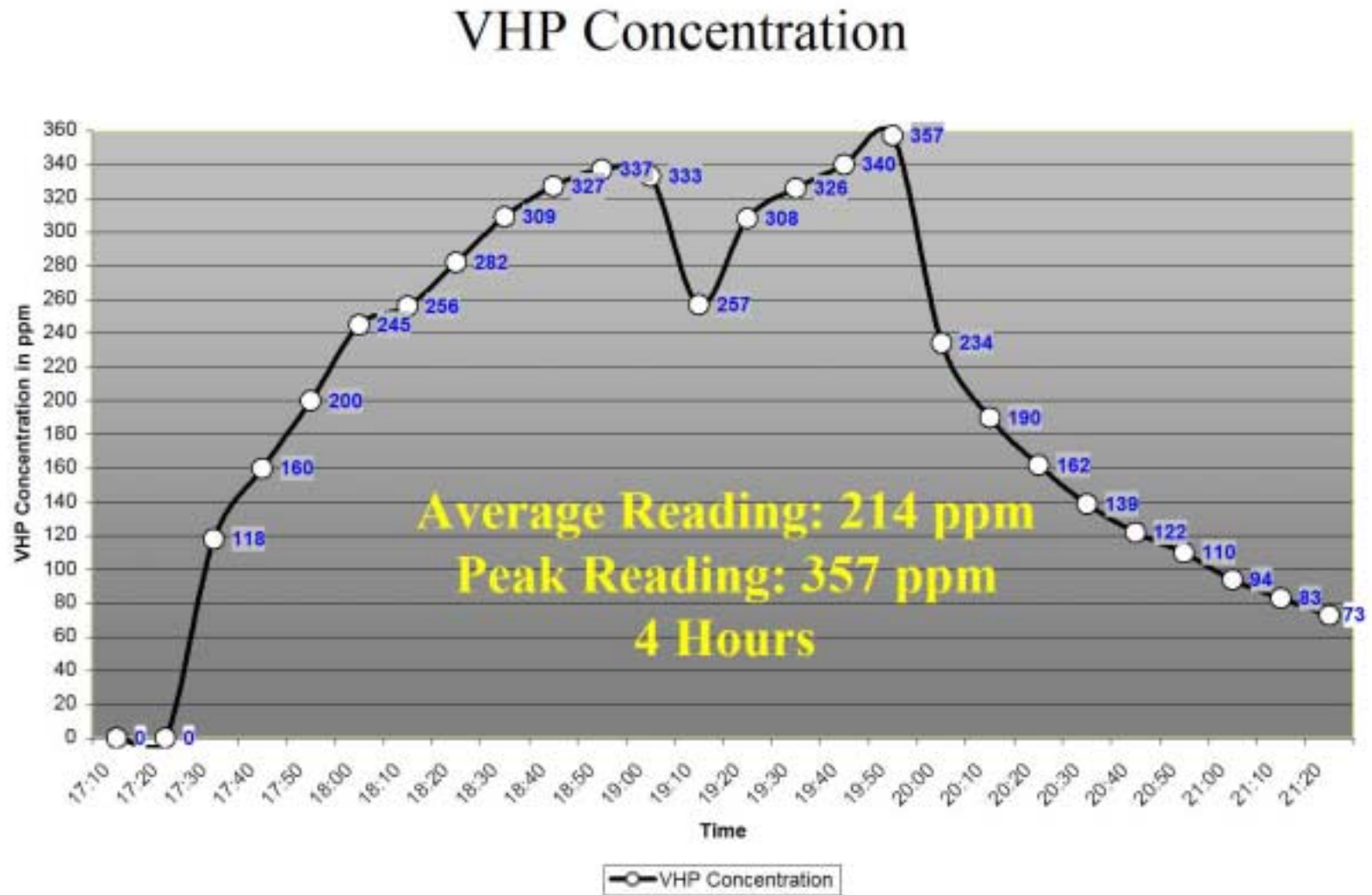




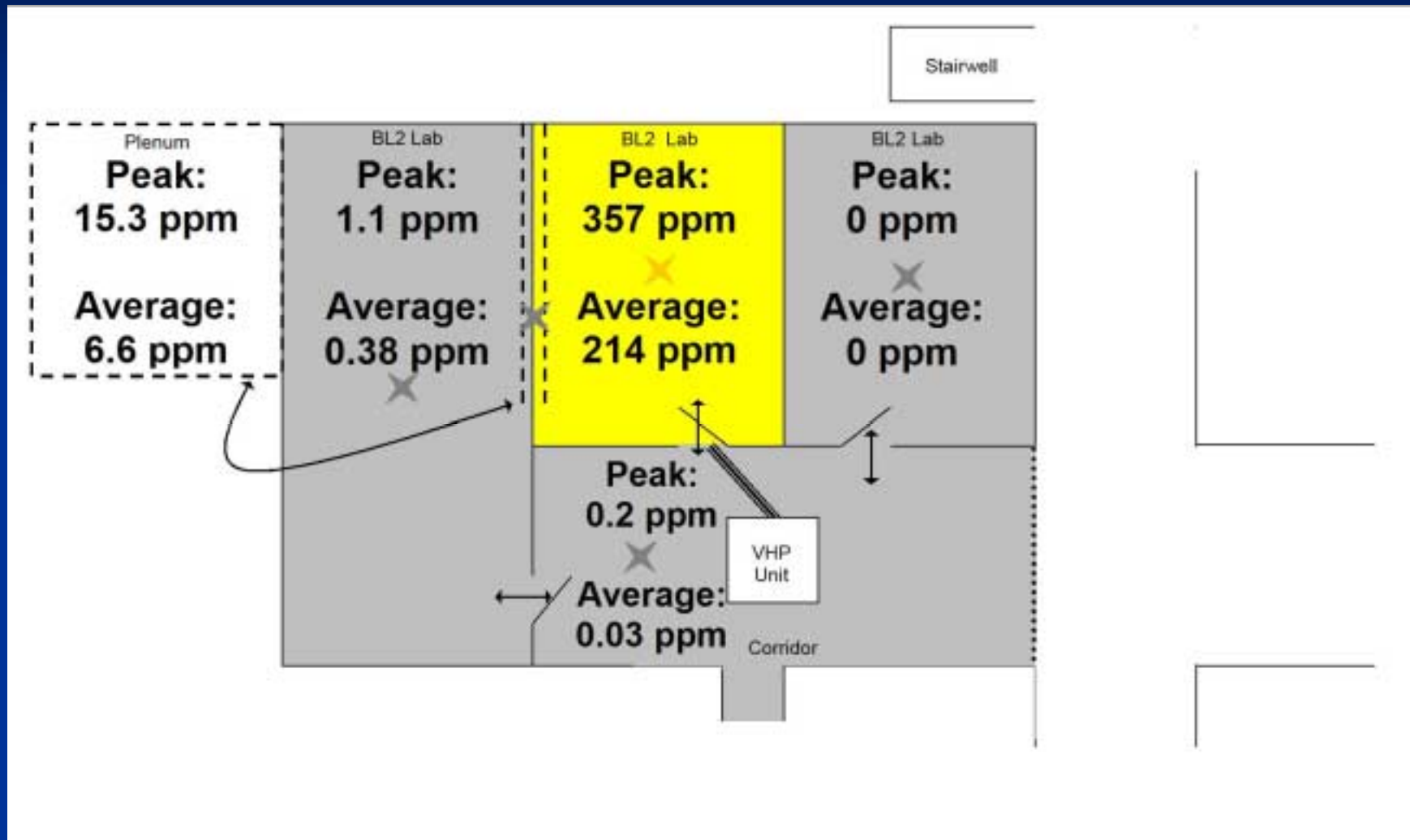
# *Conditions and Cycle Parameters*

- Humidity (RH): 17.7%
- Temperature: 22°C
- Room to Exterior Pressurization: 0.0" w.g.
- Injection Rate: 10 g/min
- Injection Duration: 121 minutes
- Peroxide Used: 1224 grams

# BL2 TC Lab VHP Concentration



# VHP Concentration Levels





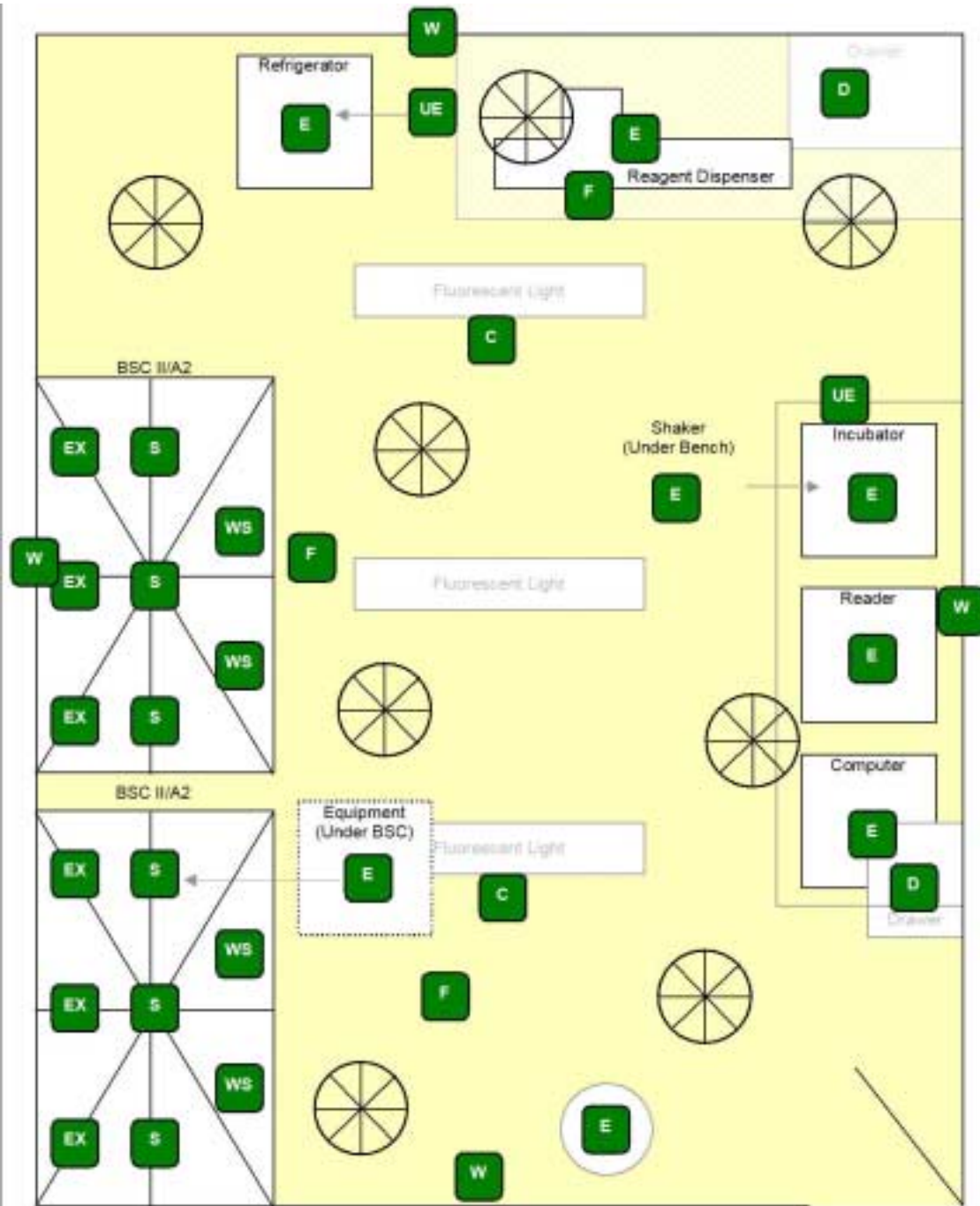


## Results

- 17 BIs no growth/20 growth
- Adjacent labs below PEL



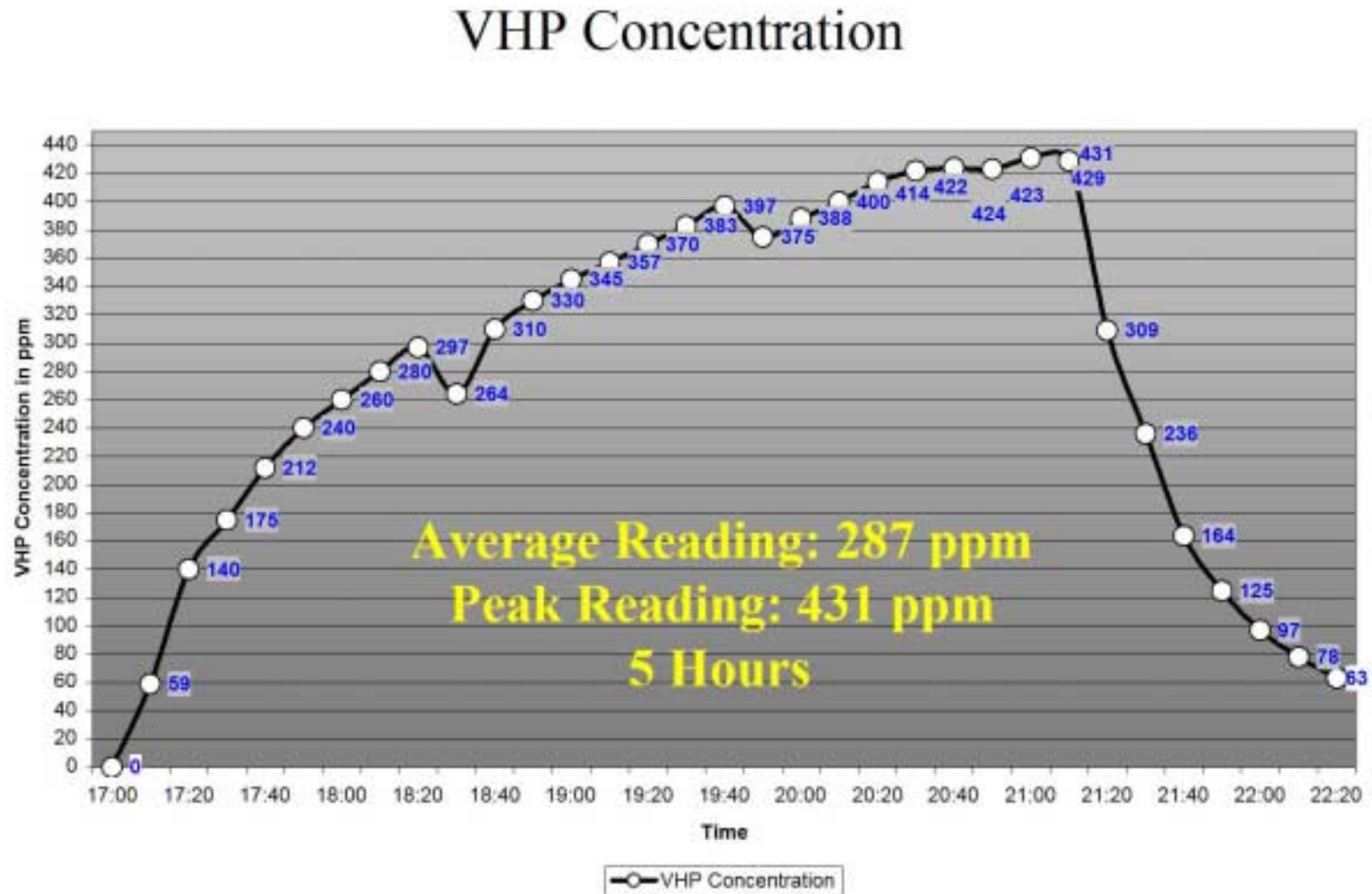
# Take II BI/Fan Location *Geobacillus* *Stearothermophilus* $10^6$



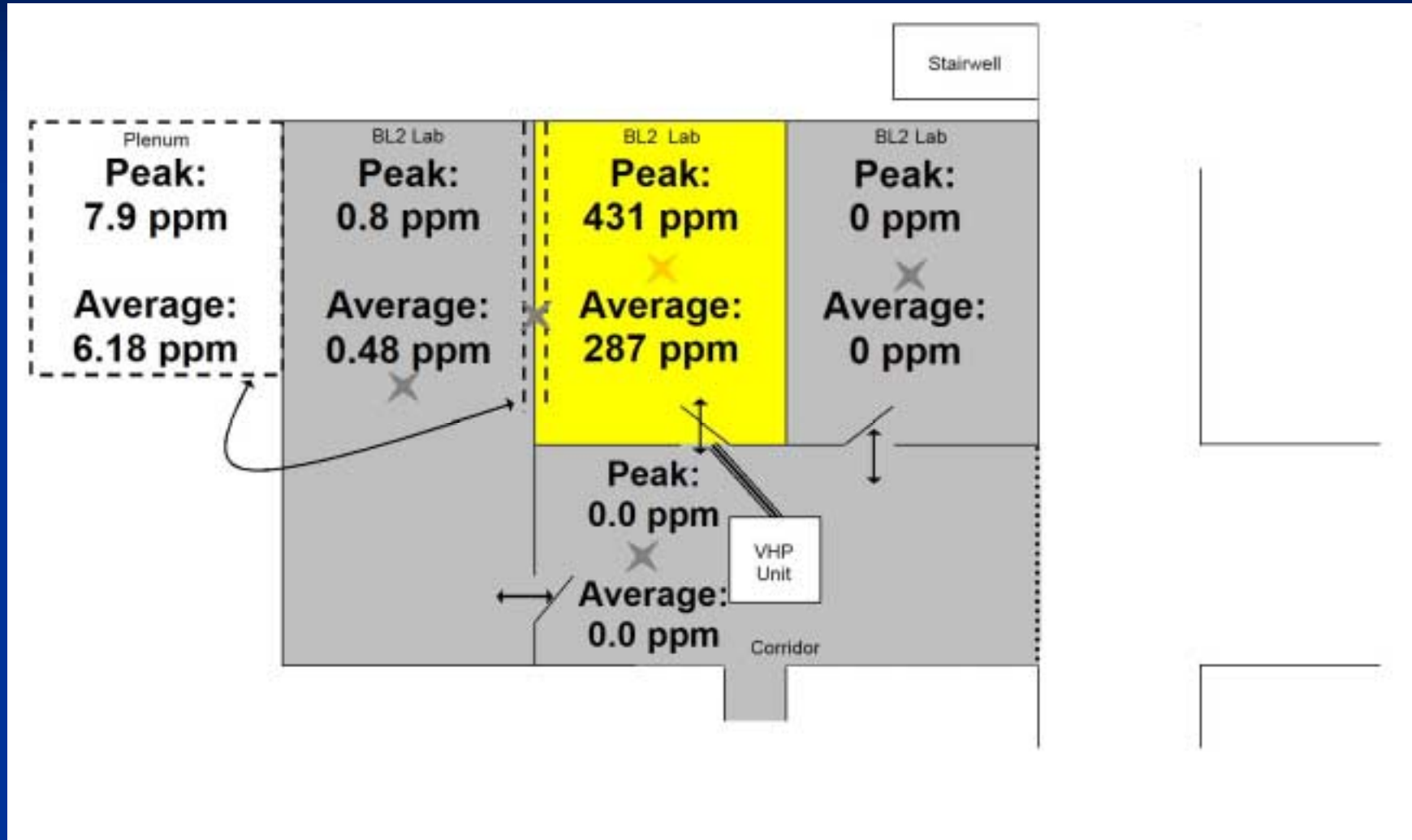
## *Conditions and Cycle Parameters (II)*

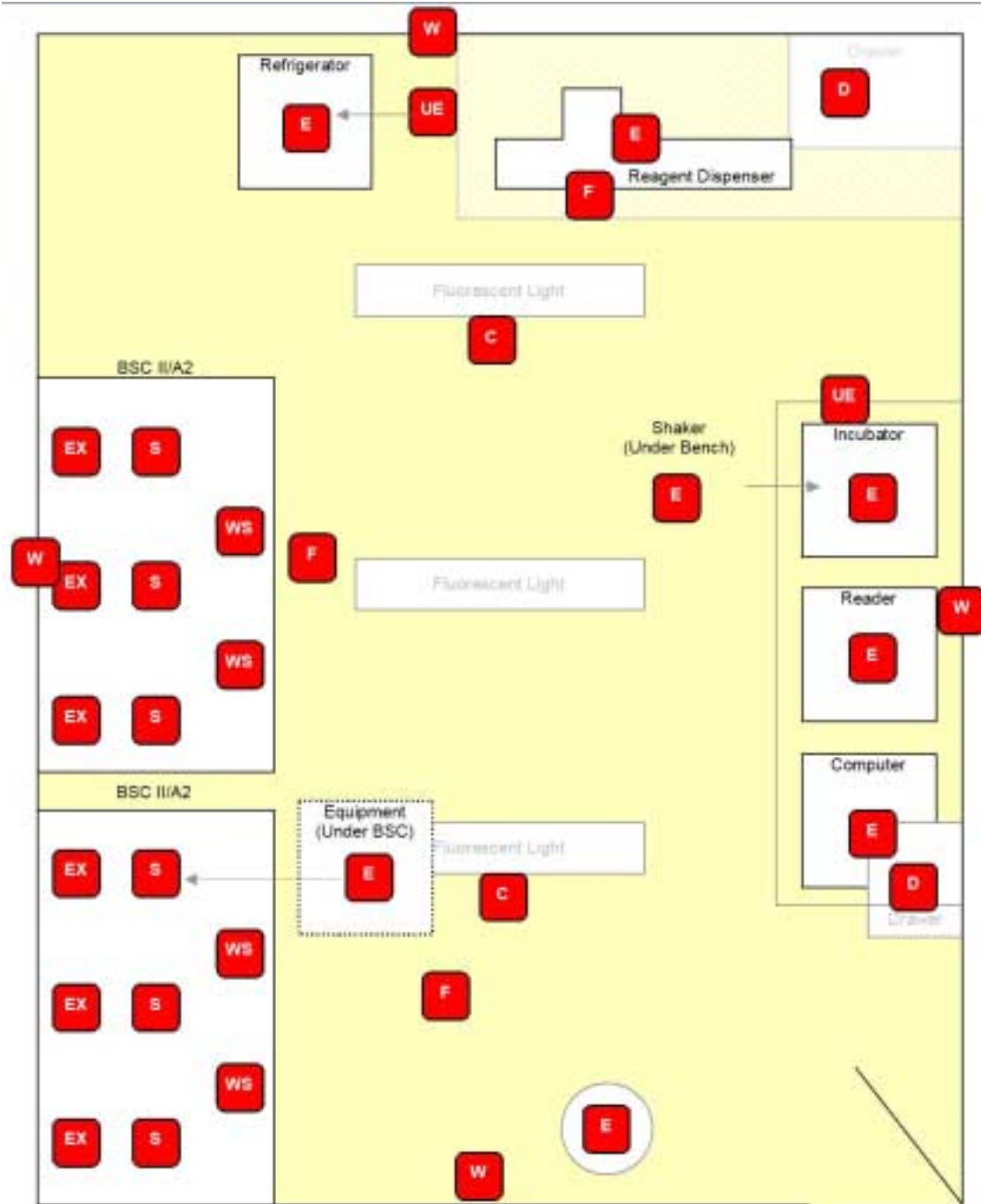
- Humidity (RH): 15.0%
- Temperature: 22°C
- Room to Exterior Pressurization: 0.0" w.g.
- Injection Rate: 10 g/min
- Injection Duration: 250 minutes
- Peroxide Used: 2406 grams

# BL2 TC Lab VHP Concentration Levels (II)



# VHP Concentration Levels (II)



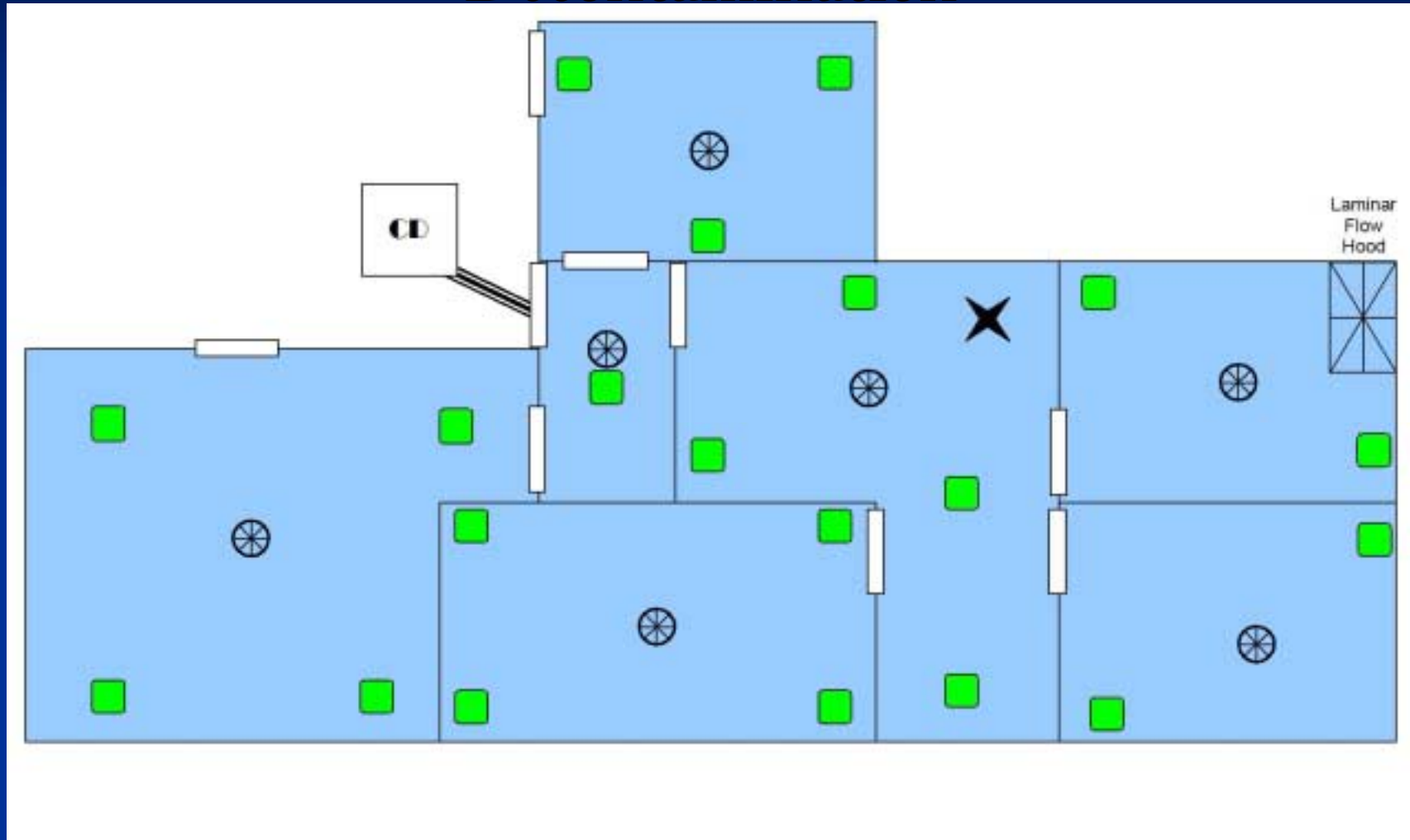


## Results

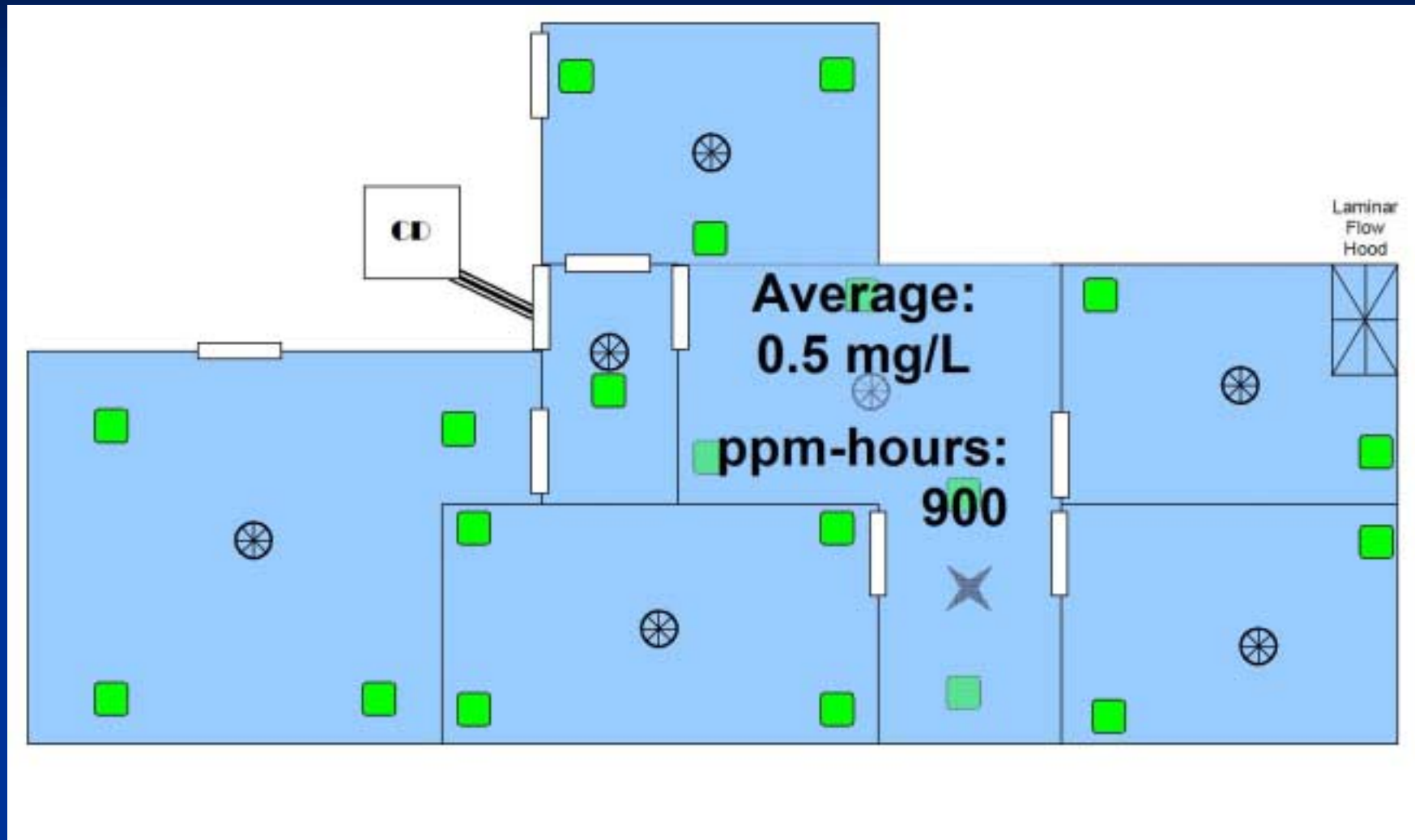
- All 37 BIs no growth
- Adjacent labs below PEL



# Case Study: 20,000 ft<sup>3</sup> Pharma Pilot Plant ClO<sub>2</sub> Gas Decontamination



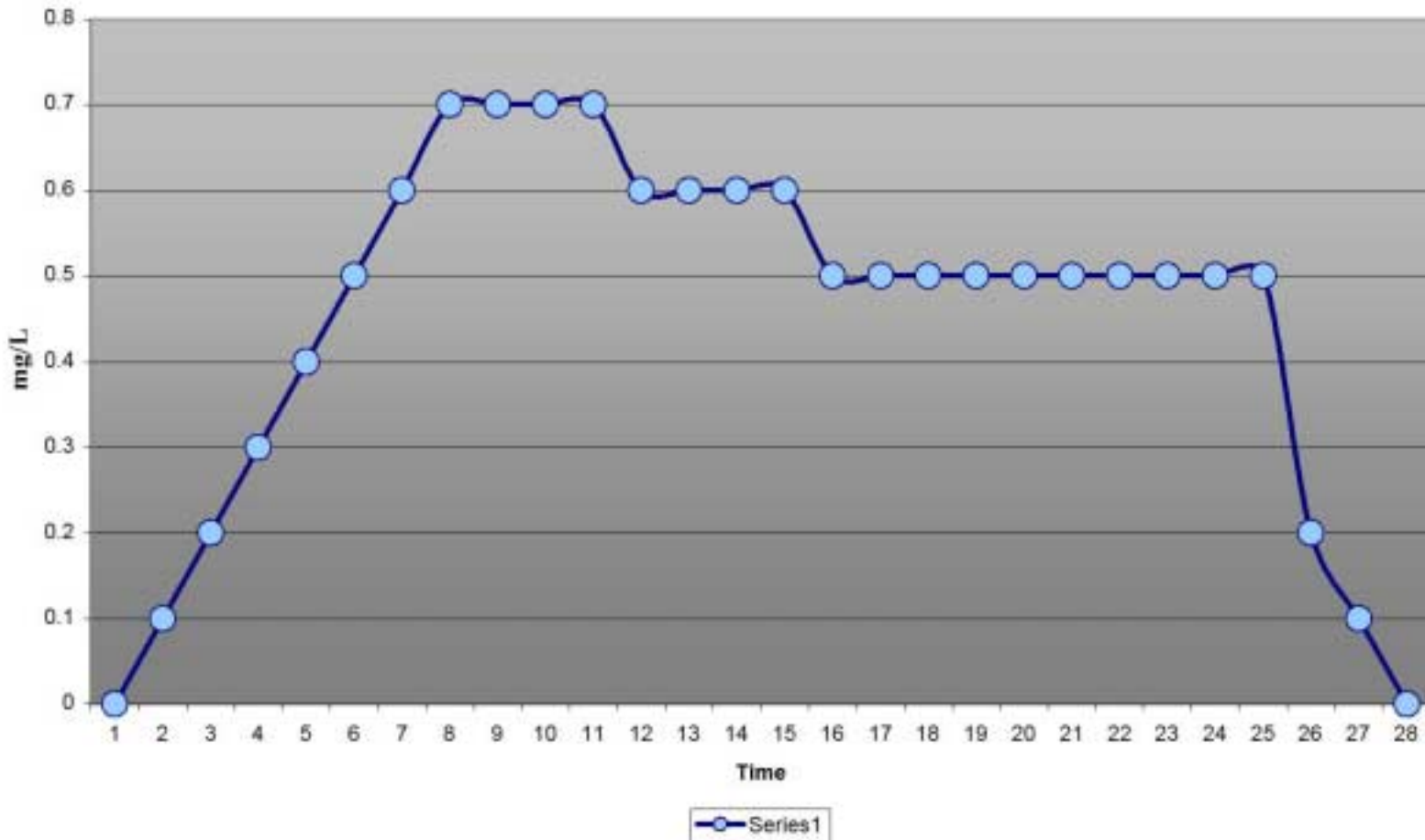
# Pharma Pilot Plant $\text{ClO}_2$ Decontamination



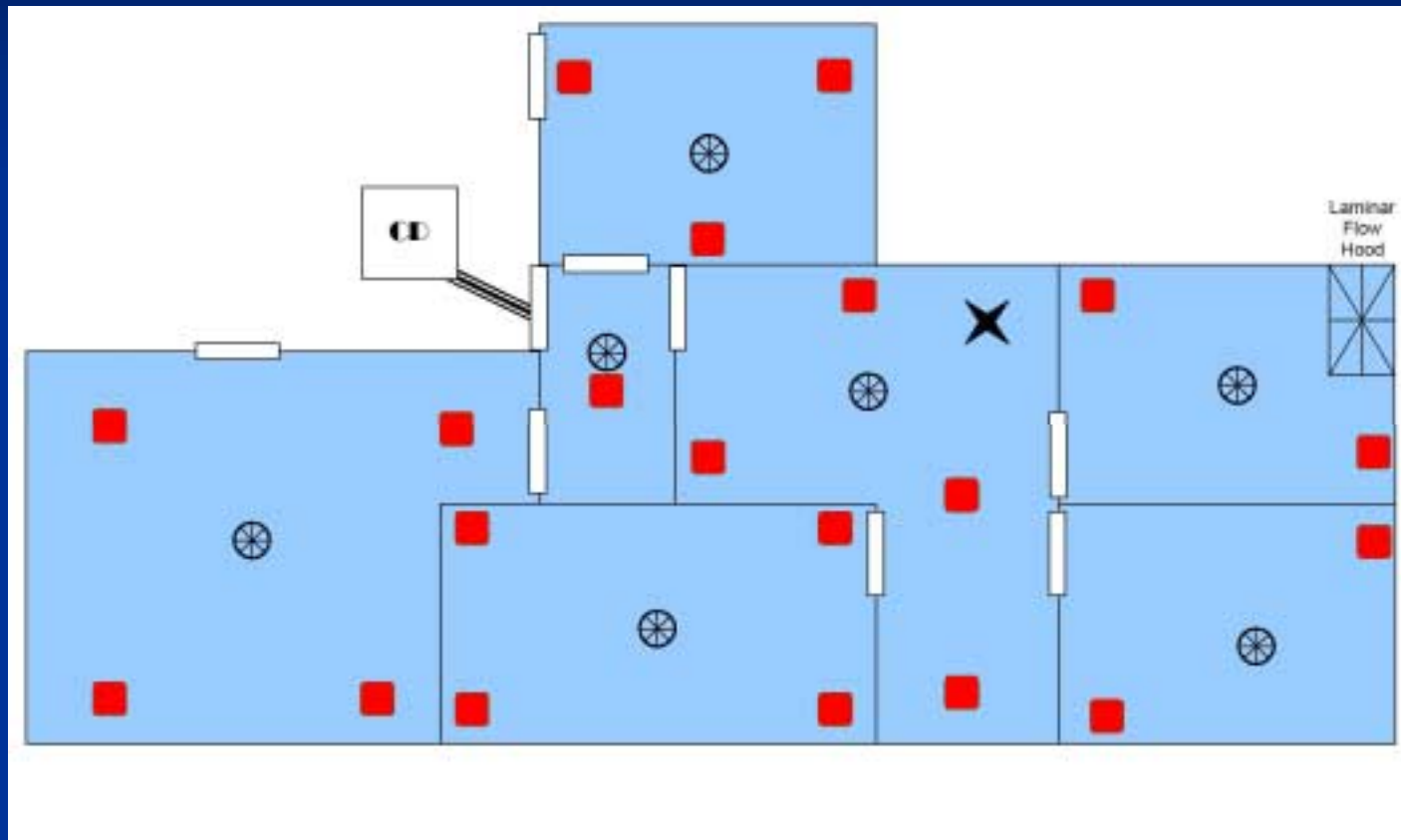


# Pharma Pilot Plant $\text{ClO}_2$ Decontamination

## Chlorine Dioxide



# Pharma Pilot Plant $\text{ClO}_2$ Decontamination Results



## Results

- All 20 BIs  
no  
growth

# *Summary*

- Viable alternatives to formaldehyde gas exist for efficacious and safe decontamination of laboratory equipment and space
- It is important to understand the physical properties and behavior of your decontaminant of choice to ensure efficacy and safety
- Different decontaminants may be appropriate for different applications