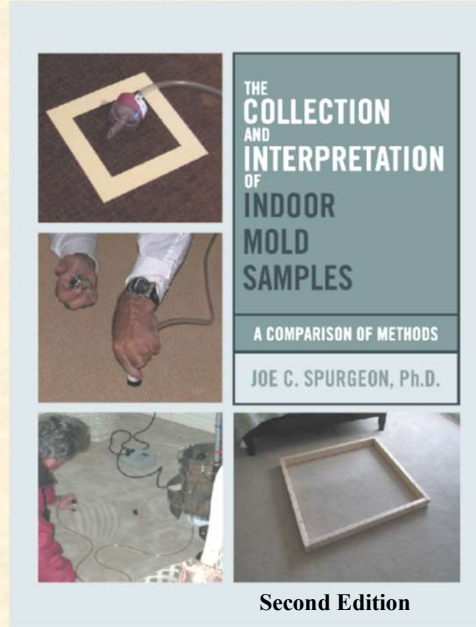


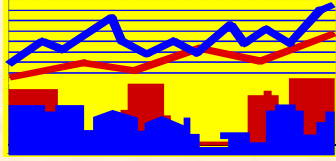
MOLD REMEDIATIONS

**Containment Configurations
and Criteria for Assessing
Airborne Samples**

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Responding to Water Intrusion Incidents

Water Intrusions: Response Time

- **Wet Wallboard, Carpet, etc.:**
- **Fungal hyphae can be visible under the microscope within 24 – 48 hours**
- **Mycelia can be visible with the unaided eye within 3-5 days**

3

Within the first 24-48 hours there are probably just wet materials. After 2-3 days, there are probably wet, moldy materials.

Mold Management Options

- **Three general responses to water intrusion incidents**
- **Repair**
 - **Paint over the mold**
- **Restoration**
 - **Dry contaminated materials in-place**
- **Remediation**
 - **Contain water-damaged areas**
 - **Remove and discard contaminated materials**
 - **Clean remaining materials and the environment**

4

These options are listed in the general order of preference.

1. Repair

- **Spray it with bleach**
- **Paint over the mold**
- **Apply an encapsulant**

Hotel Project

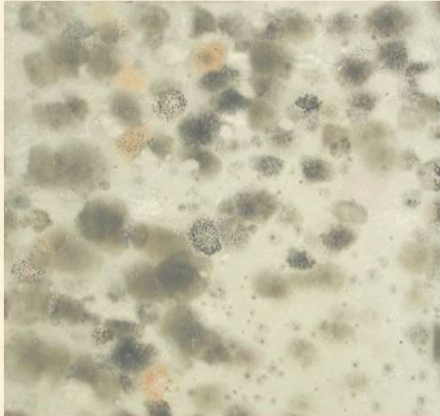
New Construction



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Repairs are typically not an effective method for removing mold from the indoor environment, for addressing the source/s of water intrusion, nor for preventing occupant exposure.

Effectiveness of Biocides



- **Burge: *Asp* and *Pen***
- **750,000 – 900,000 spores per square inch**
- **90.0 % 75,000**
- **95.0 % 37,500 per sq in**
- **99.0 % 7,500**
- **99.9 % 750**

If used, use Tilex instead of bleach (1-10 dilution) - [surfactant]

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A 1 to 10 dilution of household bleach (never use straight bleach) has been reported to kill about 95% of viable (living) mold in actual field trials. However, the remaining 5% of viable mold left on the contaminated surface is still a lot of mold, and it can start growing again as soon as the repair is completed.

2. Restoration: Drying-in-place

May not remove the water-damaged materials



- **Dry in-place**
- **Most effective within 2-3 days of incident**
- **Leaves contaminated materials in the indoor space**
- **Occupant exposures may continue**

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Restoration dries the wet materials and will probably stop any further mold growth but leaves any mold that has grown on the wet materials in-place. This may not necessarily be an issue, but mold-sensitive individuals should be aware of this potential issue.

Restoration: Dry- in- Place

Room	Kitchen	Hall Bath
Cavity	Range Base	Vanity Base
<i>Asp/Pen</i>	67,749	70,233
Total (Sp/m³)	68,257	100,268



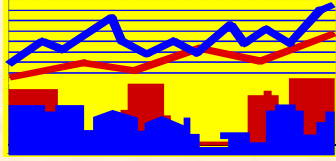
Drying holes can provide a pathway for occupant exposure

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Background concentrations of indoor airborne *Asp/Pen* spores are typically several hundred spores/m³. Here we have concentrations of about 70,000. In addition, the drying holes that were made to allow the spaces below the cabinets to dry also allow the contaminant mold spores to enter the occupied space.

3. Remediation

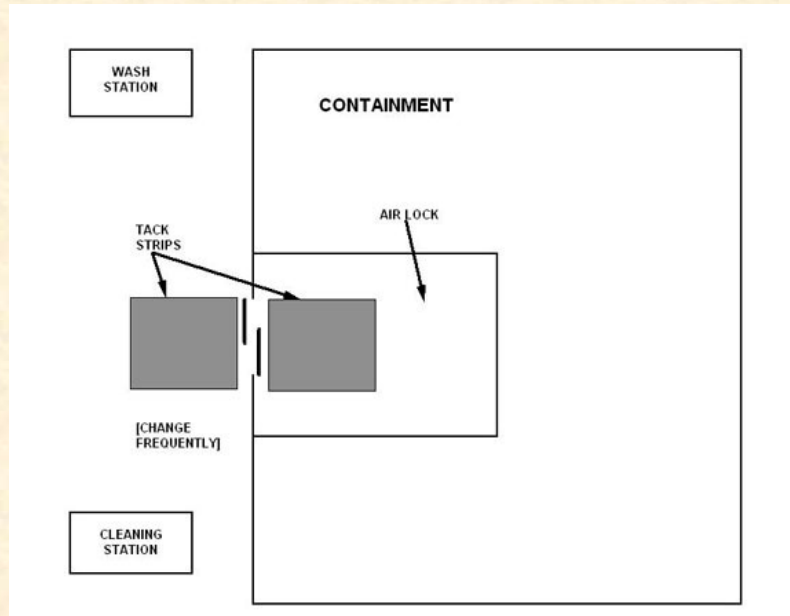
- Repairing the causes of moisture intrusion**
- Containing areas where contaminated materials were identified**
- Removing materials that cannot be cleaned**
- Cleaning structural materials to remain in place**
- Demonstrating effectiveness by post-remediation inspection and sampling**



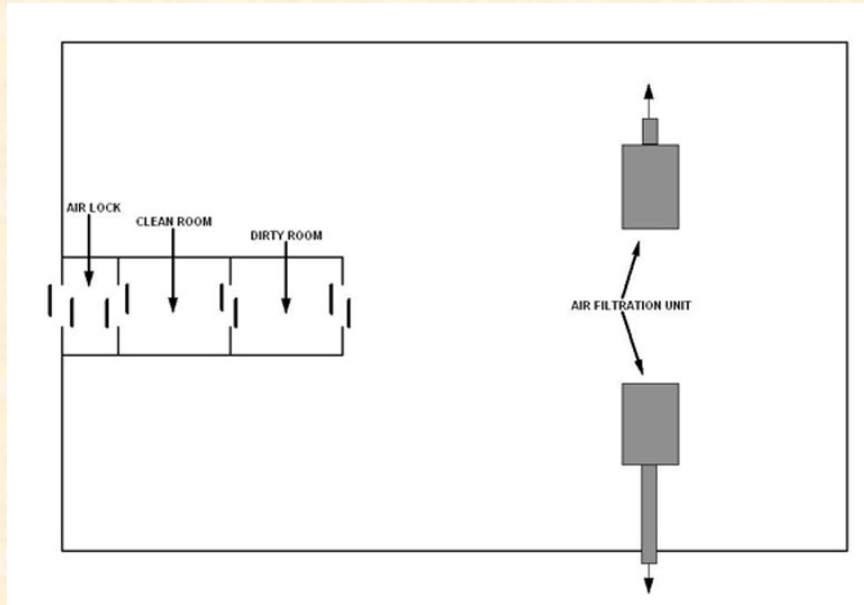
Remediation Containments

Configuration and Criteria for Assessing Airborne Spores

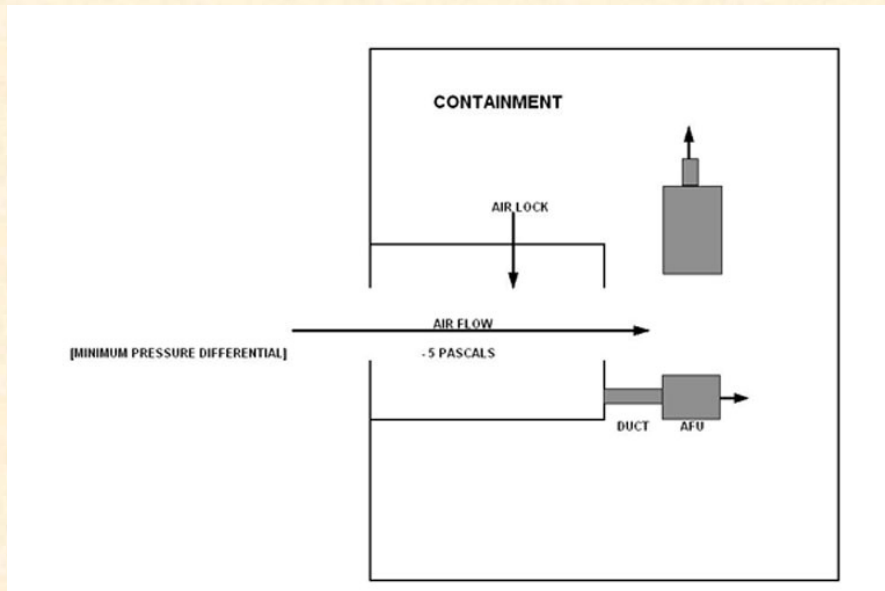
TACK STRIPS



BASIC CONTAINMENT



MAINTAINING PRESSURES



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Dehumidifier

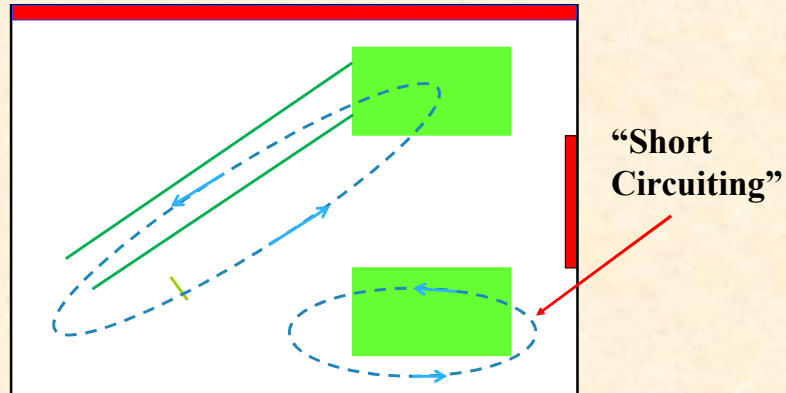
- **Dehumidifier**
 - **Removes water vapor, not spores**
 - **Dessicant Units**
 - **Condensing Units**
 - **Warm, wet environment**
 - **Can become contaminated and a potential source of airborne spores inside containment**

Air Filtration Unit (AFU)

- **HEPA-filtered AFU**
 - **99.97% efficient at 0.3 microns**
 - **Minimum efficiency**
 - **More efficient for larger particles**
 - **More efficient for smaller particles**
- **Only spores and particles that reach the AFU can be collected**
 - **“Short circuiting”**

Short Circuiting

Only spores that reach the filter can be removed



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An isolated AFU tends to re-clean the same localized mass of air repeatedly, doing a poor job of cleaning the air in the containment. Placing two AFU in containment with ducts in opposing corners of containment for example, creates a circulation pattern that minimizes short-circuiting.

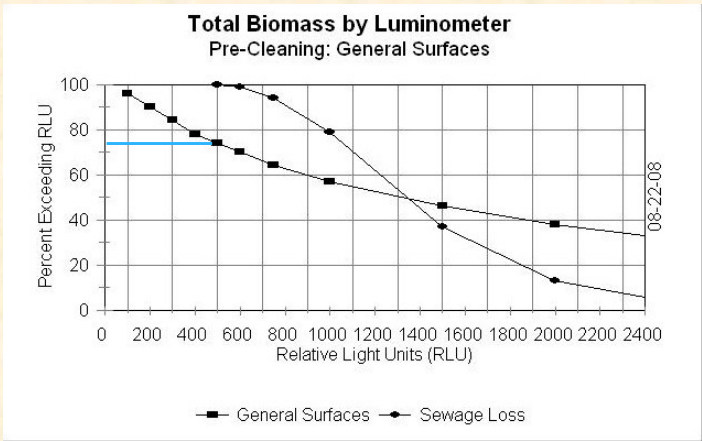
Post-remediation Inspection and Sampling

- **PHASE 1**
- **Visual Inspection**
- **Moisture Content of Surfaces**
- **ATP swabs (Optional)**
- **If any step fails, then stop and repeat**
- **PHASE 2**
- **Surface Samples (Tape Lifts or Swabs for Microscopy)**
- **Airborne Spore Samples**

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Phase 1 is a pre-inspection by the Contractor to make sure the Containment is ready for inspection by a third-party IEP. It is also intended to pre-clear any cavities that may be sealed prior to the Phase 2 inspection by an IEP. Phase 2 would typically be performed by an IEP.

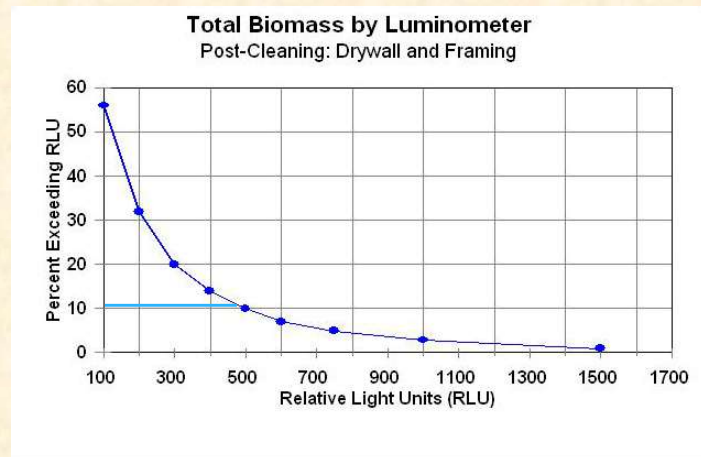
ATP Swabs Pre-Cleaning 3M Luminometer



Prior to a third-party inspection

ATP testing is a rapid and inexpensive method for assessing the condition of surfaces. A table or graph of ATP values for general conditions can be established for reference.

ATP Swabs Post-Cleaning 3M Luminometer



Prior to a third-party inspection

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The Contractor can then determine RLU acceptance criteria based their instrument.

Post-remediation Air Sampling Locations

- **Inside each containment**
 - **To verify the acceptability of the contained work area**
- **Outside each containment**
 - **To show contaminants did not breach containment**
 - **As a measure of the indoor concentration**
 - **As the control for some containment configurations**
- **Outdoors**
 - **As a reference ?**
 - **But not recommended as a comparison**

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Collecting an airborne sample inside containment is obvious. Collecting a sample immediately outside containment is not as obvious, but three reasons for doing so are given.

Mold Remediation

- **The process of reducing airborne concentrations in containment of**
 - [1] **common mold spores to concentrations that are typical of the indoor environment**
 - **Not the outdoor environment**
 - [2] **“spores of concern” [*Stachybotrys*, *Chaetomium*, etc.] to the lowest possible concentration**
 - [3] **“Indicator spores” [*Asp/Pen*] to an acceptable background concentration**
 - **Which is often poorly defined**

Debate About Sampling Conditions

- **Should Post-remediation sampling be performed under aggressive or quiescent conditions?**
- **Air Filtration Unit on or off?**
- **Opinion: It doesn't make any difference**
 - **The “acceptance criterion” can be changed to accommodate the conditions in the containment**

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This is an opinion at this point in the presentation. The objective is to present a logical argument to support this opinion.

Post-Remediation Acceptance Criteria for Airborne *Asp/Pen*

- **The “acceptance criteria” for airborne *Asp/Pen* concentrations**
 - **Is not a single value, but varies with the configuration of the containment**
 - **Can be established for either aggressive or quiescent conditions in containment**

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The discussions of the following three example containments are intended to support these opinions, as well as illustrate how criteria can be established.

Three Containment Configurations

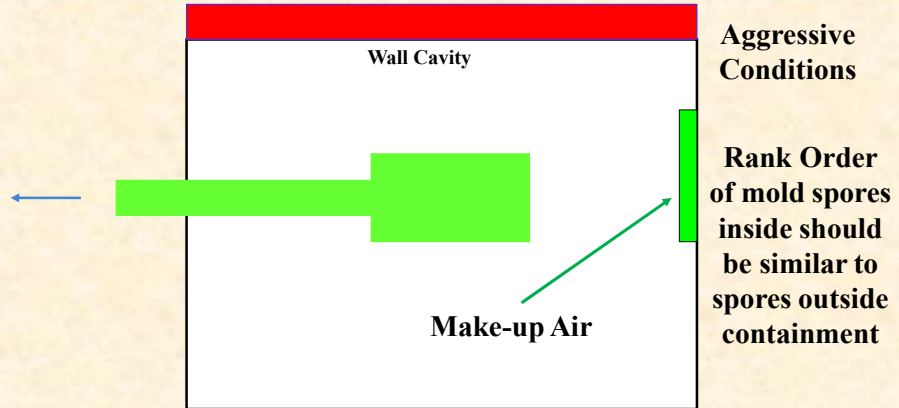
- **1. Exhausted air filtration unit (AFU) with filtered makeup air**
 - **Depressurized containment with aggressive conditions**
- **2. Sealed containment with AFU off**
 - **No depressurization with quiescent conditions**
- **3. Sealed containment with AFU in recirculation mode**
 - **Scrub mode, no depressurization with aggressive conditions**

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These are common containment configurations that illustrate how acceptance criteria can be modified to accommodate varying conditions. With a little thought, criteria can be established for any configuration or set of conditions.

1. AFU Exhausted Outside, Filtered Make-up Air, Pre-cleared & Sealed Wall Cavity

“Exhausted” PRV Criteria?



Rank Order Analysis

Spores	Outside Contain	Percent	Spores	Inside Contain	Percent
<i>Clad</i>	133	47 %	<i>Clad</i>	45	39 %
<i>Asp/Pen</i>	57	20 %	<i>Asp/Pen</i>	31	27 %
<i>Altern</i>	34	12 %	<i>Altern</i>	17	15 %
<i>Epicoc</i>	35	13 %	<i>Epicoc</i>	7	6 %
<i>Curvul</i>	24	8 %	<i>Curvul</i>	2	2 %

- *Asp/Pen* was 2nd in rank order outside and 2nd inside containment, which was an acceptable result
- *Asp/Pen* spores were 20% of total spores in the room outside of containment and 27% inside of containment

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Compare the sample inside containment to the sample outside containment (two samples in each location is even better). First, are the rank orders for *Asp/Pen* similar? Yes. Second, was *Asp/Pen* as a percentage of total spores about the same in both samples? Yes, similar. Conclusion: condition in containment was Acceptable.

Rank Order Analysis

Outside Containment	PERCENT	Inside Containment	PERCENT
<i>Cladosporium</i>	50%	<i>Cladosporium</i>	40%
<i>Alternaria</i>	25%	<i>Asp/Pen</i>	30%
<i>Epicoccum</i>	20%	<i>Alternaria</i>	20%
<i>Asp/Pen</i>	5%	<i>Epicoccum</i>	10%

- *Asp/Pen* spores were 5% of total spores in the room outside of containment, but 30% inside of containment
- Not an acceptable result

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Compare the sample inside containment to the sample outside containment. First, are the rank orders for *Asp/Pen* similar? No. 4th in the outside sample and 2nd in the inside sample, indicating a possible source in containment. Second, was *Asp/Pen* as a percentage of total spores about the same in both samples? No, 5% outside and 30% inside, again indicating a possible source inside containment. Conclusion: condition in containment was Not Acceptable.

Criteria 1

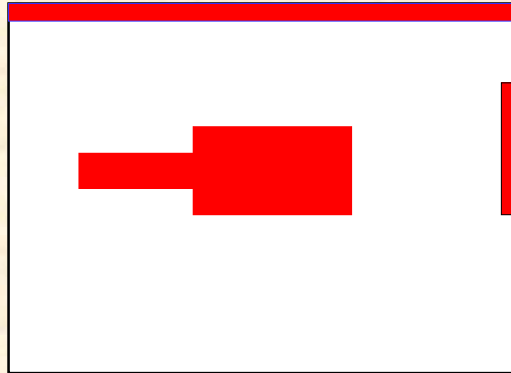
- **Filtered make-up air drawn from outside containment and exhausted outside**
 - **Containment under negative pressure**
- **Spores inside containment should be the same types and in similar rank order as in the make-up air but at a lower concentration**
 - **If *Asp/Pen* in the make-up air?**

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If *Asp/Pen* was present in the make-up air, then it should be at a similar or lower concentration in containment.

2. AFU off, wall cavity sealed, containment sealed

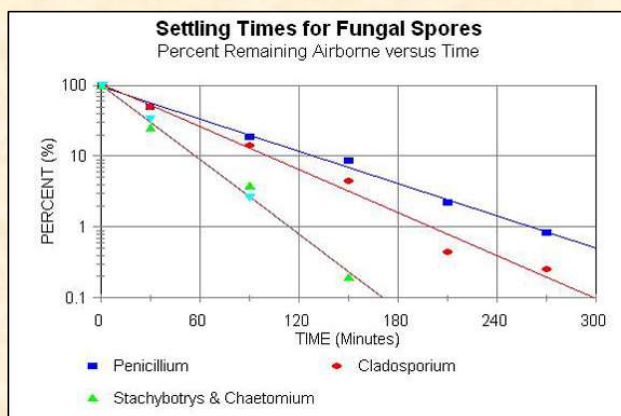
“Quiescent” PRV Criteria?



Spores
settle out

Quiescent Containment

8' x 10' x 8' Chamber



Florence Wu, Ph.D., Aemtek, Inc.; Fremont, CA

99% settling of *Stachy* spores in an undisturbed environment is less than 2 hours; *Asp/Pen* spores in less than 5 hours

Criteria: Detection of only nominal amounts of "indicator spores" after 8 hours or more of settling time

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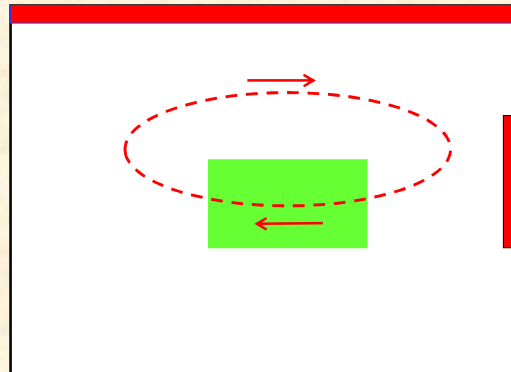
An 8 ft by 10 ft chamber with an 8-ft ceiling height. Settling time of 300 minutes or 5 hours. Starting concentrations were 100% and decreased to just a little more than 0.1% of the initial concentration during that time. All the spore types essentially "completely" settled during that time period in an undisturbed, quiescent environment.

Criteria 2

- **Containment sealed & “quiescent” for some time**
 - **No negative pressure**
 - **Quiescent conditions, so shorter settling time**
 - **Five hours or longer prior to sampling**
- **Expect “low” total spore counts with “nominal” concentrations of *Asp/Pen* detected**

3. Containment sealed, wall sealed, AFU re-circulating (“Scrub Mode”)

“Scrub Mode” PRV Criteria?



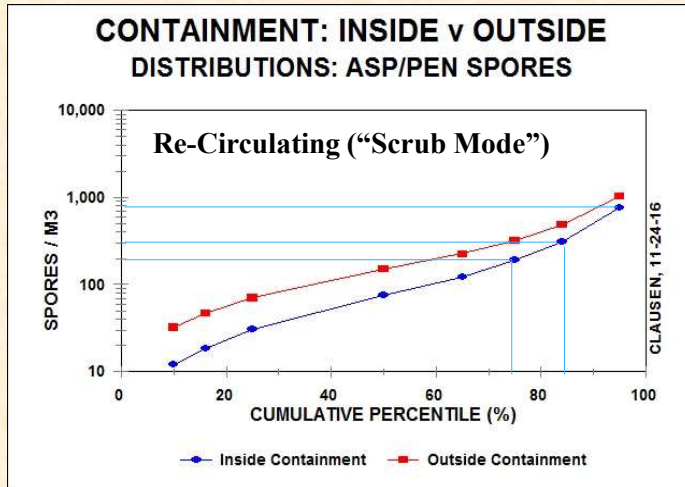
Aggressive
Conditions

Spores don't
settle out

32

This configuration is isolated from the adjacent room, so rank order analysis or indoor/outdoor comparisons are not appropriate. The “criterion” has to come from within the containment or from prior experience.

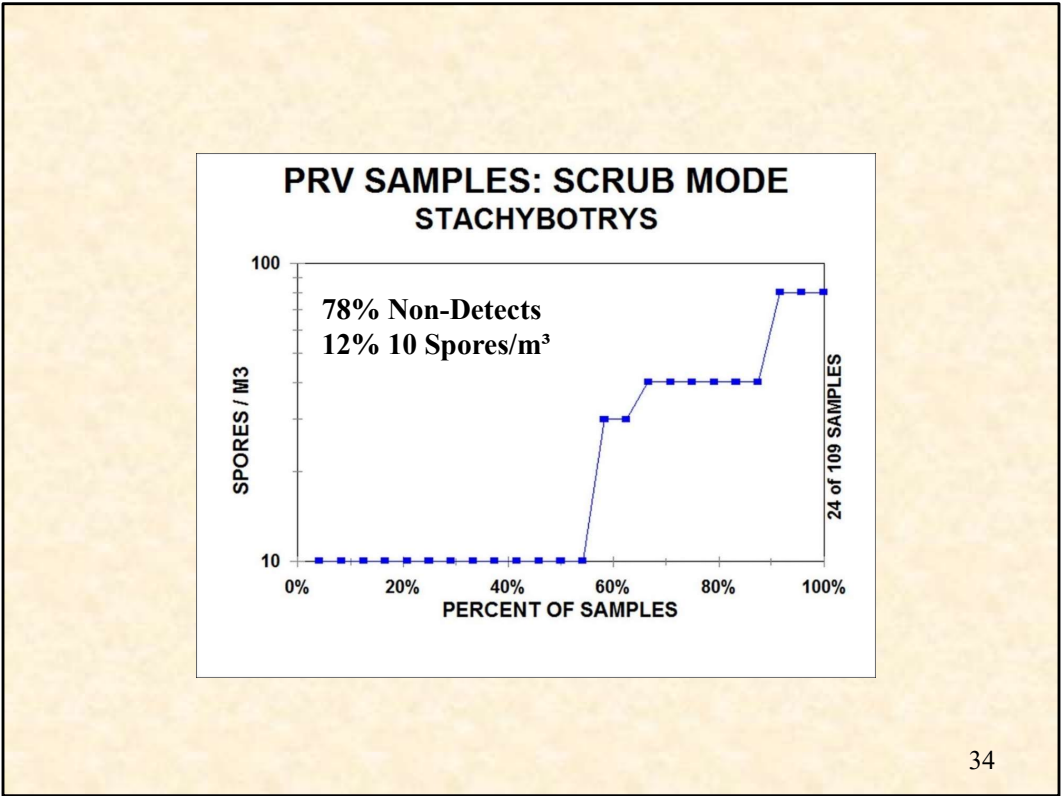
Recirculation Criteria



Criteria: Avg = 200 Sp/m³; Elev => 300 Sp/m³; 95% < 800 Sp/m³

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This is the distribution of Asp/Pen concentrations from sampling about 90 mold remediation containments while in scrub mode. The median concentration was 70 spores/m³ and the average concentration was 200 spores/m³, with 300 spores/m³ one standard deviation above the median concentration. Based on these 90 remediations, which were performed by different Contractors, the Expected Range of Asp/Pen spore concentrations would be 300 spores/m³ or less.



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78% of 109 Stachybotrys samples were nondetects, 12% were 10 spores/m³, and the remaining 10% of the samples ranged from 30-80 spores/m³. The expected concentration of Stachybotrys was Nondetect.

Criteria 3

- **Containment sealed and AFU in scrub mode**
 - **No negative pressure**
 - **Aggressive conditions**
- **Expect “moderate” total spore counts with concentrations of *Asp/Pen* in an “expected range”**
 - **200 Sp/m³ to 300 Sp/m³ or less**

Post-Remediation Acceptance Criteria for Airborne Mold Spores

- **We may not want to think in terms of a single “clearance criterion” for airborne mold samples**
 - **The “clearance criterion” may depend on the configuration of the containment**
- **The “clearance criterion” can, and should, be adjusted to accommodate the**
 - **Configuration of the containment**
 - **Aggressive or quiescent conditions in the containment**

Containment Configurations and Criteria for Assessing Airborne Samples



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