

# Moving Beyond “Is it Mold?”

Sophia Kapranos, Industrial Hygienist



Smithsonian Facilities

Nora S. Lockshin, Senior Conservator



Smithsonian Institution Archives



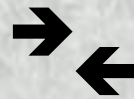
# Smithsonian Affiliations

## Visiting Professional – a Fellow for All Reasons

Laura Wahl, Library Conservator

Hagley Museum and Library, Wilmington DE

- Short-term, focused, motivated professional.
- Matched needs





## Smithsonian Affiliations

Visiting Professional –  
a Fellow for All Reasons – Mutual Goals

### Hagley Museum and Library

- Identification
- New methods of control, conservation treatment and mold remediation



+



➔ **PRODUCT**

### Smithsonian Institution Archives

- Identification & Viability
- Practical implementation of control and mold remediation
  - Cost baselines
  - Tools/Resources
  - Disaster planning
- Stakeholder education
  - Right to Know (Staff & Users)
  - Responsible Collection Management



# Smithsonian Affiliations

## Visiting Professional – a Fellow for All Reasons

*“Increase and diffusion of knowledge for all....”*

[siarchives.si.edu/blog](http://siarchives.si.edu/blog)

The screenshot shows a web browser window with the URL [siarchives.si.edu/blog/conserving-archival-collections-suffering-fungal-attack](http://siarchives.si.edu/blog/conserving-archival-collections-suffering-fungal-attack). The page features a navigation bar with 'COLLECTIONS', 'SERVICES', and 'SMITHSONIAN HISTORY'. Below this is a banner for 'THE BIGGER PICTURE' with the tagline 'Exploring Archives and Smithsonian'. The main article title is 'Conserving Archival Collections Suffering from Fungal Attack' by Laura Wahl, dated July 26, 2016. A secondary article is highlighted with a white box: 'The Mold...RETURNS! (Mad Scientist edition)' by Nora Lockshin, dated November 1, 2016. This article includes a sub-header 'Offscreen, a spooky laugh is heard...' and a paragraph: 'Welcome back horror fans! 'Tis another Halloween edition here on the blog, and try as we might, we just can't get rid of our fiend friend, The Mold, now can we? Inasmuch as we try to avoid it, we also can't quite help from falling in love with our fungal revenants. They're so clever! And even beautiful, to some eyes.' Below the text is a photograph of a germination test showing mold growth on a surface. A caption below the photo reads: 'Germination test of deaccessioned moldy material, exposed to high humidity and warm temperature (70-80F) over approx. 17 days. New growth is visible under microscopy at day 17. (25 & 100x). Courtesy of Nora Lockshin.'

# WHY identify?

*“It is essential to know - if what you think is a fungal infestation is not a wax bloom, crystalline chemicals, dust fibers, food debris, paint or ink splatter, etc.”*

Mary-Lou Florian (2012)

Conidia, ascospores, ascocarps and ethyl alcohol.

- Microscopy may be enough for a conservator to consider treatment, with ethanol based solutions, or outside vendor approaches.
- ✓ Worker protection
- ✓ Regulatory compliance
- ✓ Targeted remediation plan / decision-making
- ✓ Quality assurance



# Methods to identify

- Conservator + Industrial Hygienist
  - Visual identification/Microscopy
  - Culturing for viability = **\$0-10**
  - ATP bioluminescence (swab + analyzer) = **\$2,000+**



(Initial investment)

- Conservator + Industrial Hygienist + External Lab *per test*
  - Microscopy/spore count (Genus level) = **\$40-50**
  - Culturing for swab, air, bulk, and dust samples = **\$100-150**  
(genus-speciation)

# WHY culture and speciate?

*“Culturing is not always conclusive. Some fungi require a specific environment and are unculturable, some are viable conidia that are airborne recent contaminants, some may be dead fungal structures, many infestations are of mixed species.”*

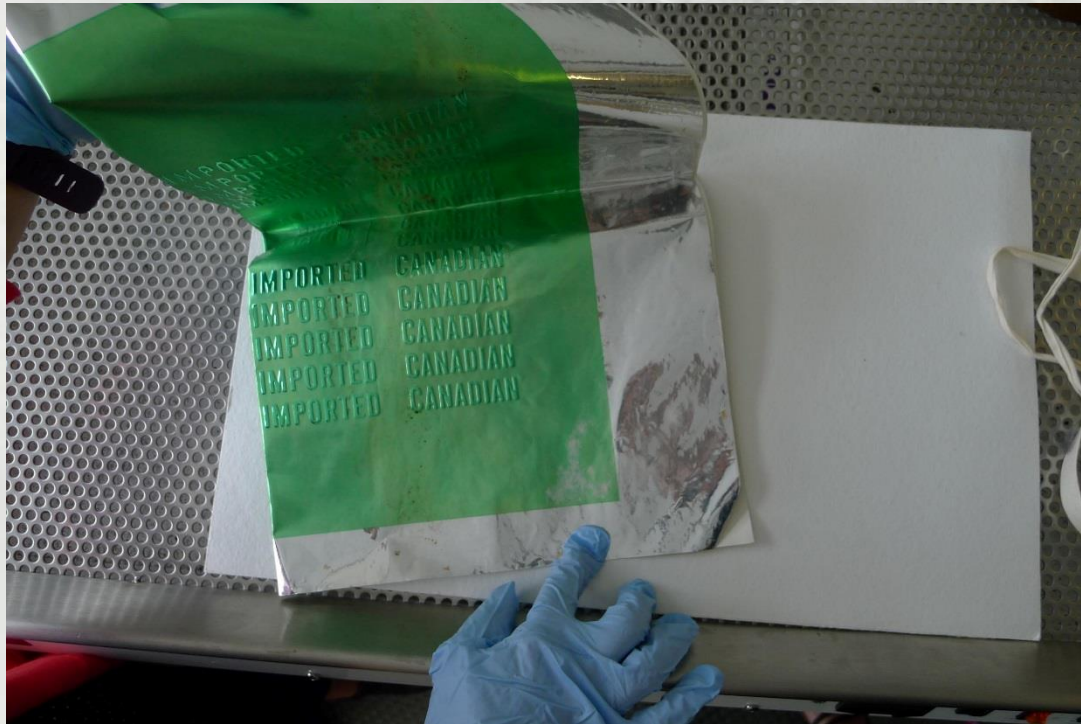
Mary-Lou Florian (2012)

Conidia, ascospores, ascocarps and ethyl alcohol.

- Determine vulnerabilities or persistence of the species
- Determine efficacy of remediation after treatment (*new or recurring species?*)
- Provide information for worker health monitoring program, or for physicians working with an affected worker.

# Sampling subjects

## Hagley Museum and Library



## Smithsonian Institution Archives





# Culturing subject

## Smithsonian Institution Archives

- Low-tech, low cost (in-house)
- Can determine viability
- **False positives** possible



17 days @  
high RH  
70-80F



# In-house culturing with lab/vendor support

- Low-tech, low cost
- Yes/No + colony count
- **False positives** possible
- Yeast & Mold – non-specific
- Wet wipe sample – *potentially destructive*



HPC Sampler

Contains m-HPC medium for recovery of "stressed" aerobic bacteria (i.e. partially sanitized or nutritionally starved).



Coli-Count™ Sampler

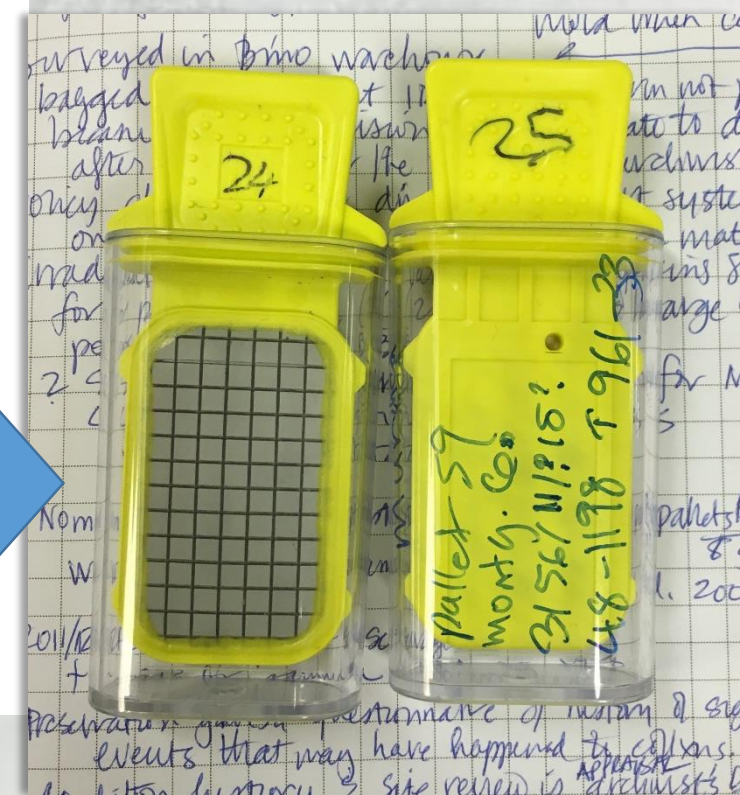
A "Total Count" of coliforms. Contains a proprietary coliform medium for recovery of coliform organisms.



Yeast & Mold Sampler

Contains m-Green medium for recovery of yeast and mold.

= **\$10/test**  
(25/pk)





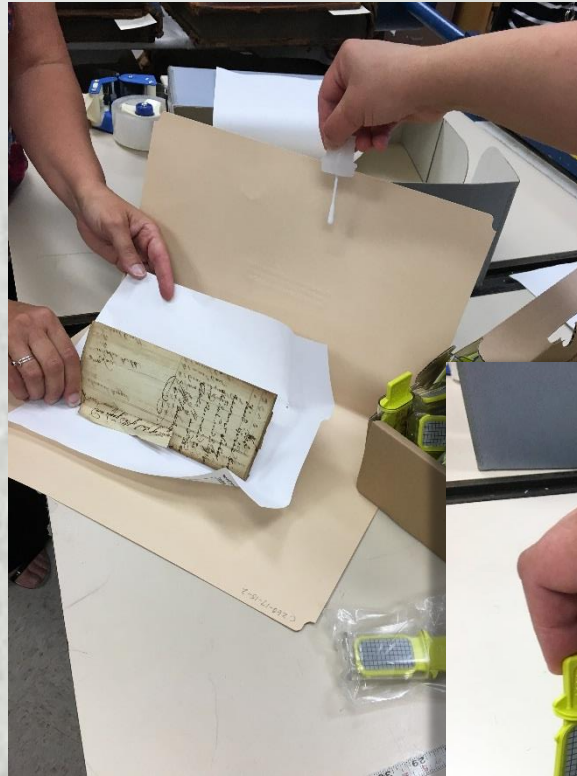
# Culturing for Monitoring @ MdSA

A collection assumed to be biocontaminated from floodwaters

Gamma irradiated by vendor

In-house wipe samples after treatment

- Quality Assurance determination
- Preventative Conservation / Monitor for reoccurrence
- With/without lab support services

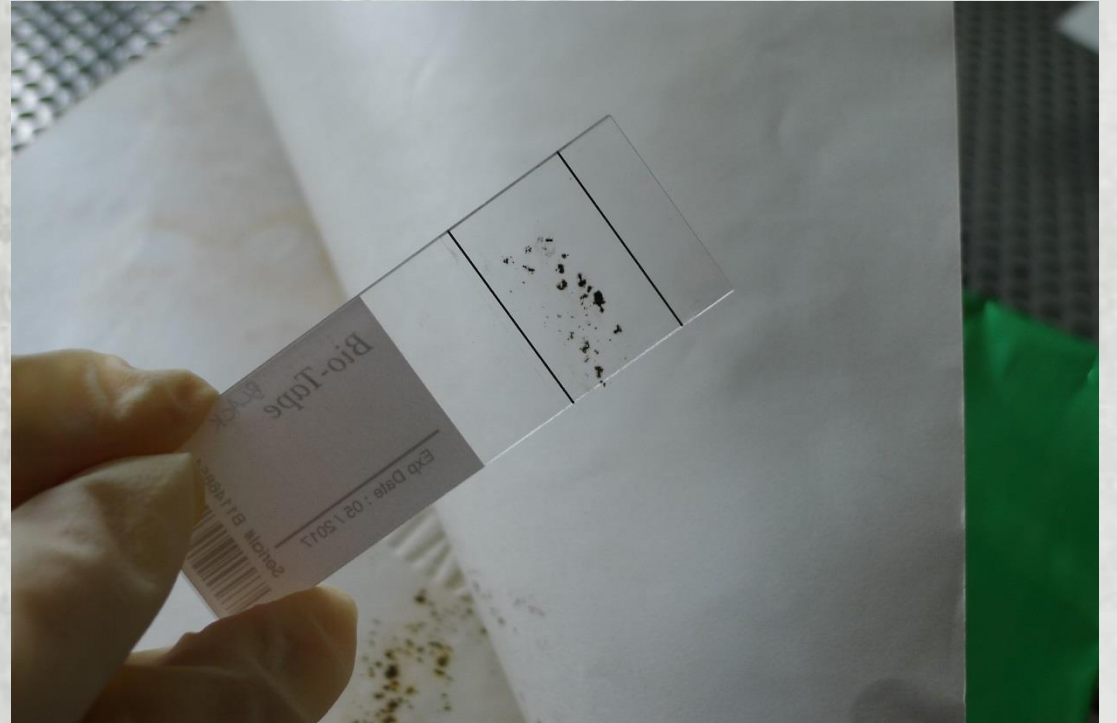


Gamma irradiation = \$91,500  
QA ≈ \$250



# Sampling at Smithsonian (+ vendor for analysis)

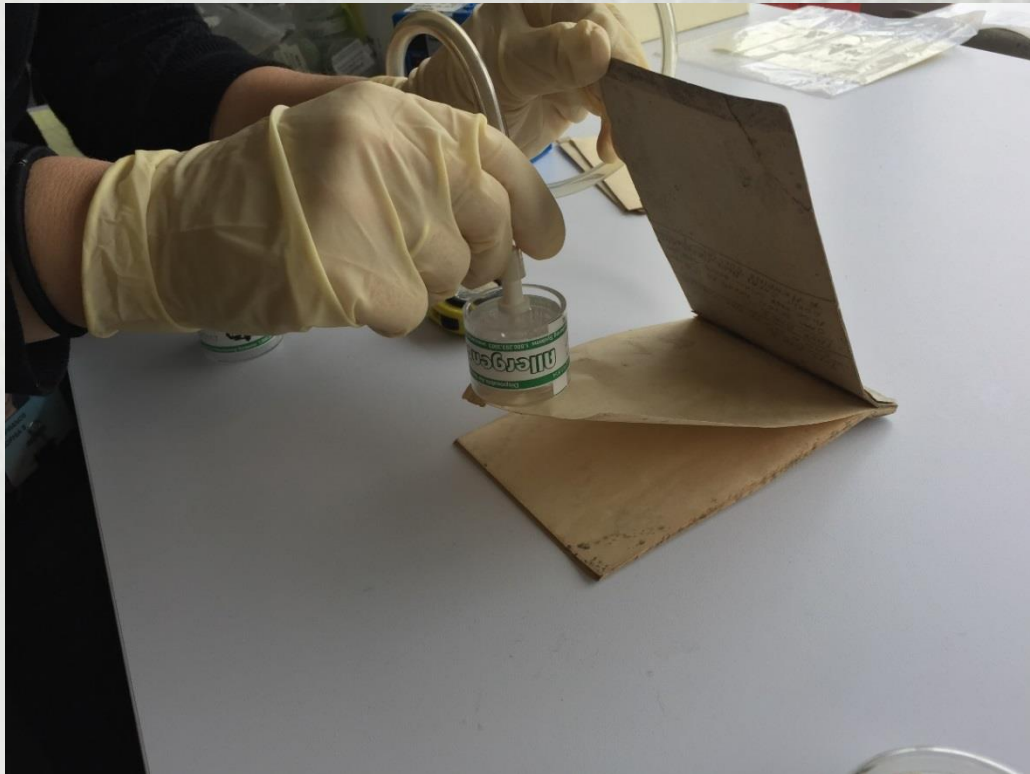
**Tape lift (vendor supplied glass slide, or plain clear tape)**



# Sampling at Smithsonian (+ vendor for analysis)

## Vacuum Air Sampling

*Note suction force on unrestrained object*



*versus mounted/restrained surface*



# Treatment at Smithsonian

## *Internal*

- IH Group:
  - Training re: Safety (PPE and Engineering Controls)
- SI Conservator
  - Can offer scaled remediation training & lab support
  - Consult (collection level)
  - Treat (item level)



CFCH RRFA's Greg Adams uses SIA lab facilities to process and surface clean moldy collections.



Video excerpt. Smithsonian Institution Archives. Nora Lockshin reducing mold on the Nat Turner Bible, NMAAHC 2011.28.

# Treatment at Smithsonian

## *External*

- Disaster services Contractor/  
Vendor
  - Freeze dry / disaster services
  - Vacuum / surface clean
  - Gamma irradiation
  - Electron beam radiation
- Independent conservator/regional conservation group



Mille Lacs Band of Ojibwe Archives Mold Remediation. Minnesota Historical Society & Midwest Art Conservation Center. Grant funded.

=**\$9,694**

# Setting up safe protocols

## Why do we want it?

- For assessment
- For treatment
- For disaster response
- For storage
- For **access** to known/potentially hazardous objects

## How do we do it? **Best Practice.**

- Education
- Inclusion in collection management database
- Right to Know documents
  - Information sheets
  - Job Hazard Analysis
  - SOPs
  - Warning labels (~ HazComm)



# Setting up safe protocols

- for Staff (including interns, volunteers)
- and External Researchers
- External Researchers access collections in reading & study rooms
- Precedent for HazComm to external stakeholders: NMAI

**NATIONAL MUSEUM OF THE AMERICAN INDIAN**

VISIT EXPLORE SUPPORT CONNECT SHOP

Home » Explore » Collections » Conservation » Pesticides

**Exhibitions**

**Collections**

- Search Online Collections
- Object Collections
- History of the Collections
- Significance of the Collections
- Moving the Collections
- Accessing the Object Collections
- Archive Center
- Repatriation

**Conservation**

- Outreach
- Training
- Research
- Staff
- Pesticides**

**Cultural Resources Center**

**Contact Collections**

**Education**

**Film & Media**

## Pesticides

- [What are pesticides?](#)
- [Why were pesticides used?](#)
- [How were pesticides applied to objects?](#)
- [What are current pest management techniques?](#)
- [Repatriation and pesticides](#)

### WHAT ARE PESTICIDES?

Pesticides are poisons or toxins used to kill pests by entering the organism through dermal contact (skin), oral ingestion (mouth), or inhalation (nose or mouth). Commonly, pesticides are divided into organic and inorganic pesticides according to their main chemical component.

**Organic pesticides**

Organic pesticides are carbon-based compounds that include pesticides such as Naphthalene and Paradichlorobenzene (PDB), two chemicals commonly known as mothballs. Naphthalene and PDB are applied as a solid (in mothball and flake form) and sublimate, acting as a fumigant. The fumes from these materials kill insects and work best in tightly closed spaces. The pesticide residue is expected to evaporate over time. Old collections often smell of these pesticides and it is not clearly understood how long it takes for the chemicals to completely sublimate in the museum environment.

**Inorganic pesticides**

# Setting up safe protocols

models @ Library of Congress and National Archives and Records Administration

## Library of Congress Preservation Directorate, Collections Recovery Room

- Dedicated workspace for recovery of wet or formerly wet collections.
- Stocked with supplies, equipment & engineering controls
- Serves all intramural units
- SOPs define training in PPE & equipment, actions from response to disposal, collection movement, warning labels



# Future



Smithsonian Facilities

+



Smithsonian Institution Archives



# PRODUCTS

## Job Hazard Analysis

- For Staff

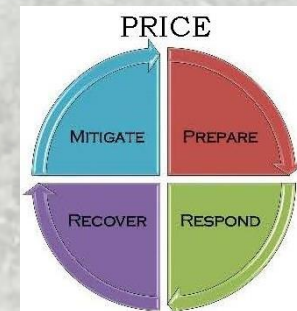
## Visual guide / information sheet

- For Staff
- For External Researchers

## Resource summary for Disaster Implementation guides

- vendors, types, steps, cost estimates
- ✓ SIA
- PRICE

## Preparedness and Response in Collections Emergencies (PRICE)



- IDIQ & SoWs for disaster services w/OCON
- JHAs; training w/ SF-OSHEM

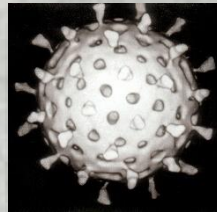
A dense field of green grass, slightly out of focus, with white text overlaid in the center. The text consists of two lines: the first line is "{Intermission}" and the second line is "EVERYBODY STRETCH!".

{Intermission}

**EVERYBODY STRETCH!**

# Microbial Classifications

- ❖ Fungi
  - ➔ Mold & Mushrooms (multicellular)
  - ➔ Yeasts (single-celled)
- ❖ Bacteria
- ❖ Viruses
- ❖ Algae, amoebas, protozoa, etc.
- ❖ Dust mites (common allergens, needs water to reproduce)



# Microbial Sampling Methods

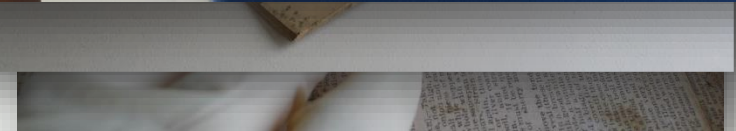
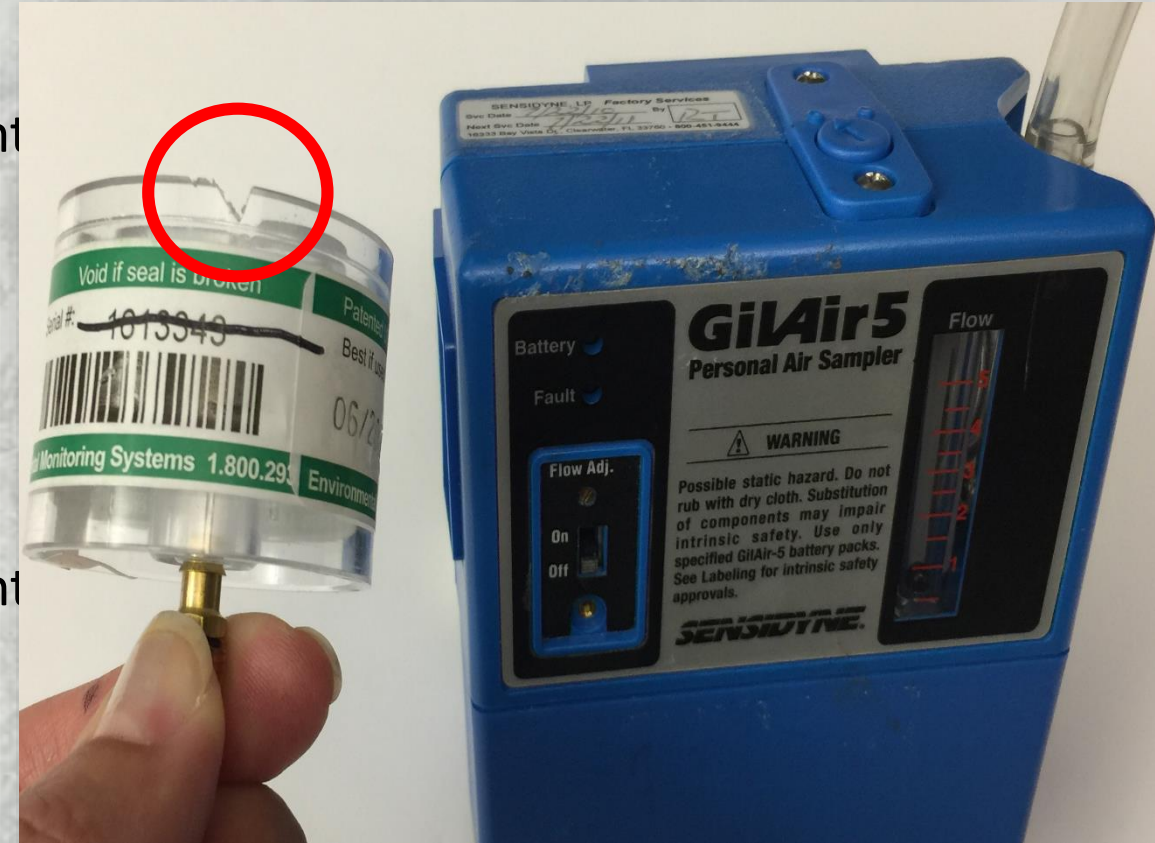
## Smithsonian Institution Archives Paper Conservation Lab

### ❖ Surface Tape-Lift Samples

- Direct microscopy: spore count & genus identification  
**(used this method)**
- Cultured: incubation & speciation

### ❖ Surface Vacuum Dust Samples

- Direct microscopy: spore count & genus identification  
**(used this method)**
- Cultured: incubation & speciation



# Additional Microbial Sampling Methods

- ❖ Surface swabs
- ❖ Bulk samples: culturable (species or genus level)
- ❖ Area or personal air sampling: culturable (species or genus level) or direct microscopy
- ❖ Water samples
- ❖ ATP Bioluminescence direct-reading meters  
Relative Light Units (RLUs)
- ❖ Merck Millipore's Samplers and Swab Test Kits
- ❖ IR thermal camera & moisture meter



# Microbial Remediation Methods

\* **Eliminate water source** (e.g., repair water leak, lower humidity)

Drying water damaged material within 48 hours will likely prevent microbial growth.  
Remediation methods if microbial growth is observed:

- ❖ Air Drying: fans, dehumidifiers
- ❖ Freezing: < 0°F ~24 hours
- ❖ Wiping/spraying: antimicrobials/biocides, 70% ethyl alcohol, isopropyl alcohol, etc.
- ❖ Gamma Irradiation: can “melt” objects
- ❖ HEPA Vacuums
- ❖ Specialized abatement companies
- ❖ Vulcanized smoke sponge



# Personal Protective Equipment (PPE)

## ❖ Handling Small Objects

- Disposable gloves
- Dust mask/filtering facepiece
- Eye protection/goggles

## ❖ Handling Large Objects

- Disposable gloves
- Dust mask/filtering facepiece or Air purifying respirator
- Eye protection/goggles
- Protective clothing (e.g., Tyvek®)

- ❖ **NOTE:** OSHA's regulations for voluntary dust mask use. 1910.134 Appendix D

# OSHA 1910.134, Appendix D



UNITED STATES  
DEPARTMENT OF LABOR

f t i r e

Occupational Safety and Health Administration

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[Regulations \(Standards - 29 CFR\) - Table of Contents](#)

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** I
- **Subpart Title:** Personal Protective Equipment
- **Standard Number:** [1910.134 App D](#)
- **Title:** (Mandatory) Information for Employees Using Respirators When not Required Under Standard.
- **GPO Source:** [e-CFR](#)

**Appendix D to Sec. 1910.134 (Mandatory) Information for Employees Using Respirators When Not Required Under the Standard**

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

[89 FR 1192, June 6, 1974; 89 FR 26836, April 23, 1974]

# Proper Handling & Engineering Controls

## ❖ Proper Handling

- Wear appropriate PPE
- Disinfect surfaces or use disposable surfaces (e.g., unprinted newspaper, sheets of poly/plastic)
- Store in airtight containers

## ❖ Portable air purifiers with HEPA filter and UV lamp

## ❖ Dispose contaminated material in airtight bags the same day

## ❖ Engineering Controls

- Chemical/fume or snorkel hoods
- Portable air purification unit with HEPA filter & UV lamp



# Mold Prevention

- ❖ Climate controlled storage environments
- ❖ Low humidity (relative humidity < 40%)
- ❖ Circulated air
- ❖ Store objects off the floor
- ❖ Routine HVAC maintenance (e.g., replace filters, duct cleaning)
- ❖ Do not introduce contaminated objects into “clean” environments
- ❖ Store contaminated objects in airtight containers

# With thanks

Laura Wahl, Hagley Museum and Library

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Washington Conservation Guild

The Potomac Section of the American Industrial Hygiene Association

Richard Wright, Smithsonian Institution's Office of Safety, Health & Environmental Management

Photos: courtesy of Sophia Kapranos & Nora Lockshin unless otherwise noted.

Background image: Thomas Bresson [CC BY 3.0], via Wikimedia Commons